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Evaluation Of Biogas Production Using Cow Dungs

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Abstract*—This study was designed to evaluate biogas production using cow dung in a bio-digester. The objective is to assess the volume of gas produced m^3, the amount of cow dung introduced into the bio-digester and the specific time needed to generate the biogas and finally the temperature that is required to generate the highest amount of biogas. Fresh cow dung samples were collected from Oginigba slaughter in a sterile polythene bag and transported to the laboratory within 6 hours of collection. Cow dung samples are aseptically administered by transferring ten grams (10 g) of a sample to 90 ml of the normally sterile saline and 10x sequence dilution up to 10-6. The Temperature was measured using the temperature gauge for the temperature and pH meter for the pH. Bacteriological analysis for total heterotrophic bacteria (THB), total heterotrophic fungi (THF), total salmonella-shigella counts, total vibrio species count, total Staphylococci species count, total pseudomonas species count were analyzed using the spread plate method. An average temperature of 33.7^{0}C and pressure of 0.0011 psi was used to generate the volume of biogas so produced. Total coliform count was also determined as recommended and bacteria and fungi isolates using standard methods. A total of 190.2 litres and 0.1936m^3 of biogas were generated in 52 days. Gas production rose with increase in retention time. The result showed that the first day recorded zero litres of biogas as expected due to slow rate of biodegradation of the fresh cow dungs. It is necessary to have control of the temperature of the bio-digester as higher temperatures favour optimum production of biogas.

Keywords—Biogas, bio-digester, cow dungs, THB, THF, methane, acetogenic, methanogenic, Oginigba,

1.0 Introduction

Fossil fuel has been a significant energy source. Its production and consumption contributes to a variety of environmental problems, including greenhouse gas emissions, which are responsible for global warming. Such emissions also contain certain soluble gasses, carbon dioxide, sulfur dioxide and nitrogen oxide that trigger acid rain and have a natural and man-made impact [1].

Such concerns have sparked a mass movement for renewable energy generation and sustainable energy as a replacement to fossil fuel. Such renewable energy sources add to sustainable development in various ways including the use of both animal and industrial waste as a major source of clean alternative energy. Such sources are deemed sustainable since waste is produced quickly by plants and animals. These are the basis on which renewable energy sources are the best solution to the global energy crisis.

Waste may be treated in various ways to produce bioenergy in liquid and gaseous fuel [2]. Anaerobic digestion of waste is a distinct advantage in the treatment of both plant and animal waste. Anaerobic organic waste disposal helps capture fuel gas (biogas), which consists mainly of methane and carbon dioxide. Biogas methane combustion can be used to generate heat and electricity. This is because methane does not emit immediately into the environment, so carbon dioxide is from a small carbon cycle of renewable source. Biogas production does not contribute to global warming by rising atmospheric carbon dioxide levels. The energy source also addresses ecological and agro-chemical problems at the same time. Anaerobic manure fermentation for the production of biogas does not lower its importance as an alternative fertilizer because nitrogen and other substances are still available for the process.

Biogas technology is well-known as the fuel gas generation from anaerobic biomass digestion. Millions of biogas plants now work worldwide. Although direct combustion gas is common in household stoves or gas lamps, biogas electricity generation is still relatively rare in most developing countries. The major purpose of Biogas plants in Germany and most industrialized countries is power generation. Biogas conversion to energy has become a standard process; sadly, despite landmarks, biogas generation has not been popular in Nigeria [3].

The potentials, barriers and conditions required in developing countries for the use of biogas for small and medium-sized electricity generation were listed

[4]. The work describes biogas production processes in general and also addresses the generation of electricity. Nevertheless, there is still not enough information about the use and value of biogas. Fuel gasses can be used in a biogas System, such as animal manure, green plants, agricultural waste and slaughterhouses. The use of biogas in gas stoves, lamps or motor fuel, for instance, may be identical. It is composed of 50-75% methane, 25-45% ammonia, 2-8% water vapor and trace amounts of O_2, N_2, NH_3, H_2, H_2S. Compare this to biogas containing 80 to 90% methane. The heat value of the gas depends primarily on the composition of the methyl. High methane levels are therefore recommended. Natural gas contains CO_2 and an inevitable water vapour, but sulfur is not suitable because it may affect the atmosphere.

