

Optimum Biogas Production from Agricultural Wastes

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Abstract

Anaerobic degradation of sugar cane and rice husk by cellulolytic fungus was studied at optimum operational concentration 1:5 w/v of the lignocelluloses: water, temperature and fungus were varied and the suitable parameters were 0.6g of fungus, 25cm³ of water and temperature of 33°C which produced biogas of 500cm³. It was also found that when the amount of the substrates were respectively doubled, the average rate of the biogas production doubled, implying that kinetically, the degradation is probably of the first order.

Keywords: Biogas, Fungal Degradation, Rice Husk, Sugar cane.

1. Introduction

Biogas system refers to the technology of digesting organic waste anaerobically to produce an excellent fertilizer and combustible gas and to disposing agricultural residues, aquatic weeds, animal and human excrement and other organic matter [1]. Biogas produced in anaerobic digester is burned to generate clean renewable energy. The main components of biogas are carbon dioxide (30-40%) and methane (60-70%) which if released in uncombusted form is harmful to the environment [1]. Therefore biogas system provides three products: energy, fertilizer and waste residue.

A lot of work has been carried out on the conversion of biomass to biogas through anaerobic biodegradation using different substrates in various conditions. These substances range from plant wastes to animal wastes but in the field of biogas production fewer works has been done on the conversion of sugarcane and rice husks to biogas production through anaerobic decomposition. Study was carried out on the chemical composition of biogas and kinetics of its production at varying temperatures [2]. Garba, studied effect of some inorganic nutrients on the performance of cow dung as substrate for biogas production [3]. Studied on biogas production from pigeon dropping has also been reported [4]. Recent research has proved that sugarcane (Pulp and Back) produces more biogas than Rice husks because of low lignin content of the pulp and Back of sugarcane which makes it very easy to hydrolyse into fermentable sugar by the microorganism [5].

Ekwenchi *et al*, reported on gaseous fuel production from fungal degradation of elephant grass at optimum condition using four cellulolytic fungi, have been reported and the only two are active producing methane, propane and carbon dioxide [6]. The development of biogas generation using sugarcane and rice husk is important for solution of fuel problems stimulating agricultural output and improving the quality of health. The techniques used for biogas productions from organic material are numerous and has been in existence since 1850s.

Methane was recognized as having a practical and commercial value in England, in the 1890s where specially designed septic tank was used to generate the gas for the purposes of street lightening. In India methane generating units using cow dung has been in operation for years. Also in Taiwan more than 75000 biogas generating devices have been constructed. In the US there has also been considerable interest in the digestion for safe and clean fuel as a source of fertilizers. Recent research was carried out on the conversion of biomass to biogas through anaerobic biodegradation using different substances under varying conditions to determine the best substrates and optimum conditions that will produce the highest volume of biogas (Methane). Research carried out showed that particle size-reduce (0.4mm) from banana peel gave better biogas production [7]. Also the use of cananbis for biogas production was simultaneously observed and found that fresh cananbis at 31% contain higher concentration of alkaloids which completely stopped biogas production [8].

The biogas potentials of eight aquatic weeds were studied and reported that salvinia and ceratopteris yielded a biogas as high as 0.2m³ kg⁻¹ [9]. Later Abbasi and Nipancy postulated that addition of inoculums sustained biogas production from pistia for 10days [10]. Borja *et al*, studied the kinetics behaviour of waste tyres for the production of biogas supported by microorganisms in an anaerobic condition and the maximum methane production was achieved [11]. Balasubramanian and Kasturi studied the production of biogas using wolffia and lemma and suggested that wolffia and lemma grown in slurry of cow dung fed digester can be effectively

used for biogas production along with cow dung [12].

Kinetics of biogas production from municipal waste using different condition were investigated and found to be promising [13]. Biogas and biohydrogenation can be obtained from waste water, in milk processing industries [14]. The effect of solid content, pH and carbon to nitrogen ratio for biogas production was also reported [15]. Study was carried out to selected novel annual and perennial plants for biogas production and the biogas produce was found to be of higher quality [16].

This study is aimed at maximizing yield of biogas at optimal operational conditions and the effect of biogas production using sugarcane pulp and rice husk, at a reproducible, profitable and efficient rate.

2. Materials and Methods

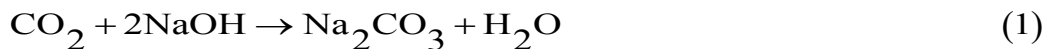
The experimental fungal degradation of lignocelluloses from sugarcane (back and pulp) and rice husks at optimum condition to produce biogas was carried out in an anaerobic condition. The procedures with all the material, apparatus and reagent used are outlined below.

