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TURNING WASTES (COW DUG AND MELON SHELLS) TO BIOGAS FOR COOKING ENERGY

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Abstract

This research was carried to determine the possibility of managing animal and melon wastes by converting it to biogas. The objectives of the research are to: experiment biogas from: (i)cow dug (ii) cow dug and melon waste and to (ii) compare the outcome of the two sets of experiments. The null hypothesis "there is no significant difference between biogas yield from cow dug slurry and yield from combination of cow dug and melon waste at 95% significant level" was tested. Two set of experiments on biogas production were set as follows: (i) experimentation of biogas production using only cow dug as substrate (A) and (ii) experimentation of biogas production using a combination of cow dug and melon waste as substrates (B). In both cases, anaerobic condition and uniform volume of slurries were maintained in the same type of digester. Result showed that Biogas production was possible in cow dug and in combination of cow dug and melon waste). However, there is a significant difference between biogas yield from cow dug slurry and combination of cow dug and melon waste at 95% significant level. The mixed substrates (cow dug and melon waste) produced more gas than the single substrate (cow dug). It was recommended that mixed substrates should be used in biogas production.

1. Introduction

Biogas production from waste is not a new technology; historical evidence indicates that Anaerobic Digestion (AD) is one of the oldest technologies. Even around 3000 BC the Sumerians practiced anaerobic cleansing of waste (Deublein and Steinhauser, 2008). However, the industrialization of anaerobic digestion began in 1859 with first AD plant sited in Bombay India (Khanal, 2008). According to Deublein and Steinhauser (2008), other countries that pioneered the evolution of biogas technology were France, China and Germany. China is recently, credited as having the largest biogas programme in the world with 27 million biogas plants installed (Alexander, 2018).

Biogas technology was introduced in Africa between 1930 and 1940 when Ducellier and Isman started building simple biogas machines in Algeria to supply farm houses with energy. Despite this early start in Africa the development of biogas technology is still in its embryonic stage in this region, though with a lot of potentials (Deublein and Steinhauser, 2008).

The earliest record of biogas technology in Nigeria was in the 80s when a simple biogas plant that could produce 425 litres of biogas per day was built at Usman Danfodiyo University, Sokoto (Dangogo and Fernado, 1986). About 21 pilot demonstration plants with a capacity range of between 10m³ and 20m³ have been sited in different parts of Nigeria (Achara, Nsukka LGA, Enugu State, Ifelodun farmer's cooperative at Ojokoro, Agege lagos, ANAPRI, Zaria,Kaduna State, Kano, Yobe, Kebbi States, etc) and none is functional (Ani, 2014). However, presently efforts are being made by individuals, companies to reinstate biogas production in Nigeria. Experimentation of biogas production has been carried out in Nigeria and other countries for examples:

Jyothilakshmi and Prakash (2016) experiment biogas production "using cow dug, kitchen and domestic biodegradable wastes in a bio-digester with a capacity of around 30 liters.

Ukpabi *et al.*,(2017) generated biogas "using cow dung and food wastes. The result supported the observation that acid concentration greatly affects the biogas production".

Azeem et al (2012) were concerned on "improving biodegradability of the organic fraction of municipal solid waste (OFMSW) and biogas yield".

Teguh *et al.*, (2017) described a comprehensive study to set up "technology for converting fruit waste to electricity via biogas production".

Jalil *et al.*, (2017) investigated biogas generation from the "waste of a vegetable and cattle market of Bangladesh".

Sopheap *et al.*,(2017) determined the "effect on methane production of adding different proportions of fresh vegetable waste to manure from pigs or buffaloes as substrate in plug-flow biodigesters".

Hilkiah (2008) studied the effect of Total Solids Concentration of Municipal Solid Waste on the Biogas Produced in an Anaerobic Continuous Digester.

Ravi and Tiwari (2013) compared different ratios of Kitchen Waste Under Aluminium Made Biogas Plant.

Alexander (2018) is concerned with generating his household cooking energy need from food and backyard wastes.

This study was carried to determine the possibility of managing animal and melon wastes by converting it to biogas. The objectives of the research are to: experiment biogas production from: (i)cow dug (ii) cow dug and melon waste and to (ii) compare the outcome of the two sets of experiments. The null hypothesis "there is no significant difference between biogas yield from cow dug slurry and yield from combination of cow dug and melon waste at 95% significant level" was tested:

Material and Procedure

Material: the materials used for the experiment are two digester constructed with valve, inlet and outlet pipes, substrates (cow dug and melon waste), water, bowl 50 liter capacity, weighing scale, and calibrated measuring cylinder with paraffin oil displacement arrangement.

