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BIOGAS PRODUCTION FROM CHICKEN DROPPINGS.

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ABSTRACT
Biogas production from chicken droppings (total solids 86.5 %, moisture content 13.5%, volatile solids 64.3 %, pH, 6.7) was undertaken. Dried chicken droppings used were 2.8 kg which was added to anaerobic digester containing 3.7 liters of warm water and it was left to digest at 28 ^{0}C. Biogas production started after 7 days and reached an average amount of 72.2cm^{2}/kg/day after three weeks. Two groups of bacteria were isolated from the digester. These were the acid formers (*Bacillus subtilis, Pseudomonas aeruginosa, Staphylococus aureus* and *Escherichia coli*) and the methane formers (*Methanobacterium* sp and *Methanococcus* sp). Fungi isolated include: *Mucor mucedo, Aspergillus niger* and *Penicillium notatum*. Temperature of 33.3 ^{0}C was optimum for the production of biogas (90cm^{3}/kg/day). The resultant sludge was used to stimulate maize plant growth and the results indicated that maize plant grown on soil which had no sludge had an average height of 711 mm while those grown on the sludge had an average height of 1564 mm after fourteen days. The results of this study suggest that chicken droppings can be used for biogas production and as biofertilzer.

Key words: Biogas, chicken droppings, anaerobic digester, methane formers, sludge

INTRODUCTION

On the average, the physical compositions of chicken droppings include faeces, urine and litters which are mainly made up of nitrates. Nitrate pollution is undesirable because of its potential role in eutrophication, methemoglobinemia and nitrosamines formation (Ajuyah, 1996).

The process of methanogenesis include hydrolysis, acidogenesis/acetogenesis and methanogenesis (Ainswort *et al*., 2001; Odeyemi, 2001; Charles *et al*., 2003). Methane is the main component of biogas (50-70%). Other components include $C0_2$ (30-40%) and traces of H_2S and H_20 vapour (Odeyemi, 2001).

The presence of $C0_2$ and H_2S in biogas is undesirable hence need to be removed for optimum performance. The $C0_2$ can be removed by passing the gas into calcium hydroxide, potassium hydroxide, barium hydroxide or water while the H_2S can be removed by passing the gas into copper sulphate, iron sulphate, lead nitrate, iron chloride or water (Lawal *et al.,* 2001). Factors affecting biogas production include the C:N ratio, temperature, retention time, pH, concentration of slurry, stirring/mixing rate and the feeding of bacteria(starter) (Oyeleke *et al*., 2003).

One of the burning problems facing the world today is the management of all sources which endangers the existence of human life. The present study aims at producing biogas from chicken droppings and to utilize the residual sludge as biofertiliser.

MATERIALS AND METHODS

Collection of Samples: Dried chicken droppings were obtained from the Niger State Livestock Feeds, Bosso, Minna, Nigeria and brought into the Microbiology Laboratory of the Federal University of Technology, Minna in clean polythene bags.

Characterization of the Chicken Droppings: The physicochemical parameters of the chicken droppings were determined by testing for the total solids, moisture content, volatile solids and ash contents using methods described by Jeffery *et al*., (1989).

Preparation of the Slurry: 2.8 kg of chicken droppings was measured into 3.7 litres of warm water, mixed and filled into an anaerobic digester with occasional agitation as described by Bajah & Garba (1992).

Determination of pH and Temperature: The pH of the slurry was determined using SUNTEX pH meter (SP-701) while the temperature was measured using a thermometer.

Preparation of Media: The culture media used were prepared following standard laboratory methods described by Cheesbrough (2003). These include: nutrient broth, nutrient agar, centrimide agar, mannitol salt agar and sabauraud dextrose agar.

Isolation and Characterization of Microorganisms: The slurry was serially diluted using a tenfold serial dilution and 0.1ml of 10^{-7} dilution factor was spread onto nutrient agar plates for the enumeration and isolation of bacteria and sabauraud dextrose agar for the enumeration and isolation of fungi. The nutrient agar plates were incubated aerobically and anaerobically at 37 ^{0}C for 24 hours. The sabauraud dextrose agar plates were incubated at 28 ^{0}C for 3-5 days. Bacterial isolates were characterized using methods described by Cowan (1974) while fungi were characterized based on macroscopic and microscopic examination (Domsch & Gams, 1970).

