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BIOGAS PRODUCTION USING SUGARCAIN BAGGAGES AND FRUIT PEELS MIXED WITH COW DUNG

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ABSTRACT

The overdependence on fossil fuels as primary energy source has led to global climate change resulting in droughts, devastating hurricanes, diminishing ozone, and human health problems. Investing in biogas as a clean, renewable energy source

INTRODUCTION

Biogas is the mixture of gases produced by the breakdown of organic matter in the absence of oxygen (anaerobically). The organic wastes used in biogas production includes agricultural waste, animal manure, municipal waste, plant materials, sewage, food waste and fruit peels. Biogas is a renewable energy source. (Gopinath *et al*., 2014). Biogas primarily consist of methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulfide (H_2S) and moisture. Gases like methane, hydrogen and carbon dioxide (CO_2) can be combusted or oxidized with oxygen. The energy when released allows biogas to be used as a fuel, for heating purpose, such as cooking. It can also be used in a gas engine to

is the way of the future. Biogas production is a process which occurred in the absence of oxygen. Several microorganisms are involved in the degradation of the organic compound and release of methane gas. The Biogas production potential of sugarcane baggages and fruit peels mixed with cow dung were investigated. Production of biogas was carried out using anaerobic digester for 12 days. The volume of gas produced was determined by taking the reading of the water displaced in an inverted measuring cylinder. The total volume of gas produced from sugar cane was 1951cm^3 with a pH range of 5.9 – 6.8 and temperature range of 25°C – 31.6°C while fruit peels mixed with cow dung had a total biogas volume of 1600cm3 with pH range of 5.4-6.3 and temperature of 26°C – 29°C. The morphological and biochemical characteristics of bacterial isolates obtained from sugarcane baggages and fruit peels digesters includes Staphylococcus aureus, Bacillus cereus, Bacillus subtillis, Streptococcus bovis, Escherichia coli, Yersinia spp Pseudomonas aeruginosa, Enterobacterium spp and Clostridium spp.

Keywords: *Biogas, production, digester, characteristics and degradation*

convert the energy into electricity and heat (Sead & Henley, 2016). Dependence solely on fossil fuel as energy source has led to global climate change. In today's technology, the environment suffers from the detrimental effect of pollution. Exposures to environmental pollution remains a major source of health risk throughout the world (Cecifi *et al*., 2015). Pollution and global warming are the major problems created by humans which affects the ecosystem (Garba *et al*., 2015). Most of the world's present problems are closely related to

the dwindling energy production, supply, distribution, and utilization (Tinay *et al*., 2016).

