International Journal of Basic and Applied Sciences

(A peer reviewed International Journal)

Production and Characterization of Biogas obtained from Sugarcane leaves (*Saccharum species*)

International Journal of Basic and Applied Sciences, Vol. 1 No. 3. pp. 258-262 2277-1921. 2012

ISSN *2277 – 1921*

Article type *Full Length Research Article*

Submission date *24 May 2012*

Acceptance date *10 July 2012*

Publication date *15 July 2012*

Article URL *http://www.crdeep.com/category/ijbas*

Authors *[*1,2]Mokobia, K., [2]Ikhuoria, E. U., [3]Olugbemide, D. [4]Omorogbe, S. O.*

International Journal of Basic and Applied Sciences Vol.1 No.3. 2012. Pp. 258-262

Full Length Research Paper

Production and Characterization of Biogas obtained from Sugarcane leaves (*Saccharum species*)

[*1,2]Mokobia, K., [2]Ikhuoria, E. U., [3]Olugbemide, D. [4]Omorogbe, S. O.

[1.] *Science laboratory Technology, Delta State Polytechnic*
[2.] *Department of Chemistry, University of Benin*
[3.] *Auchi Polytechnic*
[4.] *End Use Division, Rubber Research Institute of Nigeria*

Correspondence Author: [4] ***Omorogbe, S. O***

Abstract

Experiments on production and characterization of biogas from anaerobic digestion of sugarcane leaves (*Saccharum species*) were conducted in laboratory-scale batch digesters. The substrate was charged into the digesters at various dilution ratios (1:1 to 1:5) at mesophilic temperature range for a period of 14 days without pH control. Dilution ratio of 1:2 was found to be optimum with cumulative biogas yield of 239.40ml. Methane content of biogas was 20.73%, carbon dioxide was 1.23% while hydrogen sulphide was 0.02%. Overall, this study provides the bases for more research work on the potentials of sugarcane leaves for biogas production.

Keywords: *Sugarcane leaves, Methane, Biogas, Dilution ratio*

Introduction

The place of energy in any nation's development cannot be overemphasized. The reasons being that industrialization and development of any nation is dependent on adequate availability of energy. The inadequate supply of energy results in serious economic and social difficulties. The cost of energy for domestic and industrial use in Nigeria today has risen significantly following several reforms in the oil and energy sector.

Recently, emphasis has shifted to generation of energy from substances otherwise referred to as waste. Of all these alternatives, energy generation from agricultural wastes gains prominence because of its availability, renewability, lesser cost and reduction in the volume of the ultimate waste (Asani, 2008). Biogas is one form of energy which can be generated from agricultural wastes. The term is used because biogas is produced by anaerobic digestion or fermentation of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material and energy crops (National Non-Food Crop Centre)---improper referencing.

Surgarcane (*Saccharum species*) is one of the major agricultural crops cultivated in Nigeria. Each tonne of raw sugar cane production is associated with the generation of 250kg dry weight of cane leaves residue after harvesting. These leaves are usually discarded or burnt off. Thus the technology of biogas generation particularly from sugarcane leaves if feasible and properly explored will go a long way to ameliorating the problem of energy generation, environmental waste disposal and to a great extent the problem of unemployment (Ejukonemu,, 2009).

This study is aimed at assessing the feasibility of biogas production from sugarcane leaves and ascertaining the quality of biogas produced.

Method

Sample Collection / Preparation

The sugar cane leaves were collected from a farm in industrial development centre (IDC) Staff quarters, Evbuotubu in Egor Local Government Area, Edo State.