Digestion Process
A 60 liter cylindrical digester tank was used. The slurry was loaded into the digester through the inlet. This was sealed to exclude air from getting into the digester. The other end of the tubing was connected to a round bottom flask underwater to receive the $C0_2$ and H_2S gas within a retention period of ten (10) days. The water into which the tubing was passed was tested for acidity using litmus paper.

The Effects of Sludge on Maize Plant Growth: A small quantity of loamy soil was measured and placed in twenty containers and was adequately wetted with water. The sludge from the digester was mixed with soil ten containers while the remaining ten containers were left without sludge (control). Two grains of maize seed were planted in the soil in the containers. All observations with respect to germination and growth (in height) were recorded for two weeks.

RESULTS

Physicochemical properties of fresh chicken droppings and chicken droppings sludge at 18th day of digestion: Table 1 shows the physicochemical properties of fresh chicken droppings and chicken droppings at 18th day of digestion. There was an increase in the percentage (%) Total Solids (from 86.5 to 23.6%), moisture contents (from 13.5 to 76.4%), ash contents (from 35.7 to 44.8%), and pH (from 6.7 to 6.9) between the fresh chicken droppings and chicken droppings sludge at the 18th day of digestion but there was a decrease in their volatile solids (from 64.3 to 55.3%) and temperature (^{0}C) (from 31.3 to 30.0%).

Mean Counts of Bacteria Isolated from the Digester: Table 2 shows the mean count of bacteria isolated from the digester. The Bacterium with the highest mean count was *Methanococcus* sp. ($1.5x10^8$ cfu/g) followed by *Methanobacterium* sp. ($1.2x10^6$ cfu/g) while the bacterium with the least mean count was *Pseudomonas aeruginosa* (1.0 $x10^2$ cfu/g) followed by *Bacillus subtilis* ($1.5x10^3$ cfu/g).

Mean Counts of Fungi Isolated from the slurry before Digestion: The fungus with the highest mean count isolated from the slurry before digestion was *Mucor mucedo* ($1.7x10^3$cfu/g), followed by *A. niger* (2.0 x 10^2) and *Penicillium notatum* ($1.5x10^2$ cfu/g).

TABLE 1. PHYSICOCHEMICAL PROPERTY OF FRESH CHICKEN DROPPINGS AND CHICKEN DROPPINGS AT 18TH DAY OF DIGESTION.

PARAMETER	FRESH CHICKEN DROPPINGS	CHICKEN DROPPINGS SLUDGE AT 18TH DAY OF DIGESTION
Total Solids (%)	86.5	23.6
Moisture content (%)	13.5	76.4
Volatile solids (%)	64.3	55.3
Ash content (%)	35.7	44.8
pH	6.7	6.9
Temperature(^{0}C)	31.3	30.0

TABLE 2. MEAN COUNTS OF BACTERIA ISOLATED FROM THE DIGESTER SLUDGE.

Isolates	Mean Count (cfu/g)
B. subtilis	$1.5x10^3$
S. aureus	$1.1x10^5$
P. aeruginosa	1.0 $x10^2$
E. coli	$1.2x10^6$
Methanobacterium sp.	$1.2x10^6$
Methanococcus sp.	$1.5x10^8$

Effects of Temperature and pH on Biogas Production for 18 days: The mean biogas production was 72.2 cm^3/kg/day, mean pH was 6.9 while the mean temperature was 30.9 ^{0}C. The highest volume of biogas (90cm^3/kg/day) was produced on the 14th day at temperature of 33.3^{0}C and pH 7.0 followed by 85cm^3/kg/day on the thirteenth (13th) day at a temperature of 33.0 ^{0}C and pH 7.0. The least volume of biogas (60cm^3/kg/day) was produced on the 9th day with a temperature of 28 ^{0}C and pH 7.2.

