THE POTENTIALS OF SUGAR CANE BITES ASASOURCE OF BIOGAS (METHANE)

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ABSTRACT: *The demand and cost of domestic energy in Nigeria is on the increase, primarily due to increasing human population and demand. This is compounded by desertification, increasing cost of electricity, industrialization, lack of alternative such as solar, wind and nuclear energy. Biogas generation and methenation from waste material is on the increase, and a potential means of alleviating the increasing demand for domestic energy. In this study, attempt was made to use sugar cane waste (bites), which is a slight deviation from the traditional use of cow dung as substrate for biogas generation. Emphasis was put on the volume of gas produced per unit volume of sugarcane bites per unit time. The study was carried out in the Department of Biological Sciences, University of Maiduguri, Nigeria, between the month of May and August, 2006. The batch-fed digestion method was used in which 12kg of partially decomposed sugar cane waste was mixed with 10,000cm^3 of water and 2000 cm^3 of chicken droppings (as inoculant) in an air-tight digester to allow for the anaerobic digestion of the substrate over a period of 50 days. The result revealed a maximum gas production after 24 hours reaching a peak of 330999,33 cm^3 (0.331 m^3) after seven days of loading at a PH of 8.2 and temperature between 29^{o}C and 44^{o}C. This value fluctuated between zero (0) and 330979.33 cm^3 up to the 50th day. The result of this study, thus, demonstrates that sugarcane bite, when composted and particle size reduced to 4cm is good source of biogas. The technique provides domestic rural fuel in addition to environmental sanitation. The end product of the methane (CH_4) generation i.e. the slurry is 90% nitrogen, which can serve as bio- fertilizer for organic agriculture.*

KEYWORDS: Sugar Cane, Biogas (Methane), Domestic Energy, Population Nigeria

INTRODUCTION

All over the world the most acceptable and useful source of energy comes in the form of commercial or non-commercial energy. The readily forms of such energy includes, petroleum, natural gas, kerosene, electricity, solar and nuclear energy, while coal, fossil fuel and fuel wood as non-commercial energy. Other forms of energy which are least utilized includes seaweeds, cow dung plant wastes and by-products.Yahaya and Ibrahim (2012) observed that in most developing countries like Nigeria recycling of agricultural products into useful products is rarely practiced. This has led to environmental problem such as pollution resulting into heaps in our streets and drainage causing floods due to blockage on rainy days.

The exponential demand for energy is a consequence of a number of factors, among which are increasing world population growth, increasing level of income, petroleum and certain energy sources are limited with basement shift to renewable energy sources(solar and nuclear energy), industrialization and agricultural farm power.

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The developed nations consume more of commercial energy than fuel wood or organic material based energy sources. The United States with only 6% of the world's population consumes about 30% of the world's current energy use, Oelhaf (1978), while the United Nation's statistics (1972) indicated a higher value of about 38% of the world fuelwood. The developed country put together utilizes only 1% of fuel wood to their total energy consumption. The developing countries consumes about 20%-75%,United Nation Statistics(1972)86% as indicated by FAO(1973).The overall world consumption of fuel wood to commercial energy is 6% based on total energy consumption as indicated by the United Nation (1973), while it is 52% based on world population IBRD(1973).

Other cheaper and less utilized sources of fuel, especially in the developed world, which serve as good alternative and high energy value in the rural areas of the developing world are the use of grasses, cornstalk, rice straw or rice hull, cocoanut shell and Cyprus(Oelhaf 1978) etc. others include wet organic matter like the Giant Ocean Kelp(IDYLL1971) and animal excrete which contains about 1 to 1.5kg of dry matter per 100kg of live body weight (1kg(o m) = 4500kcal). In India cow dung and agricultural waste accounts for 22% and 34% respectively of their energy sources. The ocean kelp (weed) is a potential energy source Stout (1981). Another waste material that serve as good source of rural energy is the rice hull(husk). Yerima and Richard (2012) indicated that1000g(1kg) of rice hull with 5% adhesive moisture was more efficient in heating the cooking surface than when the moisture content was between 10-20%.Similarly Hugan (1994) in Vietnam reported that 1.5kg of rice hull can boil 1litre of water in 5mins when used in the product fuel or the Vietnamese smoking kiln. The high consumption rate of fuel wood and other organic based energy sources amongst the developing world is as a result of increasing cost and demand of domestic energy, primarily due to several reasons which include: increasing human population, low income level, drought and desertification, increasing cost of electricity, industrialization, lack of patronage and technology of renewable source, such as Biogas (methane), solar energy, wind energy and nuclear energy. These problems are compounded by wasteful usage and Lack of alternative fuel. This effect is also indicated by the developed nations. The United States department of energy is currently working on a pilot project with the aim of producing fuel from energy farm for less than 1.00$ per million Btn/1b by the year 2000.