The average heat density of biogas is about 21-23.5MJ / M^3, so that 1 M^3 of biogas is 0.5-0.1MJ/M^3 diesel fuel The biogas productivity of the plant is based not just on feedstock forms, but also on plant structures, temperature and holding period. In this research our bio-digester concept is very drinkable and can be developed by anyone at no serious cost. A standard input / output link in South Asia of about 14 kg (about the development of one cow on a single day) of fresh bovine animal dung plus 0.06 I diesel fuel to generate 1kWh of electricity [5].

If the amount of accessible regular dung (fresh weight) is established, it is easy to establish gas production in warm tropical countries daily. According [6], Nigeria produces about 227, 510 tons of fresh animal waste daily, the papers noted that since 1kg of fresh animal waste produce about 0.03m^3 of biogas then Nigeria can produce about 6.9 million m^3 of biogas per day. Development of biogas is a successful way of reducing and recycling the threats to industrial waste in many cities in Nigeria and also helping to find an adequate solution to the obvious insecurity of energy health. In 2050, biogas is predicted to compensate for nearly a third of all electricity [1]. Biogas can help in the use of waste material from human activities and manufacturing which government agencies have not been able to address, can be adequate use for biogas production which is certainly one of the best renewable sources of fuel [7].

2.0 Materials and Methods

2.1 Description of Study Area

The area of study falls within the Port Harcourt metropolis of River State, it is within the western part of the Niger Delta and situated in southern end of Nigeria bordering the Atlantic Ocean. It lies between $40^o45'$ South and 7^o 8' East, and generally accessible by networks of road and by seaport presents in River State. The Climatic condition in the Niger Delta area is a part of the Sub-Equatorial tropical region. The area is characterized by two distinct seasons, the wet and dry season. Although rainfall is observed all through the year, but the greater percentage of rainfall is during the wet season which gives good humid condition for precipitation and subsequent infiltration and recharge of ground water. The precise study area is Trans Amadi industrial layout hence lots of commercial activities strive heavily there; the presence of the abattoir in Oginigba is another source of commercialization. Bulk of the industries is mostly concentrated in these areas, so lots of industrial activities are experienced here with substantial atmospheric and sound pollutions.

Apart from the industries prevalence, there are lots of commercial activities which include markets, very active motor-park where passengers are conveyed to different part of Port Harcourt metropolis. The map of the study area is shown in Fig.1 below.

Fig 1: Study Area in Port Harcourt Metropolis

2.2 Performance Evaluation

To ensure a thorough construction has been done, the bio digester will be assessed to ensure the performance as it concerns the gas production in respect to the volume and efficiency of the improvised purifier. The bio-digester will be assessed on the following terms:

i) The volume of gas produced m^3

ii) The amount of cow dung introduced into the bio-digester and the specific time needed to generate the biogas

iii) Finally the temperature that is required to generate the highest amount of biogas

The Temperature was measured using the temperature gauge for the temperature and pH meter for the pH. Temperature and pH values were taken after each day for the period research lasted, the biodegradation takes place until the biogas produced gives an idea of the temperature and pH at various days and how the said temperature and pH affect the production of biogas also ascertained. The temperature gives the kinetic energy of the atoms or molecules; it will be measured to determine the feedstock influence on the temperature and consequently, the metabolism of the bacteria. Temperature of the digester was taken once every day for the period the bio-digester generates biogas. The pH gives the intensity of acidic or basic characteristics at a given temperature; the bio-

digester pH was also ascertained continually. The pH values were ascertained daily, specific time was not emphasized and reading was taken once.

Biogas can equally be used for cooking; biogas that will be used for cooking does not need to be purified since it will ultimately burn while being used for cooking.

