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Effect of Addition of Certain Substances During Slurry Preparation to Optimize Biogas Production

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Abstract— This research was carried out to investigate the effect of certain substances added during slurry preparation to enhance biogas formation. The biodigester was locally fabricated using plastic container of 25liter capacity. The slurry was prepared by adding Calcium Sulphate, Chopped plantain leaf, and pretreated substrate. After 15 days of anaerobic fermentation, the slurry with CaSO4 gave more biogas of 0.403kg followed by the pretreated which gave 0.270kg. The one with plantain leaf gave the least biogas. This is as a result of inhibition of enzyme activity by certain chemical substance from the leaf. Also, the amount of Calcium sulphate to be added should not exceed 200g to 1kg of substrate to be used for slurry preparation.

***Index Terms*— slurry, digestion, biogas, anaerobic, fermentation, organic biomass.**

1. Introduction

Biogas has become a household name. It is an alternative source of energy to fossil and hydroelectricity. It is usually produced during the anaerobic fermentation of organic waste. Breakdown of organic materials in the absence of oxygen produces methane. The process is known as anaerobic digestion and performed through the biological activity of microorganisms. This phenomenon naturally occurs at the bottom of ponds and marshes, which results in production of methane [1]. Biogas production is based on four main steps and the active microbes consist of a large variety group of complex and differently acting species. The stages are hydrolysis/liquefaction, acidogenesis, acetogenesis and methanogenesis [2]. Acidification is the second step in the process where acid-producing bacteria transforms the monomers and fermentation products, acetic acid (CH3COOH), hydrogen (H2) and carbon dioxide (CO2. An anaerobic environment is hereby obtained by acid producing bacteria, which is vital for the methane-producing microorganisms. Furthermore, the acid producing bacteria also reduce the compounds with a low molecular mass into organic acids, alcohols, amino acids, carbon dioxide, traces of methane and hydrogen sulphide. The main acids produced in this stage are acetic acid, propionic acid, and butyric acid; furthermore, ethanol is also produced [2]. The methane producing bacteria exist where anaerobic conditions are present. These microorganisms are very sensitive to environmental variations since they are obligatory anaerobic [2].

2. Aims and Objectives of the Research/Investigation

The aim is to ascertain the effect of addition of Plantain leaf, Hard water, pre-treated substrate biogas production.

3. Materials and Methods

The samples used in this investigation include (i) cow dung (ii) poultry dung.

Some physical properties of the samples were tested.

A. Physical Analysis of the Three Samples

Temperature and pH of the samples were tested using thermometer and pH meter. The values were recorded and shown in table 1.

Table 1
Temperature and pH reading of the cow and poultry dungs

Sample	Nature of sample	Temperature	pH
Cow dungs	Soft/solid	28	6.7
Poultry dungs	Soft/solid	32	6.3

B. Slurry Preparation and Digester Fabrication

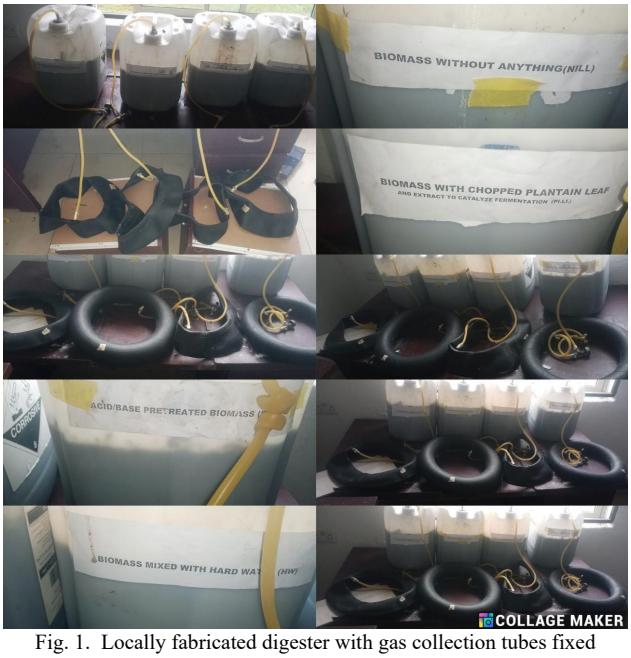

Fig. 1. Locally fabricated digester with gas collection tubes fixed

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Table 2
Mass of tube and gas from Day 0 to Day 15

Description of fermentation	Mass of tube (kg)	Mass of tube day 0 (kg) at	Mass of tube day 7 (kg) at	Mass of tube at day 10 (kg)	Mass of tube at day 14 (kg)	Mass of gas at day 0(kg)	Mass of gas at day 7 (kg)	Mass of gas at day 10 (kg)	Mass of gas at day 15 (kg)
Substrate + water and nothing	0.420	0.420	0.510	0.600	0.672	0.00	0.090	0.180	0.252
Substrate + water+ $CaSO_4$	0.42	0.42	0.530	0.685	0.823	0.00	0.110	0.265	0.403
Substrate + water + Plantain leaf	0.42	0.42	0.482	0.500	0.590	0.00	0.062	0.080	0.170
Pretreated Substrate + water	0.42	0.42	0.530	0.641	0.690	0.00	0.110	0.220	0.270

The digesters were fabricated using an empty 25 Litre container. They were made in such a way that they are water and air tight. Rubber hose and valve were used to connect them to vehicle tube. These were shown in figure 1.

The slurry for anaerobic digestion were prepared as follows,

- 1kg of each of cow dungs and poultry dungs were mixed with 15 litres of water and thoroughly mixed to ensure homogeneity.

