Global Scientific JOURNALS

GSJ: Volume 9, Issue 12, December 2021, Online: ISSN 2320-9186

www.globalscientificjournal.com

BIOCHEMICAL GENERATION OF BIOGAS FROM CORN COBS USING COW DUNG AS A SOURCE OF MICROBIAL CATALYST

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ABSTRACT

A variety of wastes such as corn cobs, packaging materials, vegetable wastes, and other biodegradable materials contain a lot of valuable resources in the form of nitrogen, phosphorus, potassium and other chemicals which are useful. Biogas production by anaerobic digestion from biodegradable organic waste is increasingly seen as a possible renewable energy source. The present study investigated the production of methane biogas by the biochemical co-digestion of corn cobs and cow dung as a source of microbial catalysts. Fresh dung was collected from Wukari Abattoir and fresh corn cobs were collected within Federal University Wukari School compound. The temperature and pH were measured off-line. The corn cobs and cow dung slurry were digested in a ratio of 2:1. After 21 days residence time, the weight of biogas produced was 0.5 kg and the average temperature and pH were 29^{o}C and 4.9 respectively. The residence time of 21 days was far lower than that reported in the literature. Consequently, the weight of biogas generated was far lower than expected. Biogas production technology from waste is however a very promising and sustainable solution to global climate change and environmental degradation resulting from deforestation challenges.

KEYWORDS: Biogas, Corn cobs, Cow dung, Waste-to-energy, Anaerobic digestion

I. INTRODUCTION

In Nigeria today, there are no sewers or underground drainage systems and as a result, all liquid wastes find their way into water courses. There are no urinals or toilet facilities in many public areas. Schools are devoid of functional toilets. Solid wastes are found everywhere and anywhere. In Nigeria, waste is generated at the rate of 0.43 kg/head per day and 60 to 80 percent of it is organic in nature (Sridhara *et al.*, 2006; Ogwueleka, 2009). Waste is generated at the rate of 0.43 kg/head per day and 60 to 80 percent of it is organic in nature (Sridhara *et al.*, 2006; Ogwueleka, 2009). A cow brought for slaughtering produces about 328.4 kg of wastes in the form of dung, bone, blood, horn and hoof (Ogwueleka, 2009). Sheep and rams produce about 0.9 kg waste per head per day (based on observation) (Ogwueleka, 2009). Markets and houses generate a variety of wastes such as corn cobs, vegetable wastes, packaging materials, paper, glass, metal, plastics and other non-biodegradable materials and some of them are excellent raw materials for various industries in the country (De Baere, 2000). Most of these wastes contain a lot of valuable resources in the form of nitrogen, phosphorus, potassium and other chemicals which are useful (Hammed *et al.,* 2011).

Microorganisms play an important role in biogeochemical cycles and convert these valuable resource s into harmless and in many cases, useful products. However, there are certain wastes arising from industries or healthcare facilities which may be hazardous or infectious and need to be treated as special wastes (Teghammar, 2013).

Agricultural wastes can be converted to manure and organic fertilizers. They can also be used to produce renewable biofuels like bioethanol from cellulosic sources, biodiesel from waste oil and biogas. Waste-to-energy, therefore, is the use of modern combustion and biochemical technologies to recover energy from wastes (Jeihanipour, 2011). Biochemical technologies are more suitable for wet wastes which are rich in organic matter. Biochemical conversion process includes anaerobic digestion or decomposition and anaerobic fermentation. These processes occur at lower temperatures and lower reaction rates compared to thermochemical processes. High moisture feed stocks such as food waste and green waste are generally good candidates for biochemical processes (Teghammar, 2013). Anaerobic digestion (AD) is a suitable technology to treat solid waste and waste water. The technology has become fully accepted as a proven and an even preferred method for the intensive biodegradation phase of organic fractions derived from municipal solid waste (Moletta, 2005). The production of biogas through anaerobic digestion offers significant advantages over other forms of bioenergy production. Limitation of carbon dioxide and other emissions through emission regulations, carbon taxes and subsidies on biomass energy is making anaerobic digestion a more attractive and competitive technology for waste management. There is an abundant availability of cellulose-based waste, which could be appropriate for biogas production e.g. lignocellulose and waste textiles. These materials are carbohydrate-rich and could be used as substrates for biogas production. However, the recalcitrance nature of these substrates makes them very difficult to digest, as their structure opposes microbial hydrolysis in biogas production (De Baere, 2000).

Major progress has been made in all areas of waste management but the introduction of anaerobic digestion into the treatment of municipal solid waste is one of the most successful and innovative technology developments observed during the last two decades in the waste management field (De Baere, 2000). This study will further contribute and broaden the already existing knowledge on the utilization of waste materials in the production of biogas.

II. METHODOLOGY

Sample collection

Fresh dung was collected from Wukari Abattoir and fresh corn cobs were collected within Federal University Wukari school compound.