2.3 Measurement of Parameters of Feedstock and Residue

To establish some scientific background, certain parameters were determined with respect to the anaerobic digestion cycle.

1. To quantify both organic and inorganic solids, cumulative solids were calculated to determine feedstock and effluent, including waste reductions. Final waste can be determined by subtracting in the bio digester the weight of the original slurry and collecting the waste after the necessary number of days.

2. Bacteriological examination was also performed, feedstock and effluent amounts of pathogens were calculated, as if the pathogens were still sufficient for irrigation purposes.

After each day for the period of days of the inquiry, temperature and pH levels were determined. During the biodegradation cycle and eventual biogas generation every day, the temperature and pH reported gave us an idea of the temperature and pH ideal for the development of biogas. The temperature produces the kinetic energy that stimulates microbial activity or metabolism on the feed stock and therefore the production of biogas, which always implies that temperature plays an important role in the development of biogas and that its measurements are required. The pH provides the strength of acidic or simple character at a given temperature that pH of a specific level is required for the promotion of microbial activity unless the microbial activity is achieved, thus, the low biogas generation. The biogas generated is shown in Fig. 2 below.

Fig 2: Biogas generation Source: [8]

2.4 Statistical and Data Analysis

After selection of the biogas, the gas holder is put on the top of a measured machine scale; the initial weight (also known as dead weight) of the gas holder is registered as P. The gas produced was calculated daily. The produced gas was measured by recording the new weight of the gas holder represented by N. The Produced gas collected will be subtracted from the new weight of the gas holder *i.e.* produced gas, N-P.

The formula that can be used to calculate the amount of gas collected was stipulated earlier [9].

The gas holder in this case has a base diameter of 0.40meter.

The base area, $A = \frac{\pi d^2}{4} = \frac{\pi x 0.4^2}{4}$ (1)

We can represent the length of flexible gas holder (h) = x which varies

2.5 Source and Handling/Processing of Experimental Feedstock

The cow dung used for this study has been gathered in fresh form, however relatively older dung can be used as well. The proportion of gas components has reduced due to atmospheric exposure, though. The dung has been collected with plastic containers with covers. For all field workers who were used for the mission, protective equipment such as covers, hand gloves, nose mask and rain boot were made available.

2.6 General Process/Procedure and Operational Routine

They have visited the site many occasions during the study process and have directly advised site staff hired for this project on their various job requirements, including presentations, throughout the course of the research. The slurry had been evacuated and measured after the time frame needed for the research to determine how much cow dung has been depleted at the end of the research.

The bio digester and the gas keeper were all airtight to insure no gas leakage, and to ensure no external atmospheric impact on the biodegradation cycle. The gas gathered is transported and extracted in makeshift manner where impurities are captured before being stored; an additional valve intended to float unpurified gas for direct cooking, the gas does not need purification because, when used for cooking, they are inevitably burned

Biogas production rate is expected to follow production trend otherwise referred to as the sigmoid function (S-curve) as generally occurs in batch growth curve. Biogas production is very slow at the beginning and the end of the biodegradation cycle. This is predicted due to the biogas production sequence of hydrolysis where complex molecules are broken down and later the acetogenic stage where acetate is produced and finally methanogenic stage which corresponds to specific growth rate of the bacteria in the bio-digester which leads to final generation of the biogas. In the first twelve days (hydrolysis stage) biogas Production is expected to be very low due to the lag Phase of microbial growth. In the next twelve to fifty (12-50) days (methanogenic stage) it is expected that a considerable growth in Biogas

Production will be observed due to exponential growth of the microorganisms. Biogas production is expected to start decreasing when the number of days of biodegradation gets to fifty days which can be referred to as the end Period of Observation.

2.7 Cow Dung Collection Analysis

Fresh cow dung samples were collected from Oginigba slaughter in a sterile polythene bag and transported to the laboratory within 6 hours of collection. The samples were collected early in the morning to ensure freshness and also meet the practical requirements. The collected samples are put into sample containers to ensure they are fresh till they are taken to the laboratory for analysis.