The associated problem of fuel wood consumption is compounded by African ecological problems of drought and desertification. The Nigerian National Petroleum Cooperation (NNPC) (1995), according to energy experts, the West African sub-region of Nigeria is the most populated, and accounts for one third of fuel wood usage in the world. The effect of this huge dependence on fuel wood as domestic energy for cooking has led to widespread desertification, erosion and its allied environmental hazards of pollution and emission in the atmosphere. Bdliya (1986), indicated fuel wood extraction and consumption in Sahelian countries has undoubtedly propelled the phenomenon of deforestation which enables the Sahara to encroach onto 650,000km^2 of Africa, once productive land in the last 50 years. This is because 95% of wood harvested in these places, like Nigeria is used as fuel wood.

Borno State is not an exception to the problem of drought and desertification coupled with the shortage of alternative sources of energy and high and consumption, all these at the mercy of fuel wood, the mother energy in the state. This situation is more severe in the rural arid zone around the Lake Chad and environs, particularly Marte where fuel wood is extracted and sent to various fishing and fish smoking camps.

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It has been estimated that between 50%-70% of Bauchi,Borno,Gombe,Jigawa, Kano,Katsina,Kebbi,Sokoto,Yobe,Adamawa and Zamfara States in Nigeria are being affected by desertification, National Action Plan(NAP)(2000). Biogas generation or methenation is primarily a means of rural energy production from the breakdown of organic waste material. This is followed by a secondary benefit like, the device to waste treatment and disposal of waste material from Intensive cattle rearing, reduced desertification, reduced environmental pollution, increased rural farmers income level from fertilizer, reduced pressure on women traveling a long distance in search of firewood and empowerment, increased soil fertility and reduction in poverty.

In the past cow dung has been the most reliable waste material for the generation of Biogas, since it harbours the methenogenic bacteria. It was observed that 0.5kg of animal manure can sustain a family in a day or 20 liters of methane can be derived from 1kg of refuse (Green et al, 1995), in the same vein, it was reported that one cow in a year produces manure which can be converted to methane equal to 227 liters of petrol (one cow/day is 0.622 liters) (Green et al, 1995). In another perspective, Letcher and Kolbe (1994) also observed that 1000kg of dry organic plant material can yield a maximum of 416m3 of methane. Similarly 25 liters of methane can generate heat energy of 890 kj/mol. Anon (1989) indicated that sugar cane is an annual crop produced by cultivation. Sugar cane (Saccharin officinarum) is a grass, the root system is fibrous and relatively shallow. The plant produces tillers (branch stem). Each stem consists of numerous internodes demarcated by prominent nodes. Sugar cane is greatly consumed in Borno state which is the study area. For instance, between the months of July and March of each year, the total import of sugar cane into Maiduguri is about8394.88 tons. Out of this, only the juice, which is about 5733.76 tons (68.3%) of the total import, is consumed leaving the rest (31.7%) as waste material, littering the environment. Due to the improper disposal or lack of disposal facilities and compliances to sanitation laws, animal and plant waste has constituted a health hazard and an eye sore in many environments in Maiduguri the Borno State capital and environs. Attempts by local farmers, faced by expensive cost of chemical fertilizer and compliance to Government sanitation laws, to collect and dump these waste materials, as a source of fertilizer has failed. Biotechnologist and environmentalist have thought of a second turn to deal with the situation by reducing the period of decomposition of waste materials to a resourceful level. This is done by generating methane gas for domestic cooking and generation of electricity, while the slurry is 100% nitrogen fertilizer. Sustainability and patronage of biogas and the fertilizer, faces a major obstacle, especially in an economy of Nigeria, mainly due to lack of encouragement from both Government and individuals. Considering the aforementioned problems, this research work have decided to examine the potency of sugar cane waste in generating biogas (methane) as an alternative fuel for domestic purposes in both rural and urban areas where sugar cane is available.