2.1 Materials

The materials used as substrate for this research are sugarcane and rice husk. The fresh sugarcane was collected from Karfi in Malumfashi district in Katsina State. Also the rice husk was collected from a farm in Kura, Kura Local Government Council, Kano State. The sugarcane bark and juices were removed; also from fresh rice the husks were removed and both samples dried in an oven at a temperature of 40°C for about 48 hours. This was then grinded to fine powder using mortar and pestle and subsequently sieved with a mesh size (100 microns). The powdered substrates was stored in reagent bottles and kept away from sunlight and moisture.

Four sets of 250cm³ round bottom flask digesters were used for the generation of the biogas. The digesters were stoppered to avoid leakages. Each digester contained sugar cane or rice husk, yeast (fungus) and water to produce the necessary biogas required experimentally.

Keeping the amounts (4g) of lignocellulose and yeast (0.06g) constant, the amount of water was varied in the range of 15, 20, 25 and 30cm³ to determine the amount of water required for the optimum yield of biogas. Next, the amounts of lignocellulose (4g) and water (25cm³) were kept constant and the amount of yeast was varied in the range of 0.06g, 0.12, 0.18, 0.24g to establish the amount of yeast for the optimum yield of biogas. After establishing constant amounts of water, yeast and lignocelluloses, at a known temperature for producing biogas, the next experiments involved varying temperature in the range of 28-40°C. After the biogas production, the pH of the content of the digester was determined. Proper steps were taken in this study to separate the biogas into CH₄, CO₂ and H₂S using appropriate reagents, NaOH, which will dissolve CO₂ and Pb(CH₃COO)₂, which will remove H₂S as a precipitate of PbS. By the arrangement was able to assess the respective amounts of CH₄, CO₂ and H₂S in the biogas produced. The reactions involved in the separation are as follows, and the volume of biogas and its component was collected by upward delivery as.



Then the volume of methane was evaluated as follows

$$V_{\text{Biogas}} = V_{\text{CH}_4} + V_{\text{CO}_2} + V_{\text{H}_2\text{S}} \quad (3)$$

$$V_{\text{CH}_4} = V_{\text{Biogas}} - V_{\text{CO}_2} - V_{\text{H}_2\text{S}} \quad (4)$$

$$V_{\text{CO}_2} = V_{\text{Biogas}} - V_{\text{H}_2\text{S}} \quad (5)$$

Where V_{Biogas} , V_{CH_4} , V_{CO_2} , $V_{\text{H}_2\text{S}}$ are the respective volume of biogas, CH₄, CO₂ and H₂S, the percentage composition of the gas generated was evaluated as follows [6].

$$\text{CH}_4 \% = \frac{V_{\text{CH}_4}}{V_{\text{Biogas}}} \times 100 \quad (6)$$

$$\text{CO}_2 \% = \frac{V_{\text{CO}_2}}{V_{\text{Biogas}}} \times 100 \quad (7)$$

$$\text{H}_2\text{S} \% = \frac{V_{\text{H}_2\text{S}}}{V_{\text{Biogas}}} \times 100 \quad (8)$$

3. Results and discussion

The result of the determination of suitable amount of water to be used in producing optimum yields of biogas is shown in Figure 1. The plot showed that 25cm³ gave the best yield of the biogas.

The results of the determination of the suitable amount of fungus (yeast) to be used in producing an optimum yield of biogas is shown in Figure 2. The figure showed that 0.12g of yeast gave the best yield of the biogas.

The results of the effect of temperature on the yield of biogas are shown in figure 3 from the temperature range of 28-33, 36-40° C as indicated in the Figure 3 it was observed that the temperature of 33° C gave the best yield of the biogas.

The combination of these three results presented above had indicated that the optimum operational conditions for the best yield of biogas should be a reaction mixture of 4gm of lignocellulose, 25cm³ of distilled water and 0.12gm of yeast (fungus).

The result of the effect of doubling the respective amounts of the lignocellulose, from both sugarcane and rice husks respectively on the rates of biogas production is shown in Figure 4. It was observed that as the amount of lignocelluloses is doubled, the respective rates of biogas yields is also doubled, implying that the rates were of first order with respect to the amount of lignocelluloses being used in the respective degradation.

