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Anaerobic fermentation of sheep droppings for biogas production

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Production of biogas in batch digesters at 30°C from sheep droppings produced 93 l gas/kg dry matter whereas cattle dung yielded 234 l/kg dry matter. When the sheep droppings and cattle dung were used at 25:75 (w/w), gas production per kg dry matter was equal to that of cattle dung only. The methane content of the biogas obtained from sheep droppings was 70 to 72% as compared to 56 to 60% from cattle dung.

Key words: Anaerobic fermentation, batch digester, biogas, cattle dung, methane, sheep droppings.

Animal wastes are a significant source of substrate for biomethanation in family-sized biogas digesters. Besides being a source of carbon, these wastes are a potential source of the nitrogen required for successful operation of an anaerobic digester. However, an important consideration in the generation of methane from these wastes is the quantity and composition of the waste, which are dependent on the type of animal. There are several reports on the utilization of cow dung, piggery wastes, poultry droppings etc. for biogas production (Biswas 1977; Hobson *et al.* 1980; Mahadevaswamy & Venkataraman 1986) but very little information is available on sheep droppings (Jain 1981). This particular substrate is important in northern hilly regions of India where a number of farmers possess sheep and goats along with cows and buffaloes. The aim of this study was to demonstrate the feasibility of producing biogas from sheep droppings with or without added cattle dung.

Materials and Methods

Collection of Substrate

Fresh sheep droppings and cattle dung were obtained from the university dairy. Effluent slurry to use as an inoculum was obtained from a 3 m^3 family-sized biogas plant fed on pure cattle dung. The chemical profiles of these substrates are given in Table 1.

Experimental Design

The details of the digestion assembly are described elsewhere (Kalia & Kanwar 1990). In brief, a 3 l bottle with a facility for drawing samples of the digesting mixtures was used as an anaerobic digester. Digesters were filled with different mixtures of cattle dung and sheep droppings, held at 30 ± 1°C and stirred manually for 5 to 6 min twice daily. The digestion of the substrate was carried out for 8 weeks, this being the retention time used in Indian biogas plants.

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Table 1. Analysis of fresh cattle dung and sheep droppings.

Analysis	Cattle dung	Sheep droppings
Total solids (%)	20	49
Volatile solids (%)*	87	87
Carbon (%)*	48	48
Nitrogen (%)	1.6	2.5

* Dry weight basis.

Analytical Methods

Samples of digesting mixtures were analysed for pH, total solids, carbon (Sharma *et al.* 1987) and nitrogen (Bremner 1965). The volume of biogas generated was measured at a fixed time daily by a saline displacement technique (Arora 1975). The methane content was determined by gas chromatography with Porapak Q column using a thermal conductivity detector and H_2 as carrier at a flow rate of 40 ml/min. Injector, detector and column temperatures were 70°C, 80°C and 60°C, respectively.

Results and Discussion

Table 2 shows the details of the mixtures used, initial and final pH values, total solids and biogas production during the 8-week digestion period. With increasing concentration of sheep droppings in the mixture, an increase in initial pH was noticed in all the digesters. The pH values of D_1 to D_4 digesters were in the range of 6.9 to 7.6 which coincides

Table 2. Mixtures of sheep droppings/cattle dung used, initial and final pH and total accumulated gas production from different digesters.*

	Digester				
	D_1	D_2	D_3	D_4	D_5
Fresh cattle dung (g)	600	450	300	150	–
Fresh sheep droppings (g)	–	60	12	180	240
Total solids (g)	119	119	118	117	117
Initial pH	6.9	7.2	7.2	7.6	8.0
Final pH	7.4	7.6	8.1	8.3	8.5
Total gas production (l)	24.5	23.9	17.9	14.3	9.7
Total methane (l)†	14.7	15.0	12.0	10.0	6.9
Gas production (l/kg wet wt)	40.3	46.9	42.6	43.5	40.3
Gas production (l/kg dry wt)	234	231	173	139	93

* Seed slurry was 100 ml in each digester.
† Value calculated on the basis of average methane concentration obtained during different weeks.

with the reported optimum limits (Dague 1968) required for satisfactory production of methane.

With cattle dung alone, peak gas production was in the second week whereas with mixtures it was in the fourth week of digestion. With mixtures, low gas production occurred in the initial weeks. On a wet weight basis, gas production from pure sheep droppings and cattle dung was identical: i.e. 40 l/kg fresh weight. This is close to the 37 l/kg fresh weight reported by Sharma (1981) from goat droppings.

From the results (Table 2), sheep droppings are a poor substrate compared with cattle dung in terms of total accumulated gas production as well as gas production per kg dry matter. This might be due to a high initial pH (pH 8) which further increased to 8.5 during the anaerobic fermentation. These high pH values increase the toxicity effects of ammonia as reported by Hashimoto (1986). Jain (1981) obtained more gas from sheep droppings than cattle dung over an 8-week test period (45 l and 28 l/kg fresh weight of sheep droppings and cattle dung, respectively). However, his value of 45 l/kg fresh weight from sheep droppings is close to the value of 40 l/kg fresh weight obtained in this study. The methane concentrations from mixtures of sheep droppings/cattle dung were 64 to 72% compared with 56 to 60% obtained from pure cattle dung.

In conclusion, sheep droppings can be used as a substrate for the generation of biogas provided they are mixed with three parts of cattle dung prior to use. Higher concentrations of droppings cause inhibition, presumably due to a combination of increase in pH and in NH_4^+.

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