The leaves were chopped into smaller sizes and sun-dried for a period of two weeks. The dried leaves were pulverized using an electrical grinder. The pulverized samples were stored in air tight containers in preparation for biogas production

Biogas preparation

Biomass- water ratio of 1:1, 1:2, 1:3, 1:4 and 1:5 were used during the experiments. The set-up consists of a Buckner flask (250ml) as a biodigester, connecting tubes for flow out of biogas produced, a water trough containing beehive shelf and a measuring cylinder. The set up is as shown below:

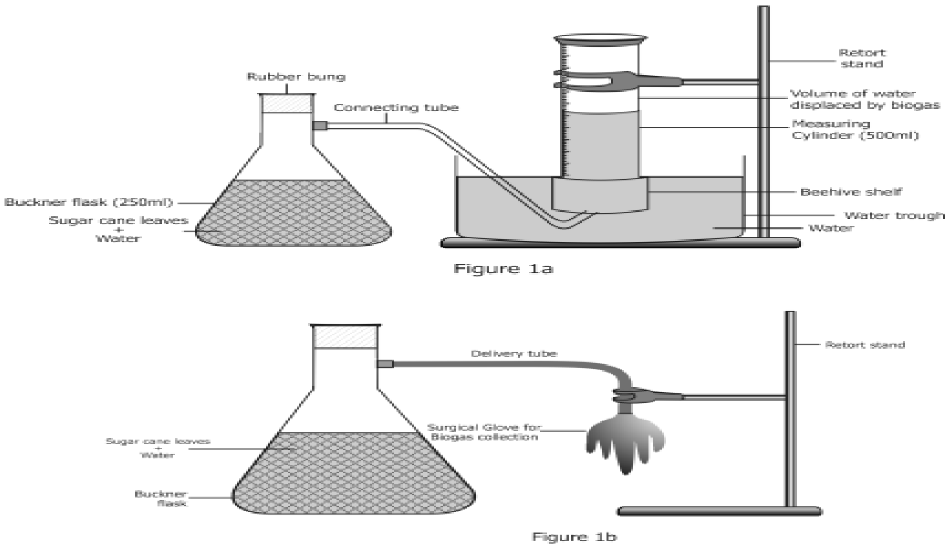


Fig 1. Set up for biogas production from sugar cane leaves

50g each of the pulverized sugar cane leaves were measured, weighed and placed into five different well stoppered Buckner flasks. Different volumes of water were used, namely 50.0ml, 100.0ml, 150.0ml, 200.0ml and 250.0ml respectively. These correspond to the dilution regime of 1:1, 1:2, 1:3, 1:4 and 1:5 in terms of substrate to water ratio. The research was carried out at ambient temperatures that varied between 28 and 30^{o}C, which represents mesophilic condition. The experiment was done in replicates, first to measure the volume of biogas produced (Fig 1a) and also for collection of the biogas produced for analysis Fig.1b.

In Fig.1a, the measuring cylinder was filled with water before being inverted over the mouth of the beehive shelf in the water trough. The volume of water displaced was taken as the volume of biogas produced by each dilution regime. The five bio-digesters were labeled A-E. Each experiment was carried at room temperatures for a period of 8days. The pH of the substrate was also determined before and after the collection of the biogas.

Analysis of sugar cane leaves

The moisture, organic carbon, organic matter, ash, nitrogen content, phosphorous content and calcium of the sugar cane leaves were determined using the method described by Association of Official Agricultural Chemists (AOAC, 1984). All determinations were in three replicates.

Characterization of the biogas using gas chromatography

The biogas composition was analyzed using a gas chromatograph (GC-6890 model) equipped with a thermal conductivity detector.

Results/Discussion

pH values of the samples are presented in Table 2. It is worthy of note that all the different dilution regimes had the same pH value before biodigestion process. However, the pH after digestion varied in the digesters with all becoming more acidic with the exception of A. The result of elemental analysis of sugar cane leaves shows a high concentration of organic matter and organic carbon with relatively low contents of phosphorus, nitrogen, potassium, calcium, magnesium and ash (Table 1). Concentration of substances obtained on elemental analysis is in the order: organic matter > organic carbon > ash content > potassium > Nitrogen > calcium > Magnesium > phosphorus in that order. High contents of organic matter and organic carbon indicate viable yield of biogas from these leaves.

