EFFECT OF INOCULUM ON CO-DIGESTION OF CHICKEN DROPLET AND FOOD WASTE FOR BIOGAS PRODUCTION

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ABSTRACT
Increased in Population brings about high demand of energy, the available source of energy is seriously reducing. The need for alternative sources of energy is vital. This paper looked at Chicken Droplet (CD) and Food Waste (FW) as sources of renewable energy. The best system of utilizing this waste is by anaerobic digestion of the substrate. In this study, Three (3) no of six (6) liters batch anaerobic reactors are fed with Chicken Droplets (CD), Food Waste (FW) and Inoculum (I) of Rumen fluid at various mixtures (100%CD, 70%CD: 30%FW & 100%I, 30%C: 70%FW & 100%I). The digestion process took place at room temperature for a thirty (30) day period, the lag phase for these reactor were six (6) days for 100%CD and four (4) days for both 70%CD: 30%FW & 100%I and 30%C: 70%FW & 100%I. This anaerobic digestion process produced biogas in all the three (3) with 70%CD: 30%FW & 100%I having highest volume of 0.1litres. The final value of Total solids for 100%CD was 682mg/L, 70%CD: 30%FW & 100%I was 633mg/L 30%C: 70%FW & 100%I was 660mg/L. Volatile solids for 100%CD was 340mg/L, 70%CD: 30%FW & 100%I was 447mg/L, 30%C: 70%FW & 100%I was 462mg/L, Total Nitrogen for 100%CD was 3.2%, 70%CD: 30%FW & 100%I was 3%, 30%C: 70%FW & 100%I was 1.7%, Organic Carbon content for 100%CD was 10%, 70%CD: 30%FW & 100%I was 9.8%, 30%C: 70%FW & 100%I was 13.55% these values were reduced because of anaerobic digestion compared to their initial value before anaerobic digestion. From the result analysis anaerobic co-digestion improved the volume of biogas produced where reactor D2 of Chicken Droplet (CD) 70%: Food Waste (FW) 30% & Inoculum (I) 100% and D3 30%CD: 70%FW & 100%I produced more biogas volume than mono digestion. Thus, Chicken droplets and food waste are good sources of biogas production.

Keywords: *Anaerobic, Chicken, Food waste, Rumen fluid*

1 INTRODUCTION

Increase of municipal solid waste in developing countries due to population increase has raised concern with respect to the best system of disposal and treatment of such waste. Water pollution and adequate energy resources affect economic human development and environmental health (Mshandete and Parawira, 2009).

Population increase brings about high demand of energy, and the wastes generated are good alternative sources of energy which is renewable. The best system of utilizing these wastes is by anaerobic digestion of the substrate. Anaerobic digestion of agricultural waste produces a by-product called biogas. Anaerobic digestion is a biochemical process whereby organic matter is first decomposed by acidic bacteria and the process is completed by bacteria which thrive in slightly alkaline environment to produce methane and other by products in the absence of oxygen (Chukwuma, 2012).
Biogas is a clean source of energy used for various purposes such as: heating, cooking, transport and power generation. Biogas usually contains about 55-65% methane, 30-35% carbon dioxide, and trace amount of hydrogen, nitrogen and other impurities (Ojikutu and Osokoya, 2014). Biogas is produced from biological breakdown of organic matter (kitchen waste, dead animals, human excretal etc.) in the absence of oxygen (Ojikutu and Osokoya, 2014). In this research, food waste and chicken droplet were used as anaerobic digestion substrate.
The aim of this study determined the effect of using Rumen fluid as inoculum on the rate of biogas production from anaerobic digestion of Chicken Droplet and Food Waste.

2 MATERIALS AND METHODS

Chicken Droplets was collected from the Farm of Niger State Ministry of Agriculture and livestock Bosso, Minna, Niger state, while Food wastes was collected from Federal University of Technology (F.U.T) Minna Main Campus food canteen and the Rumen fluid (Inoculum) was taken from Minna abattoir and were taken immediately to Water and Fishery Technology (WAFT) laboratory at F.U.T. Main Campous, Minna, for analysis.
Samples from Farm of Ministry of Agriculture and livestock Bosso of fresh poultry manure (Chicken Droplets) were taken from 5-cage layers house, to get representative result during analysis.

The following parameters were determined in the laboratory using standard method; total solid (TS), volatile Solid (VS), Biological Oxygen Demand (BOD), Total Nitrogen, Organic Carbon and Ammonia- Nitrogen Content. pH using standard method.