2.7.1 Sample Processing

Cow dung samples are aseptically administered by transferring 10 g of a sample to 90 ml of the normally sterile saline and 10x sequence dilution up to 10-6. The dung sample is tested with sample heating and incubation over a certain period of time and development of the samples is observed [10].

2.7.2 Isolation and Enumeration of Total Heterotrophic Bacteria (THB)

Total heterotrophic bacteria were isolated and enumerated using spread plate method as described [11]. An aliquot (0.1ml) from 10^{-4} dilution was aseptically transferred unto properly dried nutrient agar plates in duplicate, spread evenly using flamed bent glass rod and incubate at 37ºC for 24 hours, after incubation, the bacterial colonies that grew on the plates were counted and average taken, and express as colony forming unit per gram using the below equation:

THB (cfu/g) = Number of Colonies / Dilution (10^{-4}) x Volume plated (0.1ml) (2)

2.7.3 Total Coliform Counts

The method of [11] was adopted where 0.1 milliliter from 10^{-2} dilution of the serially diluted sample each were inoculated onto different sterile MacConkey agar plates in duplicates, the inoculums were then spread evenly on the pre- dried surface media using a flamed bent glass rod. Incubation was done at 37^{o}C for 24 hours, after which the colonies were counted and expressed as colony forming unit per gram.

2.7.4 Isolation of Total Heterotrophic Fungi

The total Heterotrophic fungi in the sample were isolated enumerated using spread plate method. An aliquot (0.1ml) of the dilution of 10^{-2} dilution was inoculated into properly dried Sabouraud Dextrose agar plates containing antibiotic (250 Tetracycline) to inhibit bacterial growth in duplicate and spread evenly using a flamed bent glass rod and incubated at 35ºC for 3 days, spores of fungal isolates that grew on the plate were counted and expresses as spore forming unit per gram after incubation.

2.7.5 Total *Salmonella-Shigella* Counts

This was determined with the *Salmonella-Shigella* agar using the spread plate method as described [11]. One millilitre from 10^{-2} dilution of the serially diluted sample was inoculated onto sterile pre-dried *Salmonella-Shigella* agar plates in duplicates using spread plate method. The plates were then incubated at 37^{o}C for 24 hours, after which the colonies that grew on the plate were counted and the average total *Salmonella-Shigella* counts were taken and expressed as colony forming unit.

2.7.6 Total *Vibrio Species* Count

Total *Vibrio* count was determined with the Thiosulphate Citrate Bile Salt (TCBS) agar using the spread plate technique as described [11]. One milliliter from 10^{-2} dilution of the serially diluted sample was inoculated onto sterile pre-dried TCBS agar plates in triplicates and then spread evenly with a flamed bent glass rod. The plates were incubated at 37^{o}C for 24 hours, after which the colonies were counted and expressed as colony forming unit per gram.

2.7.7 Total *Staphylococci Species* Count

Total *Staphylococci species* count was determined with the mannitol salt agar using the spread plate technique as described [11]. One milliliter from 10^{-2} dilution of the serially diluted sample was inoculated onto sterile pre-dried mannitol salt agar plates in triplicates and then spread evenly with a flamed bent glass rod. The plates were incubated at 37^{o}C for 24 hours, after which the colonies were counted and expressed as colony forming unit per gram.

2.7.8 Total *Pseudomonas Species* Count

Total *Pseudomonas species* count was determined with the centrimide agar using the spread plate technique as described [11]. One milliliter from 10^{-2} dilution of the serially diluted sample was inoculated onto sterile pre-dried centrimide agar plates in triplicates and then spread evenly with a flamed bent glass rod. The plates were incubated at 37^{o}C for 24 hours, after which the colonies were counted and expressed as colony forming unit per gram.