Mean effects of sludge fortified soil on growth of maize plants (mm): Table 3 shows the effects of sludge fortified soil on growth of maize plant (mm). The highest growth of maize fortified with sludge with a growth period of fourteen (14) days was 3300 mm while the highest growth of maize plant unfortified with sludge with a growth period of fourteen (14) days was 1400 mm. The mean growth of maize fortified with sludge was 1564 mm while the mean growth of maize plant unfortified with sludge was 711 mm.

TABLE 3. MEAN EFFECTS OF SLUDGE FORTIFIED SOIL ON GROWTH OF MAIZE PLANTS IN MILLIMETERS

No of days	Sludge fortified soil	Unfortified soil
1	250	150
2	400	165
3	550	200
4	750	350
5	850	420
6	1000	520
7	1400	700
8	1600	750
9	1750	800
10	1950	850
11	2500	1150
12	2700	1200
13	2900	1300
14	3300	1400
mean	**1564**	**711**

TABLE 4. EFFECTS OF TEMPERATURE AND PH ON BIOGAS PRODUCTION FOR 18 DAYS.

Days	Biogas Production cm^3/kg/day	pH	Temp (^0C)
1	75	6.7	31.8
2	70	7.0	31.6
3	68	7.0	31.0
4	80	6.9	32.5
5	75	6.8	32.0
6	78	6.7	32.5
7	82	6.9	33.3
8	68	7.4	30.3
9	60	7.2	28.0
10	63	7.0	28.5
11	68	7.1	29.5
12	75	7.2	31.0
13	85	7.0	33.0
14	90	7.0	33.3
15	65	6.9	30.0
16	65	6.8	29.0
17	64	6.7	28.5
18	69	6.7	30.0
Mean	**72.2**	**6.94**	**30.9**

DISCUSSION

The results of the physicochemical properties of chicken droppings over a period of 18 days shows a decrease in the total solids(%) and volatile solids(%) from 86.50 to 23.60 and 64.32 to 55.23 respectively. This may be due to the utilization of the wastes by the microorganisms. This agrees with the reports of Oyeleke *et al*., (2003), who stated that, the total solids and volatile solids reduce as methane yield increases. The pH ranged from 6.8 to 7.4 in agreement with Hansen (2001) who reported that pH range of 6.8 through neutral to 7.4 is required for optimum biogas production while the temperature varied from 28^{0}C to 33.3^{0}C. Gas production was observed with increased temperature (Table 4), agreeing with Lawal *et al*., (2001) that biogas production is favored with an increased temperature and as temperature drops, so the rate of biogas production declines.

The detention and retention period for biogas production were eighth days and ten days respectively. This may be due to the accumulation of acids, exhaustion of nutrient or production of auto toxic substances by the microbes because this process is a batch culture system.

Two groups of bacteria were isolated from the digester (Table 2). These include the acid formers (*B. subtilis, P. aeruginosa, S. aureus,* and *E. coli*) and the methane formers (*Methanobacterium* sp. and *Methanococcus* sp.). The acid formers convert the complex compounds in chicken wastes such as carbohydrate, protein and fats into low molecular weight fatty acids, acetate and simple organic compounds. These are then converted by methane producing bacteria to biogas.

The 2.8kg of the chicken droppings produced a total of 1300cm^3 of biogas with retention period of 10 days with an average of 72.2cm^3/kg/day. The low quantity of biogas produced by the chicken droppings may be due to its low C:N ratio of 10:1. Lawal *et al.,* (2001) stated that poultry droppings contain a high level of urea which on decomposition produced a bulk of ammonia gas.

Maize plant fortified with sludge (Table 3) gave a mean growth of 1564 mm while the unfortified soil gave a mean growth of 711mm. This may be due to the increased organic nutrient in the sludge fortified soil which serves as a fertilizer to the maize plant. Thus, although chicken dropping is not an excellent substrate for optimum biogas production, it can serve as an excellent biofertilizer.

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