This research was conducted for a thirty (30) days. Three (3) no of six (6) liters batch tank reactors are fed with Chicken Droplets (CD) and Food Waste (FD) in the following manner;

First digester named D1 contained 1500g Chicken droplets (CD) weighed with a weight balance which equals 100% was mixed with one thousand grams (1000g) of water to ensure homogeneity of mixtures which made a total of one thousand seven hundred grams (1700g) volume in the reactor; this was ascertained using a S.PYREX 1000 milliliters (ml) Measuring cylinder. The temperature and pH reading was taken before substrate was charged into the reactor.

The second digester named D2 contained 1100g Chicken droplets (CD) also weighed which equals 70%, Five hundred gram (500g) food waste (FW) which is 30% and five hundred gram (500g) of Inoculum (Rumen fluid) which is 100% these were mixed with one thousand five hundred grams (1500g) of water forming a total of two thousand five hundred gram (2500g) volume in the reactor. The temperature and pH reading was taken before substrate was charged into the reactor.

Third digester named D3 contained five hundred gram (500g) chicken droplets (CD) which is 30%, one thousand one hundred (1100g) of food waste (FW) which is 70% and five hundred (500g) grams of Inoculum (Rumen fluid) which is 100%. These were mixed with two thousand gram (2000g) of water forming a total of two thousand eight hundred gram (2800g) volume in the reactor as shown in table 2.1. The temperature and pH reading were taken throughout the study period of thirty days (30) after substrates were charged into the reactor. Readings were taken at two (2) days interval to ascertain pH nature and temperature range at which the reactor is digesting substrates to know if the reactor was at optimal condition.

TABLE 2.1 DIGESTION DESCRIPTION IN REACTORS

Digester	Chicken Droplets (kg)	Food waste(kg)	Inoculum(Liter)	Volume in Reactor (Liter)
D1	**1.5**	**0**	**0**	**1.7**
D2	**1.1**	**0.5**	**0.5**	**2.5**
D3	**0.5**	**1.1**	**0.5**	**2.8**

3 RESULTS AND DISCUSSION

The lag phase of various mixtures was different because of different composition of the substrates shown in the Table 3.1. The table describe the lag phase of various mixture and the control.

TABLE 3.1: LAG PHASE OF SUBSTRATES

Mixing Ratio	100%CD	70%CD, 30%FW & 100% I	30%CD, 70%FW 100% I
Period(Days)	**6**	**4**	**4**

3.2 Characterisation of Substrates

Total solids (TS), volatile solids (VS), Biological Oxygen Demand, Total Nitrogen, Organic Carbon and Ammonia Nitrogen (NH_3-N) were carried out using the standard methods (APHA., 2005). From these result volatile solids had the highest reduction percentage as shown in Table 3.2 this showed that volatile solids gives a measure of organic matter available for biogas production. Dupade and Pawar, (2013) reported result that treatment of food influent using micro-organisms from anaerobic digestion produced useful bi-product, biogas with a considerable rate of decrease in the values of COD, BOD, pH, acidity and alkalinity, through the successful anaerobic digestion inside their reactors for 90days.

TABLE 3.2: RESULTS OF SUBSTRATES CHARACTERISATION FROM WATER AND FISHERY TECHNOLOGY LABORATORY.

Test Conducted	Chicken Droplet (CD 100%)influent	Chicken droplet (70%) & Food Waste (30%) Influent	Chicken droplet (30%) &Food Waste (70%)Influent	Chicken Droplet (CD 100%)Effluent	Chicken droplet (70%) & Food Waste (30%)Effluent	Chicken droplet (30%) &Food Waste (70%)Effluent
Total Solids (mg/L)	**975**	**1055**	**944**	**682**	**633**	**660**
Volatile Solids (mg/L)	**680**	**746**	**834**	**340**	**447**	**462**

Total Nitrogen (%)	**4.06**	**3.55**	**2.88**	**3.2**	**3**	**1.7**
Organic Carbon (%)	**19.95**	**19.66**	**19.25**	**10**	**9.8**	**13.55**
Ammonia-Nitrogen Content(NH_3-N)mg/L	**1.4**	**1.19**	**0.91**	**1.2**	**0.8**	**0.5**
Biological Oxygen Demand(mg/L)	**15**	**13.2**	**10.8**	**9**	**6.6**	**7**
pH	**7.64**	**6.85**	**7.64**	**5.5**	**5.9**	**5.0**
Temperature (°C)	**32.1**	**31.2**	**30.5**	**36.5**	**33.8**	**38.2**

Substrates influents of 100% CD: 70% CD & 30% FW: 30%CD & 70% FW had reductions in total solids, volatile solids, ammonia nitrogen content and biological oxygen demand in mg/L after anaerobic digestion. Similarly total nitrogen and carbon content of substrates influents of 100% CD: 70% CD & 30% FW: 30%CD & 70% FW were reduced after anaerobic digestion process. This is similar to study conducted by Velmurugan and Alwar, (2011) that anaerobic digestion of vegetable waste which is a food waste had percentage reductions of 60.77% and 68.6% in total solids and volatile solids respectively.