The C:N ratio of the substrate was within the range suggested to optimal by Braun, 1982, namely between 20:1 and 30:1. He further stated that if there was too little nitrogen present in a feedstock, the bacteria would be unable to produce the enzymes which were needed to utilize the carbon. On the other hand, if there was too much nitrogen, it could inhibit the growth of the bacteria through NH_3 toxic concentration.

Table 1: Results from Elemental Analysis of Sugar Cane Leaves

Parameter	Values Obtained
% organic matter	25.008
% c organic carbon	14.464
% ash-Ash content	3.0
% K – potassium	0.832
% N – Nitrogen	0.683
% Ca – Calcium	0.497
% Mg – Magnesium	0.053
% P – Phosphorus	0.049
%total solid	19.07
% total volatile solid	78.5
C/N ratio	21.27

Table 2: pH of sugar cane leaves slurries

pH	1:1	1:2	1:3	1:4	1:5
Before digestion	6.00	6.00	6.00	6.00	6.00
After digestion	6.90	4.2	4.00	3.37	3.60

Volume of Biogas produced

Figures 1and 2 show daily biogas production and cumulative volume for a period of 14 days in the respective digesters A-E. The digesters A-E corresponds to the substrate water ratio of 1:1, 1:2, 1:3, 1:4 and 1:5 respectively.

There was no biogas production in biodigester A throughout the period of experiment. This may be as a result of insufficient amount of water in the sample to effectively aid the degradation process. The highest daily and cumulative volume of biogas was obtained in biodigester B with substrate-water ratio of 1:2, while the lowest was in biodigester E (1:5 ratio). Generally, the daily and cumulative volumes of biogas produced was dependent on substrate water ratio; maximizing at 1:2 and decreasing as the dilution regime increases. This is contrary to the findings of Olugbemide et al., 2010 in their work on Elephant grass in which substrate-water ratio 1:4 produced the highest biogas. The volume of biogas produced by the digesters with respect to substrate-water ratio was found to be of the order: 1:2>1:3>1:4>1:5 corresponding to the order B>C>D>E>A respectively. Also there was no lag phase in production as the biodigesters started producing after the first day and continued subsequently.

It was observed that the daily volume of biogas produced decreased daily until there was no production in the biodigesters. This is expected since rate of reaction generally decreases with time due to decrease in concentration of active substrates. Biodegesters D & E stopped production after 6 days while B and C stopped production on the 7th day. After the seventh day, no volume of biogas was produced by any of the biodigesters.

