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Effect of Inoculums on Biogas Yield

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Abstract: *Anaerobic digestion is a biological method used to convert organic wastes into biogas and a stable product land application without adverse environmental effects. The biogas produced could be used for heating, cooking and electricity generation while the residue Horn the process is a high quality fertilizer. Some of the organic wastes used for biogas production include cattle manure, pig manure, chicken dung, corn silage, fresh grass etc. The aim of this study is to analyze the effect of inoculums on biogas yield. The substrate used is cattle manure and the inoculum used is rumen fluid. The chemical oxygen demand (COD) of the cow manure was determined to be 9200mg/h. A 750ml biodigester was used and water displacement method was used to monitor the amount of biogas produced. 100g of fresh cattle manure (M) was fed to each biodigester and mixed with rumen fluid (R) and tap water (W) in several ratio resulting five difference M:W:R ratio i.e. 1:1:0, 1:0:75, 0:25:1, 0:5:0, 5: 1:0, 25:0:75 and 1:0:1 corresponding to 0, 12.5, 25, 37.5 and 50% rumen respectively. The operating temperature was at room temperature. The results showed that biogas production increase with increased in the amount of inoculums.*

Keywords: *anaerobic digestion, rumen fluid, inoculums, biogas production*

I. Introduction

Energy is one of the most important factors to global prosperity. The over dependence on fossil fuels as primary sources of energy has lead to environmental degradation, climate change and health problems. By the year 2040 we will have to feed 9–10 billion people and to provide them with energy and materials (okkerse and Bekkum , 1999). With the recent increase in oil price, natural gas may drive the economy toward alternative source of energy such as biogas.

Anaerobic digestion (AD) is a biological method used to convert organic wastes into biogas and a stable product for land application without adverse environmental effects. The biogas produced can be used as an alternative renewable energy source, Anaerobic digestion that utilizes manure for biogas production is one of the most promising uses of biomass waste because it provides a source of energy which simultaneously resolving ecological and agrochemical issue. The rate and efficiency of the anaerobic digestion problem is controlled by the type of waste being digested, concentration, temperature, the present of toxic material, the PH and alkalinity, Hydraulic Retention Time (HRT), the solid retention time (SRT), the ratio of food to microorganism (F/M ration), the rate of digester loading and the rate at which to toxic end product of digestion are removed (Burke, 2001).

According to Sadaka and Dan Engler (2003), water content is one of the very important Parameter effecting AD of solid wastes. Water make possible the movement and growth of bacteria, facilitating the dissolution and transport of nutrient. On the other hands, according to (Budiyono et al, 2009) rumen fluid inoculated to biodigester gave significant effect to biogas production. Rumen fluid inoculums caused biogas production rate and efficiency increase two to three times in compare to manure substrate without rumen fluid. Hence this study focuses on the use of rumen fluid as inoculums for biogas production from cattle manure.

An inoculums is a good source of bacteria (Fulford 1998):' inoculums is a biological active liquid or partially digested organic waste medium, rich in micro-organisms (Maishanu, and maishanu, 1998). Microbial flora, elimination of lag phase and hence increased biogas production and methane contents especially where the synergy existed (Kanwar and Gulari, 1994). Different sources of inocula contain different colonies of biogas microbes and each type of colony acts upon some particular substances most efficiently. (Ramasamy et al, 1990), reported that abundant proteolytic organisms was found to be present in Cow-dung fed biodigester and other animal waste-fed digesters while (Preeti et al,1993), observed that white cow-dung feed digesters have higher amylolytic microbes, poultry - feed digesters showed higher proteolytic population.

Maishanu and Maishanu, (1998) reported that addition of Inoculums on bio-gas digesters enhanced gas generation, concluding that the age of Inoculums was found to be influential especially in specific gas production, cumulative gas production, retention time and percentage degradation of solid particles. An effort to improve methane yield was carried out by increasing the Inoculums content in biodigester. The results from these study shows that Inoculums are NJ substantially relevant in process kinetics of biogas production and the amount of methane produced seem proportional to initial cattle manure inoculums (Castillo et al, 1995). A strong influence of the bovine rumen fluid inoculums on anaerobic biostabilization of fermentable organic

fraction of municipal solid waste (lopes and et al, 2004) and the higher percentage of Inoculums gave the higher production of biogas (Forster -Cameiro et al 2008). However, almost all of AD studied before, Inoculums used were dominated by digested sludge from anaerobic digester as well as animal manure. Research findings have shown that rumen liquor can be used as a seed or Inoculums to optimize biogas production. According Budiyono et al (2009) Rumen fluid inoculated to biodigester gave significant effect to biogas production. Rumen fluid Inoculums caused biogas production rate and efficiency increase two to three times in compare to manure substrate without rumen fluid.