2.7.9 Identification of the Bacteria Isolate

The cultural, morphological and biochemical characteristics of the discrete bacterial colonies on the respective culture media were compared with the recommendation in Bergey's manual of determinative bacteriology (1994). The morphological and biochemical test include; Gram' reaction, motility, catalyse, Indole production, methyl red, citrate utilization, vogees proskauer test, sugar fermentation and growth on specialized media.

2.7.10 Identification of the Fungal Isolates

The fungal isolates are focused on cultural and morphological characteristics such as patterns of colony formation, conidial morphology and pigmentation. A method to classify the isolated fungus with cotton blue in lactophenol fleck was employed earlier [12].

3.0 Result Presentation

Table 1: Biogas Data Collection

Date	Temperature ^{o}C	Pressure (psi)	pH	Biogas (litres)	Biogas (m^3)	Biogas (Standard)
1.15th June 2019	5	0.000	2.5	Nil	Nil	Nil
2.19th June	25	0.0012	7.0	3.3	0.0033	3.3×10^{-3}
3.20th June	35	0.0010	7.2	3.0	0.0030	3.0×10^{-3}
4.21th June	36	0.0010	7.3	3.1	0.0031	3.1×10^{-3}
5.30st June	28	0.0010	7.3	2.8	0.0028	2.8×10^{-3}
6.1th July	38	0.0010	7.5	4.0	0.0040	4.0×10^{-3}
7.2nd July	38	0.0010	7.5	3.2	0.0032	3.2×10^{-3}
8.3rd July	40	0.0013	7.5	4.4	0.0044	4.4×10^{-3}
9.4th July	40	0.0014	7.5	4.8	0.0048	4.8×10^{-3}
10.5th July	30	0.0010	7.5	3.8	0.0038	3.8×10^{-3}
11.6th July	37	0.0015	7.5	4.3	0.0043	4.3×10^{-3}
12.7th July	25	0.0010	7.5	2.5	0.0025	2.5×10^{-3}
13.8th July	20	0.0010	7.5	2.5	0.0020	2.0×10^{-3}
14.9th July	20	0.0010	7.0	2.5	0.0025	2.5×10^{-3}
15.10th July	34	0.0010	7.0	3.8	0.0038	3.8×10^{-3}
16.11th July	41	0.0010	7.0	4.5	0.0045	4.5×10^{-3}
17.12th July	42	0.0010	7.0	4.4	0.0044	4.4×10^{-3}
18.13th July	44	0.0010	7.0	4.6	0.0046	4.6×10^{-3}
19.14th July	42	0.0010	7.0	4.7	0.0047	4.7×10^{-3}
20.15th July	41	0.0010	7.0	4.3	0.0043	4.3×10^{-3}
21.16th July	43	0.0010	7.0	4.4	0.0044	4.4×10^{-3}
22.17th July	42	0.0010	7.0	4.5	0.0045	4.5×10^{-3}
23.18th July	41	0.0010	7.0	4.0	0.0040	4.0×10^{-3}
24.19th July	35	0.0010	7.0	3.8	0.0038	3.8×10^{-3}
25.20th July	40	0.0010	7.0	4.0	0.0040	4.0×10^{-3}
26.21st July	40	0.0010	7.0	4.1	0.0041	4.1×10^{-3}
27.22nd July	41	0.0010	7.2	4.0	0.0040	4.0×10^{-3}
28.23rd July	36	0.0010	7.1	3.8	0.0038	3.8×10^{-3}
29.24th July	24	0.0010	7.0	2.9	0.0029	2.9×10^{-3}
30.25th July	40	0.0010	7.0	3.7	0.0037	3.7×10^{-3}
31.26th July	32	0.0010	7.0	3.4	0.0034	3.4×10^{-3}
32.27th July	41	0.0010	7.2	3.8	0.0038	3.8×10^{-3}
33.28th July	38	0.0010	7.1	3.0	0.0030	3.0×10^{-3}
34.29th July	38	0.0010	7.2	3.8	0.0038	3.8×10^{-3}
35.30th July	32	0.0010	7.0	3.1	0.0031	3.1×10^{-3}
36.31st July	30	0.0010	7.0	2.9	0.0029	2.9×10^{-3}
37.Ist August	32	0.0010	7.0	3.2	0.0032	3.2×10^{-3}
38.2nd August	29	0.0010	7.5	3.0	0.0030	3.0×10^{-3}
39.3rd August	28	0.0010	7.5	3.0	0.0030	3.0×10^{-3}
40.4th August	27	0.0010	7.2	3.0	0.0030	3.0×10^{-3}
41.5th August	39	0.0010	7.1	4.0	0.0040	4.0×10^{-3}
42.6th August	40	0.0010	7.0	4.4	0.0044	4.4×10^{-3}
43.7th August	31	0.0010	7.0	4.5	0.0045	4.5×10^{-3}
44.8th August	38	0.0010	7.0	3.7	0.0037	3.7×10^{-3}
45.9th August	37	0.0010	7.2	3.5	0.0035	3.5×10^{-3}
46.10th August	36	0.0010	7.1	3.4	0.0034	3.4×10^{-3}
47.11th August	35	0.0010	7.0	3.4	0.0034	3.4×10^{-3}
48.12th August	37	0.0010	7.4	3.5	0.0035	3.5×10^{-3}
49.13th August	38	0.0010	7.4	3.8	0.0038	2.8×10^{-3}
50.14th August	38	0.0010	7.2	3.3	0.0033	3.3×10^{-3}
51.15th August	37	0.0010	7.3	3.2	0.0032	3.2×10^{-3}
52.16th August	38	0.0010	7.1	3.2	0.0032	3.2×10^{-3}
53.17th August	36	0.0011	7.2	3.1	0.0031	3.1×10^{-3}
54.18th August	38	0.0010	7.3	3.1	0.0031	3.1×10^{-3}
55.19th August	37	0.0010	7.1	3.3	0.0033	3.3×10^{-3}
56.20th August	35	0.0010	7.1	2.5	0.0025	2.5×10^{-3}
57.21st August	31	0.0010	7.2	1.9	0.0019	1.9×10^{-3}
58.22nd Aug	31	0.0010	7.2	1.5	0.0015	1.5×10^{-3}

