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Effectiveness of Biogas Production from Slaughter Waste using Two Mixing Ratios (Waste: Water Ratio of 1:1 and 1:2)

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Abstract
Biogas technology is widely used as a better alternative in the handling of waste in many societies in the world. This paper looks at the yield and the composition of biogas produced from slaughter waste using these two mixing ratios with a retention period of forty days. The study revealed that the 1:1 ratio gave 27.92 liters of Biogas per kilogram of waste, while the 1:2 gave 31.46 liters of Biogas per kilogram of waste. Analysis of the Biogas also revealed that for the 1:1 ratio, the composition of the Biogas was 67% methane, 30.7% carbon dioxide, 0.7% Hydrogen sulphide and 1.6% Oxygen. For the 1:2 ratio, the composition was 70.5% methane, 27.2% carbon dioxide, 0.6% Hydrogen sulphide and 1.7% Oxygen. The study therefore concludes that the 1:2 ratio was a better option for mixing waste and water when producing Biogas from slaughter waste.
Keywords: Biogas, Retention period, Slaughter waste, Methane, Carbon dioxide, Hydrogen sulphide, Oxygen.

1. Introduction

The most fascinating features of any civilized communities are the abundant availability of energy for domestic, agricultural and industrial purposes (Baki, 2004). Energy is the source of economic growth. Energy consumption and availability in a country is certainly a morale booster towards achieving progressive growth and development. Organic waste is continuously generated in the production of food and agricultural products. Using the right technology, these by-products can be utilized as valuable substrates for biogas production. This increases the economic efficiency of production enterprises and contributes to the generation of environmentally friendly energy. Within a series of processes, slaughterhouses produce large amounts of different wastes and wastewaters (GTZ, 2001). These wastes create lots of discomforts in the communities in which the slaughter houses operate due to the following reasons: many slaughterhouses are located in the centers of the cities; traditional ways to make use of the wastes such as application to agricultural land are cumbersome, expensive, and almost impossible because transport distances have become too long. Direct disposal of highly polluted wastewater and organic residues into the sewerage system without prior treatment on the other hand aggravates the situation due to the resulting environmental and ecological problems and the risk of clogging in the waste water drainage systems. An estimated 20% to 30% of the slaughtering costs are generated by the costs for water, waste treatment and energy (GTZ, 2001). Here, anaerobic processes can contribute in an interesting way to improve the situation. Biogas technology even though is a well known technology is relatively new in some parts of the world and can be used as a potent tool to address issues of Indoor Air Pollution (IAP), deforestation and Climate Change (Richard *et al*., 2010). Biogas is a clean fuel because it burns without leaving soot or particulate matter and also since it is lighter in terms of carbon chain length, less amount of carbon dioxide is released into the atmosphere during combustion. Biogas technology has helped some countries in many ways through income generation, life-style improvements and cost saving (Richard *et al*., 2010).According toEnergy commission (2006), Ghana government will promote biogas-for-heating in institutional kitchens, laboratories, hospitals, boarding schools, barracks, etc. The Strategic National Energy Plan (SNEP) for Ghana- strategic target is to achieve 1% penetration of biogas for cooking in hotels, restaurants and institutional kitchens by 2015 and 2% by 2020.

The associated harmful environmental, health and social effects with the use of traditional biomass and fossil fuel has enhanced the growing interest in the search for alternate cleaner source of energy globally. Ghana, a developing country depends heavy on wood fuel as a source of fuel contributing about 72% of the primary energy supply with crude oil and hydro making up the rest (Richard *et al*., 2010).There are vast biomass resources generated in abattoirs in Ghana that have the potential for use as feedstock for biogas production to reduce the over reliance on Wood fuel, and reducing it would help to reduce greenhouse gas emissions which may be affecting climate change. This work therefore produces biogas with the slaughter waste and analyzed the gas for its composition.

2. Materials and Methods

The study utilized slaughter waste from the Tamale abattoir in Ghana, while the Biogas production itself took place on the Nyankpala campus of the University for Development Studies, Tamale, Ghana.