Anaerobic digestion

Well dried ground sample of corn cobs was autoclaved and when sufficiently cool was aseptically loaded into the digester and 4 liters of distilled water was added. 2 liters of distilled water was also added to 1 kg of cow dung to form slurry and loaded into the digester, making the corn cobs to cow dung ratio 2:1. After feeding of the digester, it was properly sealed and then covered with a foil paper to protect it from direct sunlight rays. At the onset, the sample was collected from the sampling spot where the temperature and pH were measured. This measurement continued on a daily basis throughout the period of the digestion at a particular time (for 21 days). Also, the weight of the gas cylinder on day zero was measured and also throughout the period of the digestion. After the 5th day, the connected Bunsen burner was lit to check the presence of methane gas production and collected in the gas cylinder.

III. RESULTS AND DISCUSSION

Table 1: Residence time, pH and temperature of the anaerobic digestion sample and weight of the biogas produced.

Residence time (days)	pH	Temperature (^oC)	Weight (kg)
1	6.50 ± 0.005	29.00 ± 1.000	3.50 ± 0.000
2	4.55 ± 0.010	27.50 ± 0.500	
3	4.21 ± 0.010	28.50 ± 0.500	
4	3.90 ± 0.005	27.00 ± 1.000	
7	3.89 ± 1.000	27.00 ± 1.000	3.75 ± 0.050
8	4.01 ± 1.000	28.00 ± 1.000	
9	4.51 ± 1.000	28.00 ± 1.000	
10	4.68 ± 0.500	29.50 ± 0.500	
11	4.61 ± 1.000	29.00 ± 1.000	
14	4.57 ± 0.010	28.00 ± 1.000	3.75 ± 0.050
15	4.61 ± 0.005	30.50 ± 0.500	
16	4.61 ± 0.010	30.00 ± 0.000	
17	4.57 ± 0.010	29.50 ± 0.500	
18	4.56 ± 0.005	29.00 ± 1.000	
21	4.44 ± 0.020	29.00 ± 1.000	4.00 ± 0.000

Table 1 shows the mean ± standard deviation of the residence time, pH and temperature of the anaerobic digestion samples collected and the weights of the biogas produced within 21 days.

Waste management particularly in developing countries like Nigeria is one of the most serious environmental problems as there are no sewers or underground drainage systems, thereby letting all liquid wastes find their way into water courses (Ogwueleka, 2009). Some of these wastes may be hazardous or infectious. However, with the aid of certain technologies, some of these wastes can be harnessed to generate useful products. One of such technologies is anaerobic digestion which is used for the production of biogas. The technology can contribute substantially to the sustainable energy recovery from organic waste particularly agricultural wastes (Moletta, 2005).

In this study, the pH of the anaerobic digestion mixture was seen to decrease, which remained constant thereafter. This drop in pH is usually produced during the acid formation. The acidic pH is usually due to the accumulation of volatile acids in the digester. This is important as a high pH will encourage the production of acidic CO_2 to neutralize the mixture again (Lingaiah and Rajasekaran, 1986). Temperature has been reported as the most critical process parameter (Pradeepa Devi and Jenifer, 2017), and during the experiment temperature was however, not completely steady. It varied from 27^0C-30 ^{0}C while throughout the experiment the average temperature in the bioreactor was around 28^0C. Mesophilic bacteria tolerate greater changes in their environment, including temperature. The stability of the mesophilic process makes it more popular in current anaerobic digestion facilities (Pradeepa Devi and Jenifer, 2017). The low digestion temperature is controlled by the hydrolysis of the complex macromolecules which was the first stage, while the digestion temperature gradually increased during the second acidogenesis stage (production of acid). As the pH and temperature started rising, the production of methane gas commenced.

The total biogas produced within the short residence time of the digestion (21 days) process in this present study was 0.5 kg from 33.3% wt total solids. This coheres with the findings of Omoruwou and Iyagba (2014) that used 50% corn cobs after 62 days residence time. However, Ukpabi et al. (2017) produced 19.20 ml of biogas from their anaerobic co-digestion of cow dung and corn cobs. Although Kumar et al. (2012) did determine that minor influxes in temperature do not severely impact the anaerobic digestion for biogas production, the temperature variation in the present study was fairly constant and did not seem to negatively impact the process.

Therefore, the research carried out needed more residence time for the complete biochemical process to take place. The substrate concentration was 33.3% (total solid concentration), the volume or weight of biogas generated was quite low for the amount for the amount of feed used because of the shortage of time.

IV. CONCLUSION

Organic waste particularly agricultural wastes currently available for energy production are very large. Aside important energy source, it is important for comprehensive utilization of biomass, agricultural, animal husbandry, forestry and fishery residues. The biogas technology provides two important benefits: environmentally safe waste management as well as the generation of clean renewable energy. Coordinating factors like waste management, organic fertilizer, biogas production and use may further optimize the promotion and development of agricultural waste in rural areas as well as improve the living conditions of rural communities. It may be one of the important options.

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