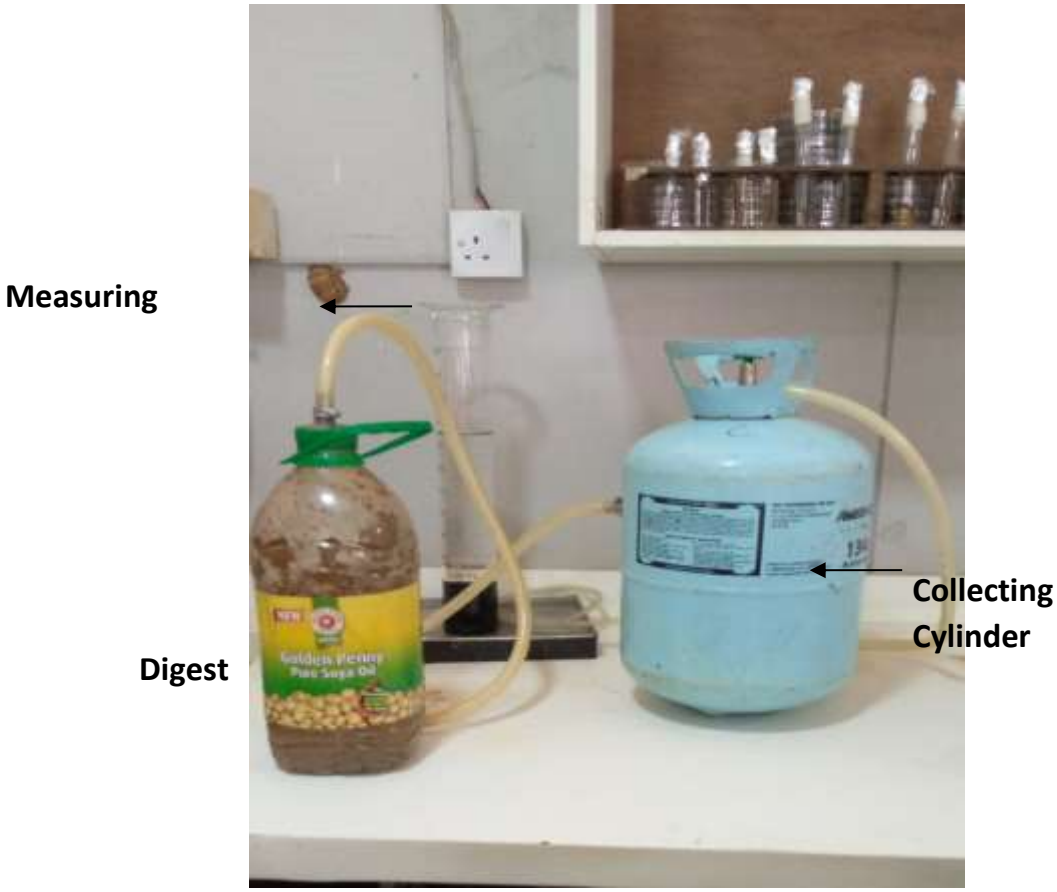
According to current research and future predictions, the crude oil will run out within 40 to 70 years, and natural gas will be finished within 50 years (Mumoki, 2016). Global average temperature is predicted to increase from 1.4 to 5.8°C by years 2100 and continue long after that (Okobue & Ojo, 2011). Several investigations point out that this will inevitably lead to drought, flooding, increases in hurricanes and tornadoes and possible widespread of crop failures (Mweninguwe, 2015, Mumoki, 2016). Biological degradation of agro wastes into biogas remains the simplest and most environmentally friendly technology to minimize the public health hazard associated with their handling and disposal (Ofoefule *et al*., 2015). This research is aimed at producing biogas from agro waste.

Materials and Methods

Samples Collection and Preparation: Samples of sugarcane baggages was collected within Kaduna metropolis. It was washed with water to get rid of sticky cane juice, after washing it was spread outside to get it dried, it was then grinded into fine particles and stored in a cool dried place till further use while different fruit peels waste were obtained from fruit selling areas around station market Kaduna, it comprises of banana, oranges and water melon. The fruit peels were cut into smaller pieces and dried. The dried fruit peels were then grinded, sieved and kept at a normal temperate until used. Cattle dung was collected at Tudun Wada Abattoir of Kaduna State.

Construction of Digester: A 4 liter container was used as digester, a small hole was made on the cover and connected with a rubber hose, the hole was sealed with adhesive to cover leakage. The rubber hose served as a channel to which gas produced in the digester was passed

into a cylinder. A tube was also connected from the cylinder for passing gas into a measuring cylinder (Abubakar, 2017).



Preparation of Slurry: 200g of grounded sugarcane baggage and 200g of cattle dung was weighed and mixed with 1000ml of water in a container. Also 200g of fruit peels and 200g of cattle dung was weighed and mixed with 1000mls of distilled water. The mixtures were continuously stirred to ensure homogenicity. The homogenized mixture was introduced into different digesters and closed properly to undergo anaerobic digestion for a retention period of 12 days (Ofuefule & Uzodinma, 2015).

Measurement of Gas Produced by Water Displacement Method: This was done by connecting a tube from the gas collecting cylinder into a measuring cylinder. The measuring cylinder was filled with water, and inverted carefully into a rectangular tray by adding water into the tray immediately. Gas production was observed by formation of bubbles and displacement of water in the measuring cylinder. The water displaced was recorded as the volume of gas produced per day (Budiyono *et al*., 2010).