Procedure

Two set of experiments on biogas production were set as follows:

- 1. Experimentation of biogas production using only cow dug as substrate (A)
- Experimentation of biogas production using a combination of cow dug and melon waste as substrates (B)

Two digesters of twenty-five (25) liter capacities were fed up to eighty percent (80%) with (A) cow-dug slurry (B) Slurry formed mixture of cow dug and grounded melon waste. In both cases, anaerobic condition and uniform volume of slurries were maintained as follows: The feeling of slurry through the inlet pipe provided were provided with suitable arrangements to ensure zero entry of air into the digesters (Ukpabi, et al., 2017). All connections (cylinder, inlet and outlet pipes) were designed and operated to maintain anaerobic conditions. For example, there were intermediate covering between the digesters and feeding/ residue evacuation pipes. In the process of feeding substrates, the intermediate covers remained close while substrates are being passed through the inlet after which the inlet pipes were covered then intermediate covers are then opened to allow the feeding of substrates without entrance of air into the digesters to achieve anaerobic conditions. After feedings, both entrances were closed. The digesters were connected to a calibrated measuring cylinders with paraffin oil displacement arrangement to measure the volume of biogas produced (Ukpbi et al., 2017). Gas production were recorded on daily basis from the calibrated measuring cylinders to find out possible daily biogas production using (A) cow dug and (B) using cow dug and melon waste. The result of the yields for set A and B were compared using student t test.

Results and Discussions

Table 1 Present The Daily Record Of Biogas Produced From The Two Sets of Experiments

(A and B)

	CowDug(A)	Dug& Melon Waste (B)		
1	0.00	0.00		
2	0.00	0.00		
3	5.90	0.00		
4	10.50	9.50		
5	15.70	19.40		
6	20.30	28.60		
7	30.40	35.70		
8	30.50	39.70		
9	31.30	37.80		
10	35.20	41.60		
11	39.60	45.70		
12	40.00	48.20		1.1
13	45.10	51.50		
14	44.00	55.20		
15	42.40	57.30		
16	40.30	59.00		
17	37.40	60.30		
18	33.50	64.20		
19	30.50	65.30		
20	26.40	65.60		
21	26.00	61.50		
22	23.50	48.50		
23	15.20	35.20		
24	12.50	30.00		
25	10.40	27.80		
26	10.30	25.40		
27	7.30	20.90		
28	5.10	18.70		
29	2.30	15.30		
30	1.90	10.50		

Table1 shows among other things that gas production started earlier in set A which also reached its peak first and diminishes earlier than set B(Figure 1). This is symbolic to Kirchofir law that " object that heat fast cool fast".



Figure 1: The Daily Volume of Biogas Produced in Both Experiments (A and B)

Figure 1 shows zero production of biogas in the first two days in both experiments. Set A started producing gas on the 3rd day when it recorded the second to least volume (5.90Ml) and accelerated until the twentieth (13th) day when it reached its peak (45.10Ml) and started reducing to the least volume recorded (1.900Ml) on the thirtieth (30th) day. On the other hand, gas production started on the fourth day in set B when it recorded the smallest volume (9.50Ml) and accelerated until the twentieth (20th) day when it reached its peak (65.60Ml) and started reducing to second least volume recorded (10.50Ml) on the thirtieth (30th) day.

The inability of the digesters to produce gas in the first two days may be due to presence of oxygen in both the digesters and substrates before the setup. Thus, fermentation could not take place until the oxygen is used up by aerobic bacteria.

Even after gas production has started, the volumes of biogas produced were never constant at any point in both set up; however, the volumes of gas recorded reached the peak in 14th to 21st day and in the 17th and 21st day in set A and B respectively.

As it is in table 1, figure1 clearly showed that even though gas production started earlier in set A, set B produced more gas and lasted longer than set A. This is because cow dug can easily decompose than melon waste and mixed waste has higher caloric value than cow dug. Earlier researches showed that multiple substrates produce more biogas than single substrate (Azeem et al,2012; Jyothilakshmi and Prakash, 2016; Ukpabi, *et al.*, 2017. According to Azeem et al (2012)

) "addition of melon waste to the substrates increased the biogas yield by 50%".

Student t test was used to compare the difference between the biogas yield in the two set up

(Table 2)

		Dug& Melon				
	CowDug(A)	Waste (B)	A-A	B-B	$A-A^2$	$B-B^2$
1	0.00	0.00	22.45	35.95	504.00	1292.40
2	0.00	0.00	22.45	35.95	504.00	1292.40
3	5.90	0.00	-16.55	35.95	273.90	1292.40
4	10.50	9.50	-11.95	-26.45	142.80	699.60
5	15.70	19.40	-6.75	-16.55	45.56	273.90
6	20.30	28.60	22.45	-7.35	504.00	54.02
7	30.40	35.70	22.45	35.95	504.00	1292.40
8	30.50	39.70	-16.55	35.95	273.90	1292.40
9	31.30	37.80	8.85	35.95	78.32	1292.40
10	35.20	41.60	12.75	5.65	162.56	31.92
11	39.60	45.70	22.45	9.75	504.00	95.06
12	40.00	48.20	22.45	12.25	504.00	150.06
13	45.10	51.50	-16.55	35.95	273.90	1292.40
14	44.00	55.20	21.55	35.95	464.40	1292.40
15	42.40	57.30	19.95	-35.95	398.00	1292.40
16	40.30	59.00	22.45	23.05	504.00	531.30