Table 1 shows biogas data collection, conditions for production and volumes of production. The experimental data as presented in the Table 1 has been used to establish the biogas produced and some bio-digester operational variables as shown in the Tables 2 and 3 below.

Table 2: Microbial Count Assessment of Cow Dung with Dilution Factor

S/N	Parameter	Unit	Dilution Factor	Plate 1	Plate 2	Average	Cfu/g
1	THBC	Cfu/g	10^4	14	16	15	$1.5x10^6$
2	THFC	Cfu/g	10^2	4	6	3	$3x10^3$
3	Total coliform count	Cfu/g	10^2	20	16	18	$1.8x10^4$
4	Total staphylococci count	Cfu/g	10^2	30	26	28	$2.8x10^4$
5	Total vibrio sp count	Cfu/g	10^2	00	00	00	0
6	Shigella and Salmonella counts	Cfu/g	10^2	00	00	00	0
7	Total pseudomonas count	Cfu/g	10^2	00	00	00	0

Key THBC = Total heterotrophic bacterial count, THFC = Total heterotrophic Fungal count

Tables 2 and 3 show microbial count assessment of cow dung with dilution factor justification of the various analysis of the Total heterotrophic bacterial count (THBC) and the Total heterotrophic fungi count (THFC) which elaborates the dilution factor and non-dilution factor which gave an impressive level of Cfu/g with respect to the THBC, THFC, Total coliform count and total staphylococci count.

Table3 shows the result of microbial count both in Cfu/g and Log Cfu/g as $9.1x\ 10^{17}$ and 18.34 respectively.