MATERIAL AND METHODS

This experiment was conducted in a laboratory located in the Department of Biological Sciences Faculty of Science of the University of Maiduguri, from the months of May to August 2006. Sugar cane waste (partially decomposed) was collected from a dumping site in Baga Motor Park, a sugar cane Depot in Maiduguri. Collection of decomposing substrate from this dumping site was deliberate in order to obtain residues in a pretreated form. This will provide

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a suitable particle and substrate composition ready for fermentation and subsequent methenation.

A digester was designed as anaerobic container like the plug flow digester which is suitable for the sugar cane waste. The digester was a prototype cylinder made of iron sheet, strong enough to resist rust and pressure. The systems consist of an inlet and an outlet for loading and flushing out of slurry, respectively. The batch- fed Digestion Method was employed for this study. 1000m3 of water was added to 12 kg of the sample to produce the proportionate mixture for digestion (solid / water ratio). When new materials of mixed substrate were added to the old at the end of each digestion, old materials were pushed out simultaneously through the outlet.

Routine mixing of substrate was done by shaking of the digester to increase the surface area for digestion. The retention time for the digestion was 50 days. Anon (2003a) had indicated a retention time of 20-30 days with animal waste. To the10, 000 cm^3 of water a single load of 12kg of the substrate and 2000 cm^3 of chicken droppings (guano) as inoculants was sustained throughout the retention time.

RESULT AND DISCUSSION

The result contained in Table 1 reveals a total of 11.93 m^3 of methane gas being generated at a single load of 12kg of partially decomposed sugar cane waste over a period of 50 days as retention time.

Table 1: Table shows the quantity of substrates fed into digester and volume of Biogas (Methane) generated.

Parameters	**Value**
Volume of partially decomposed sugar cane peels (batch fed)	12kg
Retention time	5days
Volume of Biogas (methane) generated	11.93m^3

This result is opposed to that of Letcher and Kolbe (1994) where maximum amount of methane of416 m^3 was generated from 1 ton (1000 kgs) of organic waste having low sugar content. The result of the present study showed about 0.99417 m^3/kg of methane, which is equivalent to 994.17 m^3 from 1 tone (1000kg) of sugar cane waste as organic waste. Sugar cane waste gave a higher yield probably, due to the sugar level of the substrate and secondly, the pretreatment (partial decomposition) of the substrate. This phenomenon was indicated by Nagamani et al (1990) where they observed that forage grasses ranked second in methane yield with better yield in leaves than stems. They also reported that pretreatment of feedstock improved the Biogas yield, especially where particle sizes reduced to 0.4 mm which gave better Biogas production.

Generally, the amount of methane that can be generated from a substrate depends on the composition and biodegradability of organic feedstock influenced by the microbial population and temperature (Anon, 2004 a). Braun (1982) indicated that different volumes of methane was generated due to differences in feedstock, such that sugar cane produced 5.6 m^3 in 4 days, sea grass produced O.17m^3 and sea weed 0.17m^3 in 20 days. Similarly, in this experiment, the volume of gas generated was 0.2383m^3 per day or 0.283 x 104m^3/day. In a separate trial it was

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observed that about 3127cm^3 of biogas was required to cook 477kg of rice Anon (2003 c). This indicates that sugar cane waste can be used to produce methane adequate enough to sustain a family of six (i.e. 7.5kg of rice). If the trend for gas generation is to be followed, adequate methane gas can be generated and accumulated enough to serve subsequent cooking periods.

The graphical representation of methane generation described over 50 days in this work (Fig. 1) shows that maximum gas was produced after 24 hours of loading the digester as a single load.