Fig. 1 Optimum suitable water for biogas yield

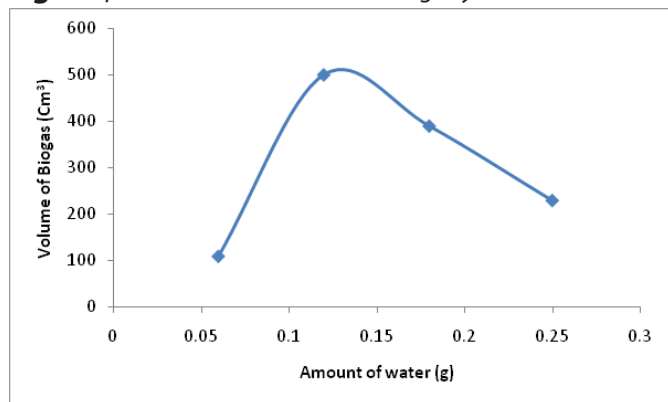


Fig 2 Optimum concentration of yeast for best yield of biogas

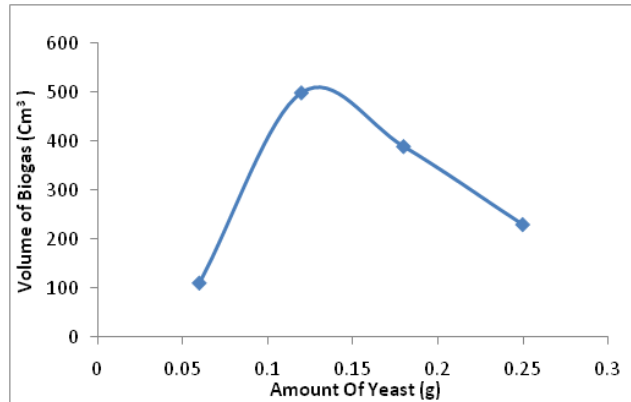


Fig.3 Optimum temperature for biogas production

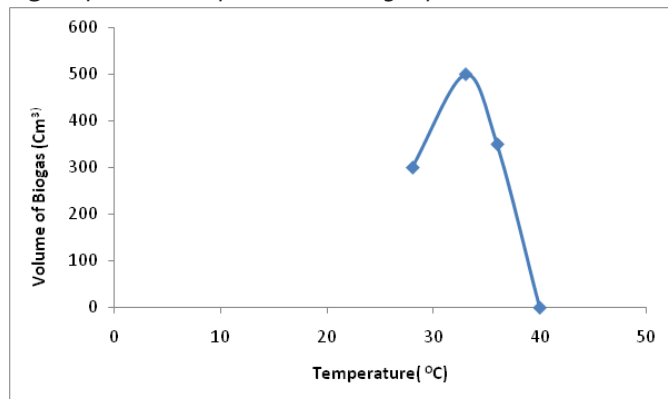
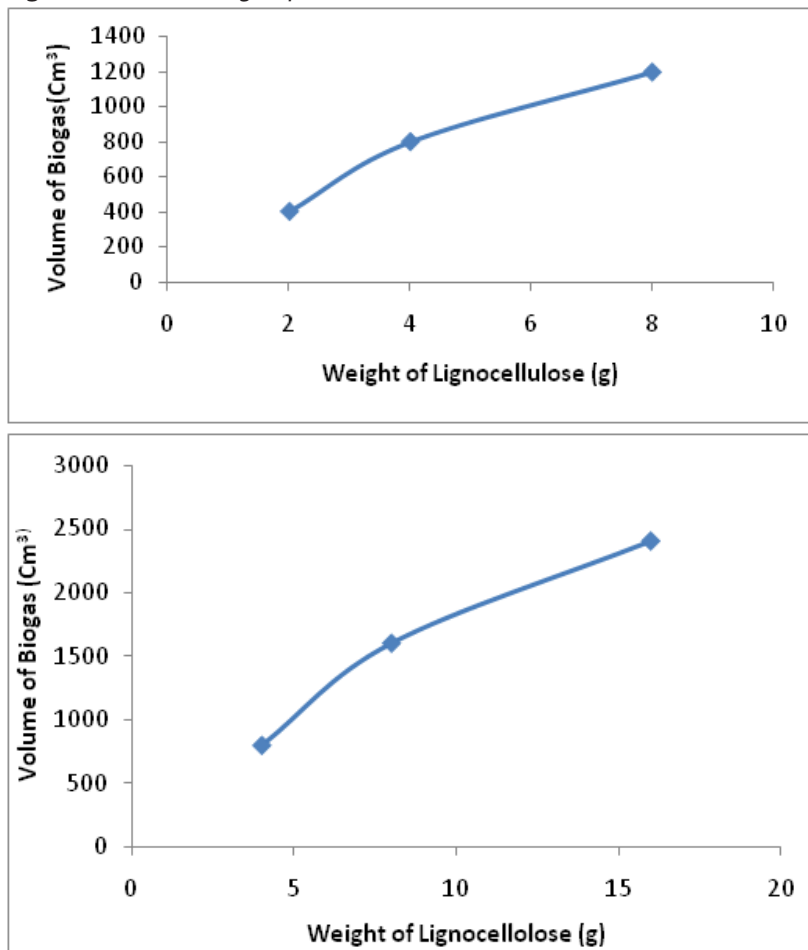


Fig.4 Effect of doubling respective amount of the reactants in the reactor for sugarcane and rice husk for biogas production.

4. Conclusion

Biogas can be produced by considering these operational condition as 4g of substrate, temperature of 33°C, volume of water 25cm³ and 0.12g of fungus(yeast) correspondingly and doubling these parameters showed an increase in the volume and also the production shows that kinetically is of the first order.

5. References

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