Table 3: Microbial Count Assessment of Cow Dung without Dilution Factor

	Parameter	Counts (Cfu/g)	Count (Log_{10}Cfu/g)
1	THBC	$1.5x10^6$	6.17
2	THFC	$3x10^3$	3.47
3	Total coliform count	$1.8x10^4$	4.25
4	Total staphylococci count	$2.8x10^4$	4.45
5	Total vibrio sp count	0	0.0
6	Shigella and Salmonella counts	0	0.0
7	Total pseudomonas count	0	0.0
	Total	$9.1x\ 10^{17}$	18.34

Table 4 shows the results moisture content, N_2, total and volatile solids and carbon content as 55.06, 0.45, 142.59, 24.34, 86.85 and 32.5.

Table 4: Results of Physical Parameters and Identity

S/NO	Sample Identity	Results (volumes)
1	Percentage Moisture	55.06
2	Percentage N_2	0.45
3	Mg/1kg	142.59
4	Percentage Total Solids	24.34
5	Percentage Volatile Solids	86.85
6	Percentage Carbon	32.5

4.0 Discussion of Findings

At the end of the research, 201.2 litres of biogas was collected and when converted will give $0.201m^3$ of biogas. Analysis carried out to check what is obtainable in previous research as against what was generated in the course of the research, found out that 148 kg of cow dung can actually generate 0.444 m^3 of biogas as against $0.201m^3$ obtain from this research.

The bulk of gas was also generated from the 18th day after the slurry was introduced into the bio-digester as against 25th day as generally recorded by various researchers [13]. It is also important to note that the biogas production exceeded the 45 days' time frame for collection. The pH was stable for almost the entire duration of the research, constant readings of 7.0-7.5 was recorded all through the period. The pressure rating was very low in spite of various temperature changes and the days recorded for anaerobic digestion period, which invariably means temperature and the number of days for digestion didn't affect the pressure that was recorded as 0.0010 psi for better period of the research.

Results showed that after the analysis of the cow dung there was substantial amount of total coliform

count, total staphylococci count, total heterotrophic bacterial count and Total heterotrophic fungal count good enough to generate the required biogas needed for the research work. Total heterotrophic bacterial count was 1.5 x 10^6, while the total heterotrophic fungi count was 3.0 x10^3 which is reasonably high for purpose of generating substantial microbial count. The total coliform count and total staphylococci count were also reasonably high with 1.8 x 10^4 and 2.8 x 10^4 respectively good for the purpose for generating enough biogas for the research purpose. The range of results showed contrary values as total heterotrophic bacteria increased from 3.1x10^6 to 14.4x10^6Cfu/ml, Salmonella-Shigella bacteria decreased from 12.0x10^4 to 1.52x10^4 Cfu/ml, total coliform bacteria, decreased from 29,000 to 18,000 coliform/100ml, while faecal coliform bacteria decreased from 16,000 to 12,000 coliform/100ml after 48 hours using Biozyme 1070 [14]. The synergistic use of mechanical and enzymatic degradation makes anaerobic fungi promising candidates to improve biogas production from recalcitrant biomass [15].

Substantial amounts of biogas were produced as various parameters, such as pressure, temperature and pH, were reported and analyzed during the period of study. The slurry began production of biogas on the 5th day. However [7], found out that biogas began production on the twentieth (20th) day following the introduction of cow dung into the digester, that is to say, biogas output on the fifth day as a result of a succulent addition. In his work on biogas output, [13] claimed that production began on the 8th day of the slurry adoption contradicting the predicted fiftieth day as the highest production rates on 4 July, 14 July and 6 August, as clearly shown in data collection in the Table 1.

The highest temperature during the three days varies from 40^{o}C on 11 day and 42^{o}C on the 21st day and 40^{o}C on 44th day after slurry introduction and it justifies the mesophilic values by [16] which helped biogas growth. The production was lowest at 25^{o}C, 20^{o}C and 20^{o}C on 14, 15 and 16 days after the introduction of the slurry as clearly shown in Table 1. This shows the basic requirement of high-temperature in biogas processing. Results also shows an impressive biogas production on 15th 16th and 17th day of August, which could not be too far from high extreme sunshine recorded during these periods contributing to high production which also conform with mesophilic temperature been ideal for biogas production. The temperature was recorded every day during the biodegradation and subsequent biogas generation gave an idea of the temperature that was ideal for biogas generation. The temperature gives the kinetic energy that enhances microbial activities or metabolism on the feed stock hence the generation of the biogas, which invariably means that temperature plays a vital role in biogas generation, hence the need for its measurements.