II. Material and Method

The materials used were as follows: Fresh cow dung, Water, Rumen fluid containing anaerobic bacteria as inoculums

Sample Preparation

The cattle manure and rumen fluid used in this research were taken from animal holding pen unit at Gariki and slaughters house located on Osubi road, Rumen fluid
was prepared as follow. Rumen content was poured to 1500ml polyethylene bottle and added 375m1 water. Solid content was separated from slurry to ensure that solid content in solution were dominated by bacteria. Before using, all raw manure collected was homogenized by mixing.

Experiment Setup

The experimental set-up represents a water displacement set-up. Three 750m1 polyethylene bottles plugged with lightly rubber plug were linked by a delivery tube. The first bottle served as the biodigester, the second bottle contained the water to be displaced and the third bottle was graduated and used as the measuring container. Biogas formed was measured by a water displacement method.

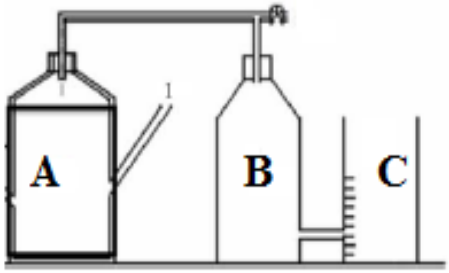

Figure 1: Water displacement set-up for biogas production

A = Bottle containing a mixture of manure and inoculums and water.
B = Bottle containing water to be displaced
C = Graduated cylinder to measure volume of gas produced.

Experimental Design

The effect of rumen fluid (inoculums) on biogas yield was studied by varying rumen fluid content in biodigester. A laboratory experiment using 750ml biodigesters were performed in batch operation mode. Manure used fixed on 100grams. A given 100grams of fresh cattle manure (M) was fed to each biodigester and mixed with rumen fluid (R) and tap water (W) in several ratio resulting five different M: W: R as shown in Table 1. Operating temperature was at room temperature. The biodigester performance was measured with respect to cumulative volume of biogas produced.

Table.1 Composition of five manure samples in different rumen content

S/N	Manure (g)	Water (ml)	Rumen (ml)	Rumen (%)
I	100.00	100.00	0.00	0.00
Ii	100.00	75.00	25.00	12.50
Iii	100.00	50.00	50.00	25.00
Iv	100.00	25.00	75.00	37.50
V	100.00	0.00	100.00	50.00

Experimental Procedures

The substrate and inoculums were fed gradually in batches into each biodigester via a plastic funnel through the inlet. The openings were tightly locked and sealed to avoid leakages and the set-up was then kept under room temperature (28-35°c) in the laboratory for the bacterial to act on the substrate. Biogas formed was

measured every five days and stopped after biogas was insignificantly produced. The biodigester performance was measured with respect to cumulative volume of biogas produced. The similar procedure was performed for the other four samples.

III. Results

The Effect of Rumen Fluid (Inoculum) Content to Biogas Production

The effect of rumen fluid content to biogas production was studied by varying manure, water and Rumen ratio, giving percent rumen fluid in mixed samples from 0 to 75% rumen with fixed 100gram manure. The data obtained from the study is cumulative volume of biogas production observed during 30 days as depicted in table 2. Numerical values of biogas yield in several days observation time is presented in Table 2

Time	Cumulative volume of biogas (ml)				
(days)	Sample I	Sample II	Sample III	Sample IV	Sample V
	(0%R)	(12.5%R)	(25%R)	(37.5%R)	(50%R)
0	0.00	0.00	0.00	0.00	0.00
5	10.00	32.00	35.00	40.00	45.00
10	38.00	75.00	76.00	90.00	96.00
15	70.00	120.00	127.00	150.00	170.00
20	115.00	135.00	140.00	168.00	205.00
25	127.00	140.00	146.00	177.00	225.00
30	130.00	145.00	150.00	180.00	240.00

% R = percent Rumen

From the chemical oxygen demand (COD) test, the result shows that the COD of the cow manure used is 19200mg/l

