VARIATIONS IN BOD AND COD AT VARIOUS STAGES OF BIOGAS PRODUCTION USING DIFFERENT AGRICULTURAL WASTES

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Abstract: Cow dung along with other agricultural wastes (press mud, poultry litter, kitchen wastes, maize stalks and fruit wastes) were used for the biogas production in lab scale. For each treatment 750 g of substrate and 1500 ml of water was used as inoculum mixture in 3 liters glass bottles. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) was estimated at various stages of gas production. BOD and COD of the slurry samples was more in the substrates initially before anaerobic digestion but later reduced gradually by the end of gas production which implies the effect of anaerobic digestion on the reduction of BOD and COD and this indirectly leads to the reduction in the environmental pollution.

Keywords: Agricultural wastes, Anaerobic digestion, Biological Oxygen Demand, Chemical Oxygen Demand

INTRODUCTION

Currently, as the fossil-based fuels become scarce and more expensive, the economics of biogas production is turning out to be more favourable. Biogas originates from bacteria in the process of biodegradation of organic material under anaerobic conditions. Anaerobic digestion, a biological conversion process that occurs in the absence of oxygen, has a number of advantages for waste conversion and ultimately producing methane and carbon dioxide (Garba and Sambo, 1995). It consists of a varying proportion of CH_4 (methane) and CO_2 (carbon dioxide) and traces of H_2S, N, CO and water vapour. Methane is the most valuable component under the aspect of using biogas as a fuel. Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) of the agricultural wastes is very high. Through this anaerobic digestion BOD and COD levels monitored.

MATERIAL AND METHOD

Collection of substrates

Different substrates were collected from different places and biogas digesters were set in lab scale. Press mud was collected from Nandyal sugar factory located at Nandyal, Kurnool district and cow dung was collected from the cattle farm of Veterinary University, Rajendranagar, Hyderabad. Poultry litter was collected from poultry farm of Veterinary University, Rajendranagar, Hyderabad. Kitchen wastes were collected from the mess of hostel-C. Maize stalks were collected from the college farm of ANGRAU, Hyderabad. Fruit wastes were collected from the fruit market at Rajendranagar, Hyderabad. Cow dung was collected from the cattle farm of Veterinary University, Rajendranagar, Hyderabad.

Treatment	Substrate
T_1	Press mud + Cow dung
T_2	Poultry litter + Cow dung
T_3	Kitchen wastes + Cow dung
T_4	Maize stalks + Cow dung
T_5	Fruit waste + Cow dung
T_6	Cow dung alone

Equipment and apparatus used

BOD incubators were used for incubating the samples in BOD bottles to estimate the BOD in the slurry samples. COD apparatus was used for estimating COD in the slurry samples.

Laboratory analysis

BOD in the slurry samples

Biological Oxygen Demand is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain

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temperature over a specific time period. It was determined by measuring oxygen concentration in slurry sample, idometrically before and after incubation in the dark at 20^0 C for 5 days by the colorimetric method (APHA, 1992).

COD in the slurry samples

Chemical oxygen demand is the total measurement of all chemicals in the water that can be oxidized. It was determined by the closed reflux colorimetric method (APHA, 1992).

Measurement of Gas production from different treatments

The biogas production readings were taken on an alternate day by water displacement method in the measuring jar.

RESULT AND DISCUSSION

Biogas production

All the biogas production units with six treatments and three replications were set on the same day with 750 grams substrate and 1500 ml water (1:2 ratio).

The highest gas production was observed in T_1 (Cow dung + Press mud) 9903.31 ml, as compared to T_6 (Cow dung alone) 8103.31 ml, T_2 (Cow dung + Poultry litter) 6079.98 ml, T_3 (Cow dung + Kitchen waste) 4066.63 ml, T_5 (Cow dung + Fruit waste) 3373.32 ml and less in T_4 (Cow dung + Maize stalks) 3099.97 ml. (Table 1).

Ofoefule *et al.* (2010) stated cow dung produced highest amount of biogas while goat dung produced less volume of biogas. Anaerobic digestion of some animal dung like cow, swine, rabbit, poultry and goat was carried out. The average volume of biogas produced was 44, 40, 37, 33 and 31 dm^3 per total mass of slurry respectively

Biological Oxygen Demand (BOD)

At the end of the process (on 56^{th} day) the reduction in BOD was observed and significantly more reduction was in T_5 (Cow dung + Fruit waste) 58.74 per cent compared to T_2 (Cow dung + Poultry litter) 52.20 per cent T_6 (Cow dung alone) 51.03 per cent, T_3 (Cow dung + Kitchen waste) 50.30 per cent, T_1 (Cow dung + Press mud) 45.57 per cent and less reduction in T_4 (Cow dung + Maize stalks) 27.68 per cent (Table 2).

The above results were similar to that of Bhumesh Singh and sai (2011) who studied on biogas generation from dairy effluent and explained that BOD and COD reduced to the extent of 50 per cent by the end of the process.

Chemical Oxygen Demand (COD)

At the end of the process (on 56^{th} day) decrease in COD was observed and more decrease was in T_6 (Cow dung alone) 52.15 per cent compared to T_2 (Cow dung + Poultry litter) 49.88 per cent, T_1 (Cow dung + Press mud) 41.55 per cent, T_3 (Cow dung + Kitchen waste) 40.26 per cent, T_5 (Cow dung + Fruit waste) 30.04 per cent and less reduction in T_4 (Cow dung + Maize stalks) 18.77 per cent (Table 3).

Li and jha (2014) studied the characteristics of semi-dry anaerobic digestion of cow dung and pig manure mixture under psychrophilic condition. The Chemical Oxygen Demand (COD) in the substrates was estimated. In cow dung the COD was 150.54 g l^{-1} and in pig manure 163.63 g l^{-1}.