Determination of pH : The pH of the slurry was measured before, and after digestion using pH meter. This was done by first turning on the pH meter, distilled water was used to calibrate the pH meter to neutral before inserting the electrode into small quantity of slurry obtained from the digester and then taking the pH reading. (Viswanath *et al.,* 2012).

Determination of Temperature : The temperature of the slurry was measured at the initial and final stages of the digestion. This was done by inserting a clean thermometer into small quantity of slurry obtained from the digester. The thermometer was held at the stem end with the finger tip, then slowly turned until the blue line was seen, the point where the line stopped was identified and recorded as the temperature of the slurry in ^{o}C. After taking the reading the thermometer was washed with soap and warm water (Aylas, 2017)

Media Preparation: Nutrient agar, chocolate agar and MacConkey agar used were prepared according to. manufacturer'sinstruction.

Culturing Procedure: Tenfold serial dilutions of each slurry was carried out, **z**ero point one milliliter (0.1ml) of the 10^{-4} and 10^{-5} dilution of each of the slurry was inoculated in triplicates using spread plate technique on Nutrient agar (Oxoid) and Chocolate agar, supplemented with 50µg/ml nystatin to suppress the growth of fungi (Agbor *et al*., 2012). The plates were allowed undisturbed for 15 minutes and were

incubated in an incubator as well as anaerobic jah at 37^{O}C for 24 hours. Representatives of the different colony types of the bacteria which developed on the plates were picked and purified by repeated sub-culturing unto fresh Nutrient agar plates using streak plate technique. The isolated colonies were transferred unto nutrient agar slants and properly labeled and stored as stock cultures at 4^{O}C.

Identification of Isolates: Morphological, Gram staining, and Biochemical test were carried out and they includes Catalase test, Coagulase test, Citrate test, Indole test, Oxidase test, Urease Test, Spore Staining, Capsule stain**,** Motility test, Nitrate reduction, Methyl red test, Voges – Proskauer test, Glucose fermentation test, Mannitol fermentation test, Lactose fermentation test, Nitrate Reduction Test (Cheesebrough, 2006).

Results

Table 1: pH and Temperature (^{O}C) of The Slurry At The Initial and Final Stage of digestion

Substrates	Time (Days)	Temperature (^{O}C)	pH
Sugarcane baggage and cow dung			
Initial Reading	1	25	5.9
Final Reading	12	31.6	6.8
Fruit peels and cow dung			
Initial Reading	1	26	5.4
Final Reading	12	29	6.3

Table 2: Volume of Gas produced in (cm^3) for a Retention Period of Twelve Days

Days	Sugarcane baggage Volume of gas in cm3	Fruit peels Volume in cm^3
1	110	100
2	120	100

3	120	100
4	140	200
5	140.5	300
6	160	100
7	170	100
8	170.5	100
9	180	100
10	200	100
11	210	150
12	230	150
Total	1951	1600

Key: Cm^3 = Centimeter cube

Table 3: Morphological and Biochemical Characteristics of Bacterial Isolates Obtained From Biogas Digester and Probable Organisms

Isolates		Grain Reaction	Cell Shape	Catalase	Coagulase	Oxidase	Indole	Citrate	Spore test	Capsule	Urease test	Motility	Nitrate reduction	Methyl Red	Voges Proskaure	Glucose	Mannitol	Lactose	Probable Organism
1		+	Cocci	+	+	–	–			-		–		+	+	+	+	+	*Staphylococcus aureus*
2		+	Rod	+	-	–	–	+	+	-	-	+	-	-	+	+	-	-	*Bacillus cereus*
3		+	Rod	+	–	+	–	+	+	-	-	+	+	-	+	+	+	–	*Bacillus subtilis*
4		+	Cocci	–	–	+	–	-	-	-	-	-	-	-	+	+	–	+	*Streptococcus bovis*
5		–	Rod	+	–	–	+	-	-	-	-	+	+	+	–	+	+	+	*Escherichia coli*
6		–	Rod	+	–	–	-	-	-	-	-	-	+	+	–	+	+	–	*Yersinia* spp
		_	Rod	+	-	-	-	+	-	-	-	-	+	-	+	+	+	-	*Enterobacter* spp
		+	Rod	-	-	-	-	+	+	+	-	-	+	+	-	+	+	+	*Clostridium* spp
		-	Rod	+	-	+	-	+	-	-	-	+	+	+	-	+	+	-	*Pseudomonas* aeruginosa