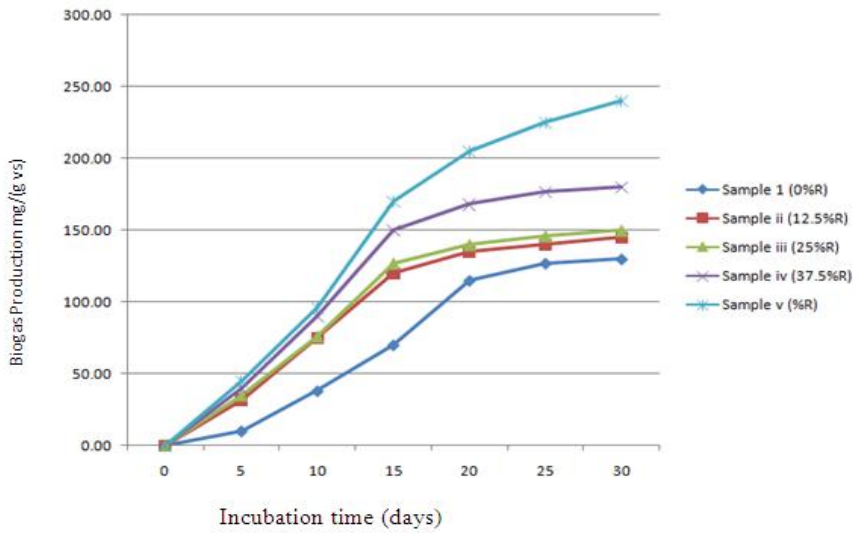

Figure 2. the relationship between biogas production (ml/g vs) and incubation time (days).

IV. Discussion of Results

Table 2. Shows that in general, substrates consist of manure and rumen (I 2.5 to 50%R) exhibit higher cumulative biogas production than substrates containing manure and water only (0%R). In other terms, specific biogas production per grain VS added of' samples containing rumen fluid is higher than sample containing no rumen fluid. In the 30 days observation, cumulative biogas production of 12.5, 25, 37.5 and 50%R are 145, 150, 180, 240 mg/g VS respectively while sample with 0%R give cumulative biogas production of 130mg/g VS

The above results suggest that the optimum rumen fluid content for giving the best performance of biogas production is in the range of 12.5-50%. Similar to this results, lopes et al (2004). Reported that no substantial difference was in evidence when 5% and 10% of the inoculums were used in preparation of the substrate in the Range of 0 to15% rumen tested, the sample with the highest rumen content (15%) gave the highest biogas production. Unfortunately, lopes et al do not extensively investigate yet in using inoculums content more than 1 5%. Hence, of course this study does not give data concerning optimum content of inoculums for biogas production. On the other hand, according to foster Carneiro et al (2008), when treated food waste restaurant with 20-30% inoculums, the best performance for food waste biodegradation and methane generation was the reactor with 30% of inoculums. However, we cannot call this as the optimum condition because the research (does not extensively investigate in using inoculums content more than 30%.

Table 2 Shows also, that biogas production lend to obey sigmoid function (S curve) as generally occurred in batch growth curve and as also has be resulted by Budiyono et al. (2009). Biogas production is slow at the beginning and the end period of observation. This is predicted due to the biogas production rate in batch condition which directly corresponds to specific growth rate of methanogenic bacteria in the biodigester. In the first 5 days observation, biogas production is low due to the lag phase of microbial growth. In the range of 5-20 clays observation, biogas production is significantly increased due to exponential growth of in microorganism.

After 20 days observation, biogas production tends to decrease and this is predicted due to stationary phase of microbial growth Castillo et al. (1995).

From Table 2. it can be seen that after 30 days observation there is the tendency to increase biogas production. This is predicted that the carbons contained by all of waste constituents are not equally degraded or converted to biogas through anaerobic digestion. According to Richard (1996) and Wilkie (2005), anaerobe bacteria do not or very slowly degrade lignin and some other hydrocarbons. In other word, the higher lignin content will lower biodegrability of waste. Animal manure such as waste used in this study includes lignocellulosic rich materials, so anaerobic degradation is also rather unoptimum (Nielsen and Angelidaki, 2008).

V. Conclusion

From the project work done on the effect of inoculums on biogas yield, it can be concluded that biogas production increases with increased in the amount of inoculum. The most important finding from this work is that substrate consisting of manure and rumen exhibit higher biogas production than substrate containing manure and water only.

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