SUMMARY AND CONCLUSION

The combination of Cow dung + Press mud (T_1) was found to be the best in biogas production. However, all the combinations were also proved to be better for the biogas production. Hence the agricultural wastes can be utilized for biogas production. Reduction in BOD and COD was observed gradually from the initial stage of anaerobic digestion till the end of gas production in all the treatments. This implies that anaerobic digestion of agricultural wastes can be used to reduce the environmental pollution.

Table 1. Biogas production from combination of different substrates

	At the end of first week (ml)	At the end of second week (ml)	At the end of third week (ml)	At the end of fourth week (ml)	At the end of fifth week (ml)	At the end of sixth week (ml)	At the end of seventh week (ml)	At the end of eighth week (ml)	At the end of ninth week (ml)	At the end of tenth week (ml)
T_1	1110.00	1236.67	1313.33	1353.33	1483.33	1380.00	1076.67	586.66	266.66	96.66
T_2	353.33	383.33	460.00	1276.67	1380.00	886.66	616.66	563.33	120.00	40.00
T_3	313.33	623.33	1123.33	723.33	540.00	416.66	203.33	76.66	26.66	20.00
T_4	213.33	920.00	683.33	503.33	203.33	183.33	150.00	123.33	106.66	13.33
T_5	520.00	680.00	840.00	563.33	240.00	150.00	123.33	106.66	90.00	60.00
T_6	370.00	523.33	1240.00	1380.00	1523.33	1280.00	966.66	563.33	176.66	80.00
S.E(m)	4.082	3.600	5.270	3.043	3.333	3.333	3.043	4.082	4.303	1.925
CD (P=0.05)	12.719	11.217	16.420	9.480	10.385	10.385	9.480	12.719	13.407	5.996

T_1 = Cow dung (250 g) + Press mud (500 g) + water (1500 ml) – 1:2:6

T_2 = Cow dung (250 g) + Poultry litter (500 g) + water (1500 ml) – 1:2:6

T_3 = Cow dung (250 g) + Kitchen waste (500 g) + water (1500 ml) – 1:2:6

T_4 = Cow dung (250 g) + Maize stalks (500 g) + water (1500 ml) – 1:2:6

T_5 = Cow dung (250 g) + Fruit wastes (500 g) + water (1500 ml) – 1:2:6
T_6 = Cow dung (750 g) + water (1500 ml) – 3:6
*The values within the brackets in the table indicate the difference between the values of adjacent weeks

Table 2. BOD at different stages of biogas production

	Zero day (Inoculum mixture) (mg l^{-1})	At the end of first week (7th day) (mg l^{-1})	At the end of second week (14th day) (mg l^{-1})	At the end of third week (21st day) (mg l^{-1})	At the end of fourth week (28th day) (mg l^{-1})	At the end of sixth week (42nd day) (mg l^{-1})	At the endof the process (56th day) (mg l^{-1})
T_1	101.00	94.33(6.67)	90.67(3.66)	80.14(10.53)	76.83(3.31)	71.90(4.93)	67.34(4.56)
T_2	118.00	104.00(14.00)	103.15(0.85)	91.28(11.87)	76.26(15.02)	74.74(1.52)	62.00(12.74)
T_3	134.85	124.05(10.80)	121.47(2.58)	107.64(13.83)	95.01(12.63)	83.55(11.46)	71.89(11.66)
T_4	106.88	95.02(11.86)	96.76(1.74)	90.71(6.05)	84.78(5.93)	82.98(1.80)	81.21(1.77)
T_5	67.25	60.64(6.61)	51.32(9.32)	44.00(7.32)	39.87(4.13)	35.70(4.17)	32.84(2.86)
T_6	151.75	139.51(12.24)	132.43(7.08)	117.40(15.03)	103.63(13.77)	92.83(10.80)	81.88(10.95)
S.E(m)	2.207	1.378	0.897	0.612	1.074	1.085	0.909
CD(P=0.05)	6.876	4.294	2.795	1.906	3.346	3.380	2.832

Table 3. COD at different stages of biogas production

	Zero day (Inoculum mixture) (g l^{-1})	At the end of first week (7th day) (g l^{-1})	At the end of second week (14th day) (g l^{-1})	At the end of third week (21st day) (g l^{-1})	At the end of fourth week (28th day) (g l^{-1})	At the end of sixth week (42nd day) (g l^{-1})	At the endof the process (56th day) (g l^{-1})
T_1	111.85	110.24(1.61)	107.82(2.42)	101.59(6.23)	92.59(9.00)	85.14(7.44)	71.91(13.23)
T_2	101.35	94.81(6.54)	87.27(7.54)	72.01(15.26)	62.52(9.49)	58.57(3.95)	54.91(3.66)
T_3	133.81	130.53(3.28)	128.28(2.25)	113.12(15.16)	104.71(8.41)	90.99(13.72)	82.62(8.37)
T_4	127.49	125.78(1.71)	123.58(2.20)	118.78(4.80)	113.59(5.19)	109.53(14.06)	106.19(3.34)
T_5	109.54	105.44(4.10)	103.93(1.51)	97.84(6.09)	95.47(2.37)	90.24(4.23)	80.54(9.70)
T_6	138.24	131.41(6.83)	124.74(6.67)	102.38(22.36)	84.57(17.81)	78.74(5.83)	71.10(7.64)
S.E(m)	0.655	0.431	0.282	0.498	0.255	0.267	0.321
CD (P=0.05)	2.041	1.343	0.877	1.551	0.794	0.833	1.000

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