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Key: + = Positive, - = Negative. Spp=species

Discussion:

The total volume of gas produced for a retention period of 12 days was 1951 cm^3 from sugarcane baggages and 1600 cm^3 from fruit peels and it happens to increase with increase in time. This was in conformity with the result of (Rabah *et al*., 2010) where 1840cm^3 of gas was produced. The increase in the volume of gas was attributed to the increase in temperature of the slurry and suitable environmental condition for the microorganism signifying higher rate of biodegradation of organic waste. The increase in the production rate may also be attributed to the combined effect of cattle dung and sugarcane baggages, fruit peels. sugarcane bagasse is high in cellulose while fruit peels is high in crude fibers, carbonhydrate, lipid, and protein which are substrate that favours biogas production while cattle dung can harbor higher number of microorganism and nitrogen content. This agrees with the report of (Angelidaki *et al*., 2013) that the process of biogas generation from mixture of agricultural waste such as cattle dung and sugarcane baggages proceeds better than when agricultural waste is digested alone. The results of fruit peels also showed that certain species of bacteria appear to extend over one stage of the digestion period to another, suggesting a succession in species of anaerobic bacteria during the process of biogas production. pH and temperature are important factors that facilitate or hinder biogas production, a range of pH value suitable for anaerobic digestion has been reported by various researchers. The pH of the slurry increases with increase in time agreeing with the report of (Dobre *et al*., 2010) that pH value may increase due to the accumulation of ammonia. The pH value obtained were optimum for biogas production which agrees with the report of (Converti, *et al*., 2010) that for biogas

production, the optimal pH value varies between 6.5 – 8.0. If the pH value decreases below 6, methane production is strongly inhibited. The temperature of the slurry increases with increase in time attributed to the increase in the biogas volume agreeing with (Lawal *et al*., 2010) that biogas production is favored with an increased temperature. The temperature of the slurry was at the mesophilic range hence optimum for biogas production agreeing with the report of (Speece *et al*., 2011) that useful gas production takes place at the mesophilic range between 25°c and 40°c and thermophilic range between 45°c to 55°c, when the temperature goes down to 10°c gas production will virtually stop. The bacteria isolated from the digester are mainly facultative anaerobe which include *Staphylococcus aureus*, *Bacillus cereus*, *Bacillus subtillis*, *Streptococcus bovis*, *Escherichia coli*, *Yersinia enterolitica Pseudomonas aeruginosa, Enterobacterium* spp and *Clostridium* spp. The bacteria isolated was due to their ability to withstand the anaerobic condition and heat evolved during anaerobic digestion, these findings were similar to that of (Rabah, *et al*., 2010) in which *Bacillus species*, *Yersinia enterolitica, Escherichia coli* and *staphylococcus aureus* were isolated from anaerobic digester.

Conclusion:

The result of this research work indicates that the mixture of cattle dung and sugarcane baggages, cattle dung and fruit peels could serve as a suitable substrate for biogas production as both mixture favours the growth of biogas producing microorganism if suitable environmental conditions such as pH and temperature are provided in order for biogas producing microorganism carryout anaerobic digestion of various organic material. Hence, the utilization of these substrate for biogas production could eliminate disposal problems,

provide an alternative feedstock for efficient biogas production and a source of renewable energy.

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