Production of Biogas from Cattle Paunch Manure

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Abstract—Slaughter house waste contains high levels of organic matter and pollutants. These pollutants can affect the ecosystem and public health negatively, to minimize the effects of these pollutants many treatments are used, one of these is biological treatment methods. In this study potential of biogas production from cattle paunch manure (stomach digestion content) was investigated using a batch process laboratory scale of one liter’s digester size. Three replicate of total solid concentration of (5%, 7%) of cattle paunch manure were mixed with (10%v/v) inoculums with control units for each concentrations at room temperature. The total amount of biogas produced after 49 days of experiments were, 12.678, 11.544, 8.154 and 5.724 lit for, 7% ,5% TS seeded sample,7% and 5% total solid control respectively.

Index Terms— Anaerobic Digestion; Cattle Paunch Manure; Biogas; Total Solid.

I. INTRODUCTION

Slaughterhouse or abattoir is a facility where animal are slaughtered for consumption as food, Slaughtering animal on a large scale poses significant environmental problems, it contains a mixture of fats, proteins, complex organic compounds, water and paunch manure [1]. Sudan has a vast and extensive meat processing industry, which generates large volumes of wastewater and solid waste [2]. Thus, it requires considerable treatment before the materials can be safely released into the environment. Slaughterhouse wastes can be treated anaerobically to reduce the volume of the biodegradable volatile solids waste stream and produce methane that can be used for energy production [3].

Anaerobic digestion is a promising and sustainable technology that minimize the organic matter and pollutant in the slaughterhouse waste, also it recovers energy in the form of methane beside the nutrients from effluents when used as source of fertilizer for agricultural crops [4]. So in this paper the potential of biogas production from cattle paunch manure (undigested stomach content) was investigated using two total solids concentration of cattle paunch manure, the effect of room temperature was detected while the daily pH of the samples was recorded. The effect of time on rate of biogas production was also considered in the experiments; the results was taken as average of three replicates.

II. MATERIAL AND METHODS

A. Substrate

The cattle paunch manure samples were collected directly, after slaughtering process of cattle’s in four different containers from Shafa slaughterhouse in Khartoum State, Sudan. Prior to use, Tests such as pH, chemical oxygen demand (COD), biological oxygen demand (BOD5), total solids (TS) and moisture content were immediately carried out for the fresh samples, then the contents of the four containers were mixed homogeneously, and subjected to drying at room temperature for five days, and stored for further use.

B. Experimental works

The biogas production experiments have been carried out in laboratory scale set up. The set up consist of 1 L conical flask that work as digester, three replicate of (5%, 7% total solid, were mixed with (10%v/v) of the inoculums, with control units for each of cattle paunch manure the volume were completed to 1000 ml. The biogas volumes were measured after the flammable tests were conducted, the experiment were carried for 49 days at room temperature (30±5 °C), and the results were reported.

C. Analytical Test

Total Solids, moisture content, Biological Oxygen Demand (BOD) and, Chemical Oxygen Demand (COD) test were investigated using (APHA 1999) method [5], while PH were measured by digital PH meter (HANNA, pH 209).

III. RESULT AND DISCUSSION

| Parameter | Average value |
|-----------|---------------|
| pH | 6.7 - 7.8 |
| Total solid (T.S) w/w % | 22 – 34 |
| Chemical oxygen demand (mg/L) COD | 790.9 – 810.6 |
| Biochemical oxygen demand (mg/L) BOD5 | 410 – 423.5 |
| Moisture content w/w % | 66 – 78 |

A. Effect of Temperature on biogas production rate

The ambient temperature variation during the experiment with biogas production by volume (ml) is shown in the Fig.1. The range of temperature in the experiment lies within the mesophilic temperature range (27-33°C), generally the biogas production increase with temperature elevation, while it decreases with the temperature reduction. This agree with what mentioned in [6], an increase in the ambient temperature generally increases the rate of reaction and therefore the rate of biogas production since the optimum temperature at mesophilic bacteria condition is (25-37°C)
It was also recorded that biogas production from duckweed increase with increasing of room temperature (23-28°C), the experimental results demonstrated that at higher temperature decomposition of the substrate take place quickly [7].

The commence of biogas for both control samples started later than the seeded sample with same total solid, it seems that the productivity of biogas in this control units is affected by addition of inoculum rather than elevated temperature.

B. Effect of Time on Biogas production rate

The daily biogas production in (ml) is illustrated in Fig.2, generally excessive production of biogas was noticed in the first two weeks of production duration for (5, 7 %TS) seeded sample, this may be due to high concentration of the substrate and addition of the inoculums. a gradual reduce with fluctuation is sometimes was detected this because of the blocking in the digester which solved by excessive manual agitation, while the drop in biogas productivity is clear by the end of the experiments in all the biogas production units. The production of biogas in control units started 13 days later than the seeded sample for the both concentration (5%and 7% TS) The total amount of biogas produced in experiment is, 12.678 lit, 11.544 lit, 8.154 lit, and 5.724 lit for, (7% ,5%) total solid seeded sample, and 7%,5% total solid control respectively. This result show that the amount of biogas increased with total solid increasing that agree with other finding [8]. The seeded sample (with inoculums) gave high biogas amount than the control (without inoculums) Fig.2. as well as mentioned in [9], anaerobic fermentation proceeds with help of acid-forming and methane-forming bacteria which available in the inoculum. So, addition of inoculum tends to improve both gas yield and methane content in biogas. the higher biogas amounts were appeared at first days of fermentation process for all concentration, this may be due to high concentration of the substrate in beginning, while the drop in biogas productivity is clear by the end of the experiments.

C. Effect of pH on Biogas production rate

During the experiment the value of PH varied from (5.18-6.83) for 5% total solid control and (5.66 - 7.27) for 5% total solid seeded sample, Fig.3.a and Fig.3.c, and that of 7% total solid control is (5.2 - 6.96), while for 7%total solid seeded sample is (5.79-7.45), Fig.3.b, and Fig.3. d.

Since the optimum pH range of the digester is neutrally (6.8-7.4) as mentioned in [6]. It was observed from the general trend of the pH profile that the biogas volume increase with higher pH range while it is productivity decrease when the pH drops out of this range, as well as published in [10]. The pH began to rise gradually as the volatile fatty acids was consumed by methanogens to produce methane, then a gradual decrease was observed when the experiment proceeds. The highest biogas amount observed in the experiments at 7-7.45, this same like [12] maximum biogas achieved at pH 7 then followed by pH 8. In control Fig.3. a, b the production of biogas delayed because of low pH, a low pH in digester inhibits the activity of microorganisms involved in the digestion process particularly methanogenic bacteria [11]. But it clear that the productivity of biogas decreased progressively till the end of the experiments.

Fig. 1. Effect of temperature on rate of biogas production

Fig. 2. Effect of time on rate of biogas production

Fig. 3. a Effect of pH on biogas production (control 5% TS)
IV. CONCLUSION

The total amount of biogas produced in experiment were, 12.678 lit, 11.544 lit, 8.154 lit and 5.724 lit for, 7% total solid sample, 5% total solid sample, 7% total solid control and 5% total solid control respectively. The results show that rate of biogas production increase with increase of total solid, temperature, pH when has been controlled.

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