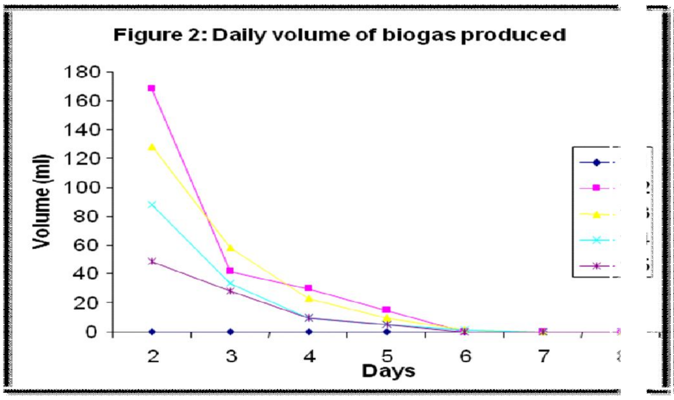
Characterization of the Biogas Produced

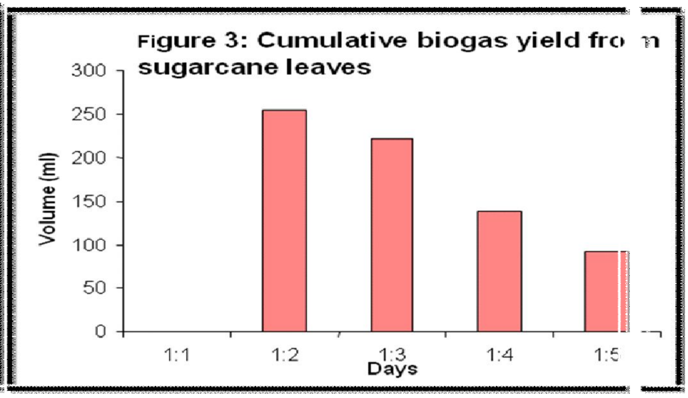
The results of characterization of the biogas produced (table 3.4) shows a higher yield of methane (20.73%) gas to other usual components of biogas such as CO_2 (1.234%), H_2S (0.02%). The methane content compared favourably with 21.70% reported for Eichhornia crassipes by Pereira et al., 2011 after 14-day anaerobic digestion.

However, high nitrogen gas content seems to be associated with the biogas produced. The presence of nitrogen gas in the biogas produced may be due to the method of biogas collection, by employing the use of balloon. This could give room for contamination by atmospheric gases of which nitrogen is a principal content. However, some sugar cane varieties have been reported to be capable of fixing atmospheric nitrogen in association with the bacterium glucoacetobacter diazotrophicus (Yamadu et al, 1998). This is unlike legumes and other nitrogen fixing plants which form root nodules in the soil in association with bacterium G diazotrophicus which lives within the intercellular spaces of the sugar canes (Dong et al 1994, Boddey et al 1991)

Table 3: Quality of biogas from sugar cane

Parameters	**Value**	**Agip Standard**
	Values, Mol.%	**Values, Mol. %**
Methane (C_1)	20.73	96.93
Ethane (C_2)	0.28	2.55
Propane (C_3)	0.00	0.40
iso-Butane (iC_4)	0.00	0.00
n-Butane (nC_4)	0.00	0.00
Iso-Pantane (iC_5)	0.00	0.00
n-Pentane (nC_5)	0.00	0.00
Hexane plus (C_6+)	0.00	0.00
Hydrogen Sulphide (H_2S)	0.02	0.00
Oxygen O_2	10.30	0.00
Carbon Dioxide (CO_2)	1.234	0.000
Nitrogen (N_2)	67.75	0.13
TOTAL	**100.32**	**100.00**





Conclusion

The result from this analysis shows that sugar cane leaf is a potential source of raw material for biogas production. The methane content is relatively high and encouraging compared to the other common contents of biogas e.g. CO_2, H_2S etc.
However, difficulties associated with method of gas collection in the laboratory tend to introduce atmospheric gases such as nitrogen and oxygen in such quantities to reduce the technical parameters of the gas obtained.

References

AOAC, Association of Official Agricultural Chemists, 1984. In: Williams, S. (Ed). Official mthods of Analysis. 14th Ed, AOAC. Arlington. VA

Asani, P.V. (2008). Modernization of solid waste management practices in Bangalore City. Technical Report.

Braun, R. (1982). Biogas methane garung organischer abfallstoffe. Springer-Verlag Wien, New York.

Ejukonemu, F.E. (2009). Entrepeneurship in Biogas technology implication for National Development. Nigeria Journal of Industrial and Technological Research. Volume 1, No. 2 p. 49

Olugbemide, A.D., Ufuah, M.O.E., Igbonazobi, L.C. and Osula, J.E. (2010). Effect of Alkaline Pre-treatment on Anaerobic Batch Digestion of Elephant Grass (Pennisetum purpureum). Journal of Chemical Society of Nigeria, vol. 36 (1): 176-179.

Pereira, R.G., Pereira, M.D.E., da Silva, J.G., de Abreu, F.L.B. and Lameira, V. 2011. Production an characterization of biogas obtained from biomass of aquatic plants. International conference of renewable energy and power quality. Las Palmas de GGran Canaria, Spain.