2.1 Production of biogas

Six bioreactors, labeled 01, 02, 03, 04 05 and 06 were used and arranged as seen in plate 1 and 2. The reactors were fed with a total of 60Kg of the substrate made up of slaughter waste and water. Two mixing ratios of waste to water (1:1 and 1:2) were used. In the first instance, reactor 01, 02 and 03 were fed with waste to water ratio of 1:1, while reactor 04, 05, and 06 were fed with waste to water ratio of 1:2. In the second instance, reactor 04, 05 and 06 were fed with waste to water ratio of 1:1, while reactor 01, 02 and 03 were fed with waste to water ratio of 1:2. The initial temperature and pH was recorded for each of the reactors in all instances. The experiments were allowed a retention period of forty days (40days) with the following parameters taken on daily basis.

- Temperature
- PH
- Volume of gas produced

Plate 1: Side view of the experimental setup

Plate 2: Front view of the experimental setup

2.2 Measurement and Analyses of Biogas

Measurements of gas volumes were done using a water displacement method, where the displaced heights (plate 3) were measured.Upon production the biogas was analyzed for the following parameters using the Status

Mentor PGD3-IR Gas Detector.

- Methane content
- CO_2 content
- H_2S content
- O_2 content

Plate 3: Picture of the setup showing the displaced height of Biogas

3. RESULTS AND DISCUSSIONS

In the Production of Biogas the waste to water ratio of 1: 1 (30kg: 30 liters) produces a total of 837.62 liters of Biogas for the forty days retention period. This gave 27.92 liters of Biogas per kilogram of waste. Also, the waste to water ratio of 1:2 (20kg: 40 liters) produces a total of 629.28 liters of Biogas for the period under study. This gave 31.46 liters of Biogas per kilogram of waste. The findings show clearly that the 1:2 ratio of mixing waste and water is 12.68% more efficient than the 1:1 ratio, probably because the waste had greater surface area of contact with water in the 1:2 ratio, thus enhancing microbial activity.

On both cases of Biogas production, week four recorded the highest volume of Biogas while week six recorded the lowest volume of Biogas (Figure 1), this may be due to the fact that microbial activity was at its peak during the fourth week of the digestion process.

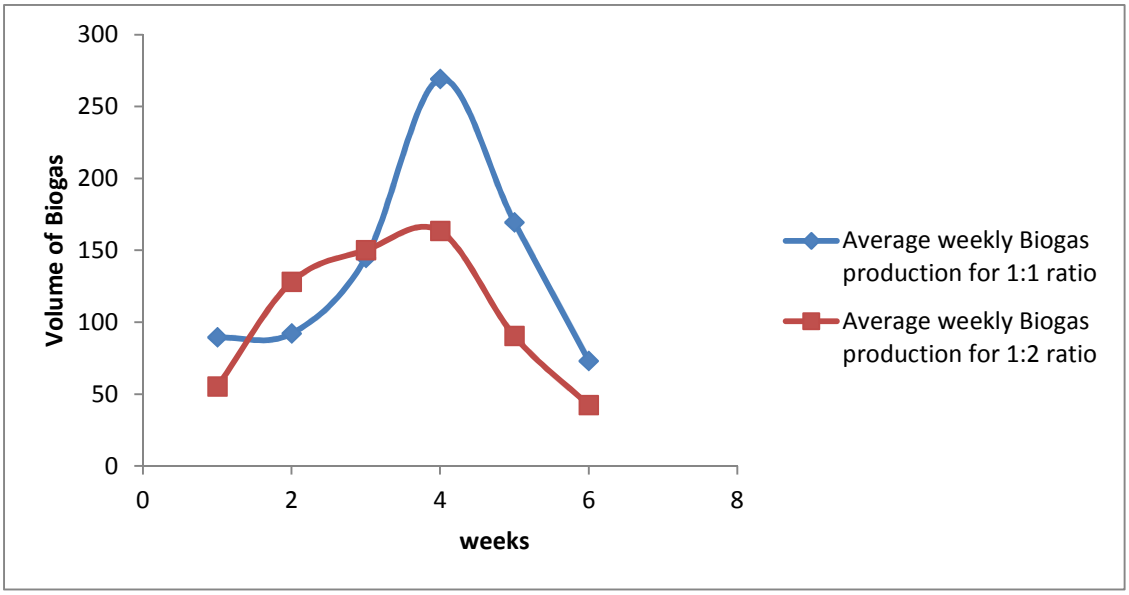

Figure 1 Average weekly Biogas yield for the two ratios (1:1 and 1:2) in a batch culture system.