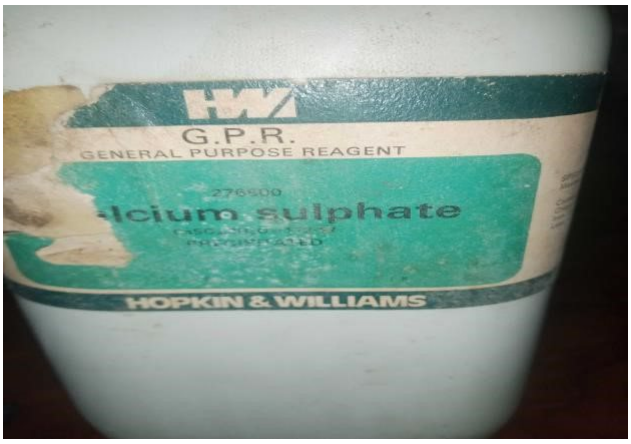

Fig. 2. Calcium Sulphate added to digester 3 for hardness

4. Results and Discussion

A. Results

The four tubes were initially weighed at the first day recorded as day zero. The set ups were allowed to stay for 15 days. The tubes were weighed at Day 7-15 and the readings presented in Fig. 3.

B. Discussion

The results of the anaerobic digestion were represented in the form of mass of tube with gas minus the mass of empty tube. This will give approximately the mass of the gas produced. This was presented in table 2 above. The mass of the tubes was measured as 0.420kg.

In the containers 1, 2, 3, and 4; when the process was set, no significant effect on the output. From day 0 to 3, there was the process of hydrolysis. According to osuji [3], this hydrolysis is a limiting process. The bacteria involved in biogas production will be in their lag phase. As time goes on, they enter the log or exponential phase. This account to why the collection tube starts showing signs of increase in volume. From day 7 to day 15, acetogenosis and methanogenesis came into play. This is the reason the volume of methane increases. From the presentation above, container 2 which contains hardwater (CaSO4), produces more gas at day 15, while the container 4 (pretreated substrate) was second with record of 0.403kg and 0.270kg respectively.

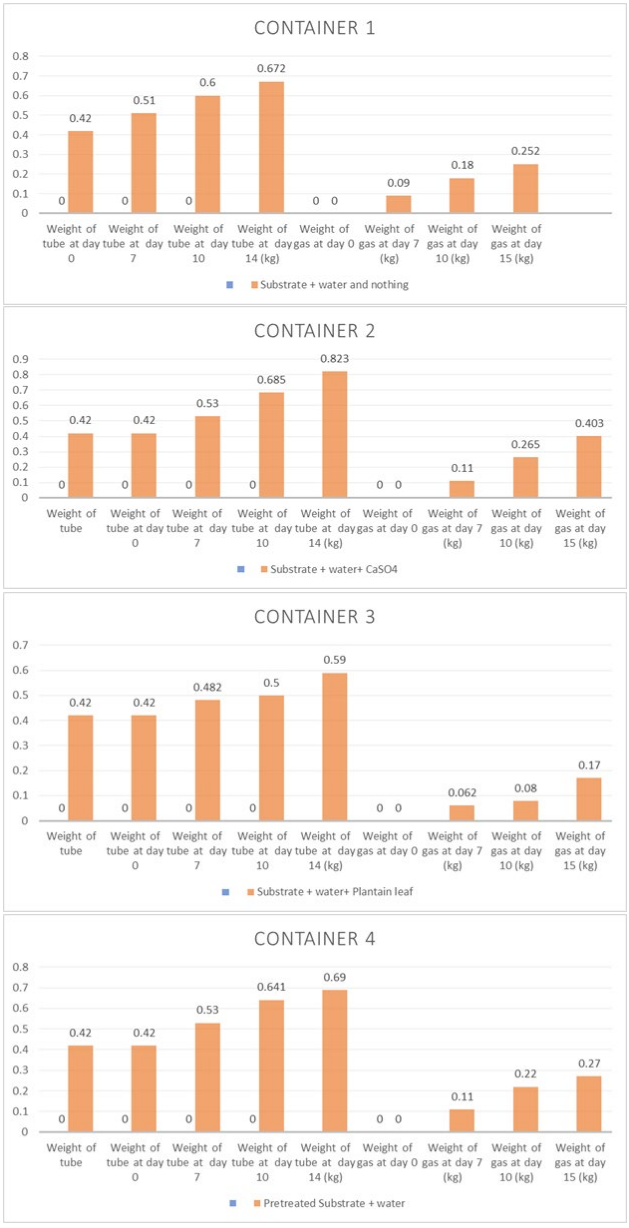

Fig. 3.

5. Conclusion

Based on the above tables, calculated amount of Calcium

Sulphate (10-200g) should be added to the substrate during slurry preparation. Alternatively, the substrate can be pretreated using acid/alkaline method. According to Osuji (3) this preatreatment will release the sugar that is already trapped in the lignocellulose by the lignin and the ones in the cellulose and hemicellulose.

A. Conflict of Interest

According to Uli (4), excessive total hardness over 200 mgL^{-1} in water decelerates AD process, causes poor biogas yield and slows the rate of biogas production, whereas moderate amount of total hardness 100- 200 mgL^{-1} favours a higher yield in biogas, faster AD process and higher rate of biogas production, but an extremely low total hardness of 20 mgL^{-1} appears to be unsuitable for optimum biogas production because of its lower yield relative to AD. But this investigation showed that about 200g of Calcium Sulphate which was added to the slurry aided biogas production. According to Chen (5) excessive amounts of calcium lead to precipitation of carbonate and phosphate, which may result in scaling of reactors and pipes, scaling of biomass and reduced specific methanogenic activity, loss of buffer capacity and essential nutrients for anaerobic degradation.

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