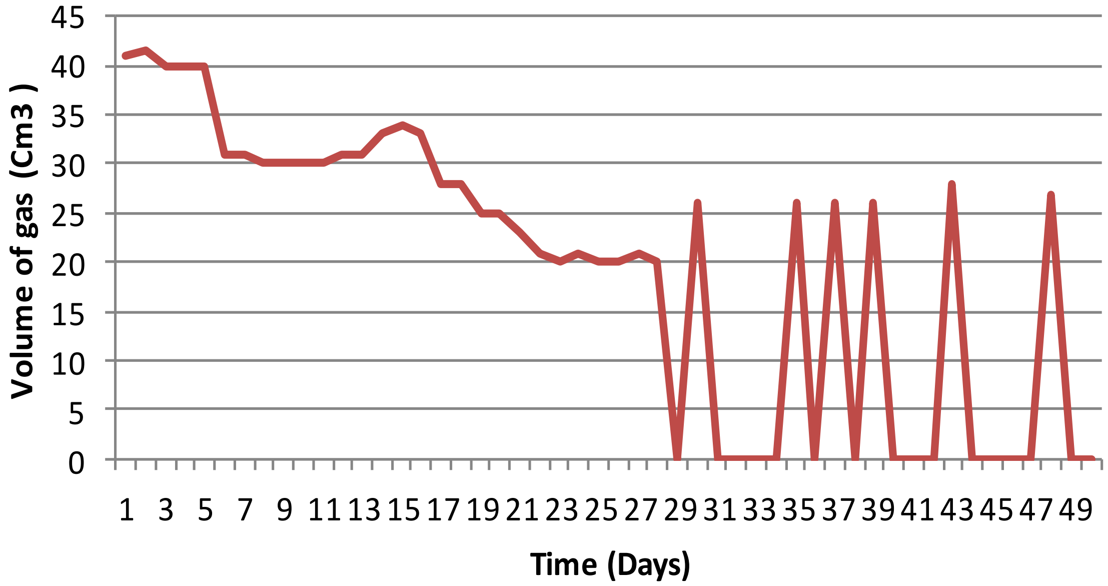

Fig.1 :Figure one shows the rate of biogas production per day

This striking result was primarily attributed to pretreatment (decomposition) of the waste material during which stages of delignification, hydrolysis, fermentation and acidification took place. Production rate reached its peak after seven days of loading to produce a volume of 330999.83 cm^3 (0.331m^3) of methane. This volume declined to 330991.33cm^3 (O.331m^3) after the 8th day of loading with corresponding decline in temperature by 1°C representing about 20% decrease. This decline in yield of biogas may be attributed to microbial response to temperature requirement. Nagamani et al (1990) observed a higher yield at 55°C although unstable. Fig.1 also reveals that gas production declined with a slight fluctuation until after the 30th day when it fell to zero and rose again to 330979.33cm^{3}as the maximum volume generated. This fluctuation continued between zero and the maximum up to the end of the retention time of 50 days. Different agricultural wastes ranging from cattle dung to pig excrete, straw, potato, cellulose and starch have been found to give different yields of methane mainly due to their degradability Nagamani et al (1990) Ngulde et al(2012) obtained 9.7×10^{-6} and 6.6×10^{-6} from Cow dung and Camel dung respectively. If the process of digestion can be sustained to heaps of sugar cane peels or bites at dumping sites or littering our streets, it can save a lot of cost for domestic energy as well as environmental sanitation. The alkaline condition of 8.2 and a temperature range of 29°C to 44°C were found to be adequate enough for methenation of sugar cane waste.

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CONCLUSION

It is, hereby, concluded that in selecting a feedstock of sugar cane waste for biogas generation, one should consider the sugar status (maturity) and degradability of the feedstock. Pretreatment of the material is also essential to methenation. Given the result of this research with sugar cane waste, it shows that with slight improvement, continuous use of gas in various ways can be sustained through batch system of loading and gas collection. However, it appears from this study that collection and compression of gas was difficult and could be expensive. Further research should be directed towards getting a device that can collect and compress the gas as in other cases of gas usage. It is, finally concluded that production and utilization of biogas for domestic purposes in both urban and rural areas is highly economical.

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