Oliveira and Doelle, (2015) result also reported that volatile solids reduce by 81% at twenty-eight (28th) day of anaerobic digestion. Tamrat *et al*, (2013) result from Co-digestion of cattle manure with organic kitchen waste to increase biogas production using rumen fluid as inoculums also proved anaerobic digestion reduces total solids, volatile solids.

The figure 1 shows production of biogas from 100% chicken droplet, started on the sixth (6th) day which rose slowly to 0.062 litres on the twenty-second (22) day, reduced to 0.058 litres on the twenty-fourth (24) day and increased to 0.06 litres on the twenty-sixth (26) day. Volume of the biogas declined gradually as number of days increased. This could be as a result of exhaustion of volatile solid content present in the substrates which is a measure of organic matter available for production of biogas (Sidik, *et al* 2013). It was observed that daily biogas production from 100% chicken droplet was lower than both 70% chicken droplet and 30% food waste and 70% food waste and 30% chicken droplet. Molinuevo *et al*, (2013) reported chicken manure digested singly produced lower biogas volume compared to co-digestion with food waste. This study showed pure chicken droplets (Controlled) produced lower volume of biogas when compared to the other reactors where co-digestion was achieved with presence of inoculum.

Biogas produced from 70% chicken droplet and 30% Food Waste started on the fourth (4th) day, a reduced time compared to mono digestion without presence of inoculum. This volume rose slowly to 0.1 liters. Production of biogas decreased slightly till 0.035litres, this volume of 0.1 liters biogas which is the highest of all three (3) reactors could also result from inoculum presence or adequate proportion mixture with water during preparation. Previous study from Ravi *et al*, (2013) confirms this where one of the reactors had a mixture of eight kilograms (8kg) of substrate to sixteen (16) liters of water digested singly without inoculum, with methane percent of (48%). Hence this study proved inoculum improves percentage of methane in biogas because methane percent in 70% chicken droplet and 30% food waste co-digestion had fifty-five (55%) percent methane.

Lag phase for biogas generation in reactor D2 (70% Chicken Droplet & 30% Food Waste) and D3 (30% Chicken droplet & 30% Food Waste) was shorter compared to reactor D1 (100% Chicken Droplet), this could result of inoculum added to both reactor. It is possible the presence of this inoculum contributed to the increase in biogas volume of reactor D2 and D3 which had the highest volumes. However, it should be noted that the digestive system of the animal will influence the amount of organic matter in its faeces (Ahmadu *et al*, 2009). Biogas production from 70% chicken Droplet & 30% Food Waste could also be attributed to the available nutrients in both substrates as well as co-digestion as shown figure 3.1.

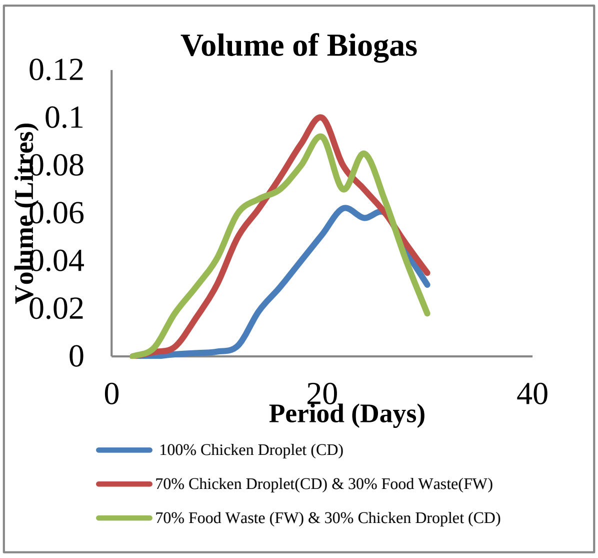

FIGURE 3.1: VOLUME OF BIOGAS PRODUCED

4. CONCLUSION

In this study inoculum (rumen Fluid) reduced lag phase for biogas production from Chicken Droplet and Food Wastes of different mixtures, compared to the control. Therefore, Co-digestion improved the volume of biogas produced. And reactor D2 of Chicken Droplet (CD) 70% & Food Waste (FW) 30% had the highest biogas volume of 0.1litres within the study period.

This study showed rumen fluid has an effect on the rate of biogas produced at different mix ratio. Therefore, using the rumen fluid as inoculum would be of high benefit.

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