The pH for almost 95% of the study period was 7.0 except for the first day of incorporation of the cow dung, 15 June, were pH was registered at 2.5. This comparison is not compatible with the argument put forward by [7] that methanogenic bacteria were highly active at the pH point of 7.0. The pH gives the intensity of acidic or basic character at a given temperature and at a specific level is needed for microbial activities to become more active because when this optimum pH level is not attained, microbial activities will be low hence low biogas generation. The biogas pressure generated was very low, so it was difficult to analyze the reading got from pressure gauge. Expected mesophilic (35^{o}C–45^{o}C) temperature was not exceeded, which could be reason for low pressure since the production was average [17]. High biogas production in week 2 was recorded for the digester which is relative to the finding of [18] who reported highest biogas production in week 2 for anaerobically digested abattoir waste. If high microbial activity occurs in the bio-digester, the pressure of biogas will be high, as previous research work has shown that temperature is one of the leading factors in biogas generation. On the 10, 11 and 13th day, the maximum pressure recorded was from 0.013 psi, 0.014 psi and 0.015 psi respectively, with a fairly high temperatures of 37^{o}C and 40^{o}C as registered in Table 1. The pressure revealed that the microbial behaviour is not at its highest, which is why the output level is low. For nearly 95 percent of the research time a constant pressure of 0.0010psi was observed. The biogas pressure rating generated is directly proportional to the amount of cow dung inserted into the digester and also to the temperature level that must be at least in the mesophilic level (35-45) or even in the thermophilic level (55^{o}C – 65^{o}C) . The strain found in this research may be due to low temperatures and the volume of feed injected into the digester. About 148 kg of cow dung was introduced into the bio-digester in this study. After testing, a total of 201.2liters of biogas was generated for 60 days, which is 0.201m^3 when processed as was done earlier by other researches [8] [19].

Similar results reported that 1 kg of cow dung would generate 0.003 m^3 of biogas, and this findings show that 1 kg of cow dung would produce 0.0014 m^3 but the inability to attain the thermophilic temperature of 45^{o}C–65^{o}C could be the reason not attaining the research standard [7]. The highest total volume of biogas produced (15.60 cm^3) was left at ambient temperature and in which gas was collected over water [20]. The purpose of the cow dung gathered for the study was able to generate the requisite fungal and bacterial count, which would eventually create the biogas. A six-hour microbial study, as reported by [11], was conducted in a laboratory to conform to suitability. The figure revealed that the coliform count was 6.17 with the total heterotrophic count of bacteria, 3.47 coliform counts with the total heterotrophic fungal count, the coliform total count and the total staphylococci count is 4.25, and 4.45 coliform counts respectively (see Table 2 and 3 above). Biogas production rose with increase in retention time as found in previous studies [20].

5.0 Conclusion

The evaluation of biogas production using cow dung in a digester was carried out and found that a total of 190.2 litres and 0.1936m^3 of biogas were generated in 52 days. Gas production rose with increase in retention time. An average temperature of 33.7^{0}C and pressure of 0.0011 psi was used to generate the volume of biogas so produced. One (1) kg of cow dung would produce 0.0014 m^3 which can be achieved using the best combination of various parameters like temperature, pressure and pH that will give maximum biogas production as clearly shown in this study. Microbial analysis carried out on cow dung used for the research show high a level of total heterotrophic fungi count (THFC) and total heterotrophic bacterial count (THBC) which was sufficient to generate the required biogas, and further determine the amount of cow dung required to generate a specific amount of biogas. This implies that the more the quantity of cow dung hence microbes, optimum temperature and alkaline system should be provided to obtain adequate biogas production.

Conflict of Interest : Both authors declare that there are no conflicts of interest

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