The Compositional analysis of the study shows that the mixing ratio of 1:2 gave a higher percentage of methane (70.5%) than the 1:1 ratio (67%). However, the 1:2 ratio had lower percentages of carbon dioxide (CO_2), Hydrogen Sulphide (H_2S) and Oxygen (O_2) compared to those of the 1:1 ratio (Table 1 and 2), making the 1:2 ratio a better alternative to the 1:1 ratio.

The results of this study agrees with the finding of Teodorita*et al*., 2008, which reports that Biogas compose of 50-75% methane, 25-45% carbon dioxide, <2% Oxygen and <1% Hydrogen sulphide. It also agrees with the findings of Juniper (2005), who reports that Biogas contains 55-75% methane.

After the Biogas was produced it was tested for its ability to burn. Plate 4 and 5 show pictures of the flames.

Table 1 composition of Biogas from 1:1 ratio

Compound	**Chemical symbol**	**Content (Vol.-%)**
Methane	CH4	67
Carbon dioxide	CO2	30.7
Hydrogen sulphide	H_2S	0.7
Oxygen	O2	1.6

Table 2 composition of Biogas from 1:2 ratio

Compound	**Chemical symbol**	**Content (Vol.-%)**
Methane	CH4	70.5
Carbon dioxide	CO2	27.2
Hydrogen sulphide	H_2S	0.6
Oxygen	O2	1.7

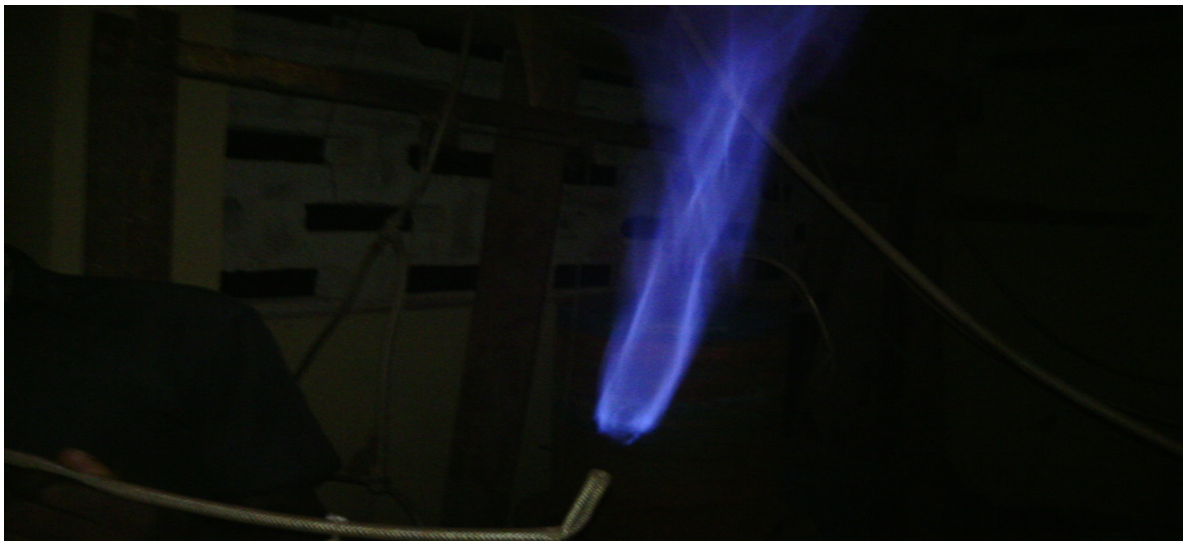

Plate 4: Picture of flame from a 6mm hose.

Plate 5: Picture of flame from a 9mm hose

4. Conclusion

The study looked at the effectiveness of Biogas production from slaughter waste using two mixing ratios (1:1 and 1:2). The 1:1 ratio gave 27.92 liters of Biogas per kilogram of waste, while the 1:2 ratio gave 31.46 liters of biogas per kilogram of waste. The analysis of the Biogas shows that the mixing ratio of 1:2 gave a higher percentage of methane (70.5%) than the 1:1 ratio (67%). The study therefore concludes that the 1:2 ratio of mixing waste and water is better than the 1:1 ratio.

Acknowledgement

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