17	37.40	60.30	22.45	24.35	504.00	592.92
18	33.50	64.20	-16.55	28.25	273.90	798.06
19	30.50	65.30	8.05	35.95	64.80	1292.40
20	26.40	65.60	3.95	35.95	15.60	1292.40
21	26.00	61.50	22.45	35.95	504.00	1292.40
22	23.50	48.50	22.45	12.55	504.00	157.50
23	15.20	35.20	-16.55	-0.75	273.90	0.56
24	12.50	30.00	-9.95	-5.95	99.00	35.40
25	10.40	27.80	-12.05	35.95	145.20	1292.40
26	10.30	25.40	22.45	35.95	504.00	1292.40
27	7.30	20.90	22.45	35.95	504.00	1292.40
28	5.10	18.70	-16.55	-17.25	273.90	297.56
29	2.30	15.30	-20.15	-20.65	406.02	426.42
30	1.90	10.50	-20.55	35.95	422.30	1292.40
Statistical Technique						
Total	673.50	1078.40			10136.04	24822.76
Mean	22.45	35.95				
Variance	212.76	418.42				
Standard Deviation	14.59	20.46				
T test	12.04					

The degree of freedom (n-2) 28 then critical t at 28 is 3.68. Therefore, calculated t 12.04 is greater than critical t 3.68(Cal.>Cri @0.05%)

Decision:

Since the calculated t value of 12.04 is greater than the critical t value of 3.68 Ho "there is no significant difference between biogas yield from cow dug slurry and yield from combination of cow dug and melon waste at 95% significant level" is rejected. Thus, there is a significant difference between biogas yield from cow dug slurry and combination of cow dug and melon waste at 95% significant level. Therefore, mixed substrates with higher mean of 35.95 compare to 22.45 mean for cow dug yielded more gas than single cow dug.

Conclusion

Biogas production was possible in cow dug and in combination of cow dug and mixed substrates (cow dug and melon waste). However, there is a significant difference between biogas yield from cow dug slurry and combination of cow dug and melon waste at 95% significant level. The mixed substrates (cow dug and melon waste) produced more gas than single substrate (cow dug).

References

Alexander Samuel (2018)Home biogas: turning food waste into renewable energy. The Conversation Africa, Inc.

References

Abila N (2012) Biofuels development and adoption in Nigeria: synthesis of drivers, incentives

and enablers. EnergyPolicy2012;43:387-95. http://dx.doi.org/10.1016/j.enpol.

Ani Nina Chioma (2014) biogas technology Reasons why the industry is being undermined in

Nigeria. Seminar on "Biogas".www.avenamlinks.com.

Azeem Khalid, Muzammil Anjum, Tariq Mahmood and Muhammad Arshad (2012) Anaerobic co-digestion of municipal solid organic waste with melon residues to enhance biodegradability and biogas production. Journal of Material Cycles and Waste Management. Volume 14, Issue 4, pp 388–395.

Dangogo, S. and Fernado, C. (1986) A simple biogas plant with additional gas storage system.

Nigerian J. Solar Energ. 5: 138141.

Deublien, D. and Steinhauser, A. (2008) "Biogas from Waste and Renewable Resources".

IEA, (2012) Energy from Biogas and Landfill Gas. Working Group .www.ieabioenergy.com

/task/energy-from-biogas/.

Hilkiah Igoni, Abowei M. F. N., Ayotamuno M. J. and Eze C. L., (2008)"Effect of Total Solids Concentration Of Municipal Solid Waste on the Biogas Produced in an Anaerobic Continuous Digester",.

Jalil A, Basar S, Karmaker S, Ali A, Choudhury MR, et al. (2017) Investigation of Biogas

Generation from the Waste of a Vegetable and Cattle Market of Bangladesh. Int J Waste Resour 7: 283. doi: 10.4172/2252-5211.1000283

Jyothilakshmi R and Prakash S.V.(2016)Design, Fabrication and Experimentation of a Small Scale Anaerobic Biodigester for Domestic Biodegradable Solid Waste with Energy Recovery and Sizing Calculations. International Conference on Solid Waste Management, 5IconSWM 2015

Khanal, S.K. (2008) Anaerobic Biotechnology for Bioenergy Production: Principles and

Applications. Wiley-Blackwell.

Ravi P Agrahari and G N Tiwari, "The Production of Biogas Using Kitchen Waste", International journal of Energy Science (IJES) Vol:3,pp. 12-06,2013

Sopheap Yen, Preston T R and Nguyen Thi Thuy(2017)Biogas production from vegetable wastes combined with manure from pigs or buffaloes in an *in vitro* biodigester system. Livestock Research for Rural Development,29 (8).

Teguh Ariyanto, Rochim B Cahyono, Abby Vente and Siti Syamsiah (2017) Utilization of Fruit Waste as Biogas Plant Feed and its Superiority Compared to Landfill. International Journal of Technology 8(8).

Ukpabi Chibueze, Ndukwe Okorie, Okoro Oriaku, John Isu and Eti Peters (2017) The Production

of Biogas Using Cow Dung and Food Waste. International Journal of Materials and Chemistry. 7(2): 21-24.