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BIOGAS FROM BUFFALO DUNG

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Changes in weather effected the dry matter content of buffalo dung and the production of biogas. The plant produced maximum biogas 1.78 M_3/Day at the loading rate of 2.4 Kg. total solids (TS)/M_3 digester/day at 34.8 C atmospheric temperature. Anaerobically fermented dung, i.e. effluent from biogas plant showed decrease in the fibre content from 26.24 % to 22.34 %. Application of effluent as fertilizer at the rate of 1800 litre/hactare/day resulted in 10.9 % increase in the yield of barseem/cut.

Key words: Animal dung; Anaerobic fermentation; Biogas.

INTRODUCTION

The rising fuel prices and fear of early depletion of fossil fuel has forced the developing countries to look for renewable sources of energy. Agricultural, animal and domestic wastes form a useful raw material for the production of methane gas by anaerobic fermentation. Developed countries [1,2] have converted pig manure into fuel gas and fertilizer. The gas produced had a calorific value of 6500 k.cal/m^3. Clausen *et al.* [3] reported the production of methane gas by anaerobic digestion of grasses and corn stalks. Pfeffer [4] studied different parameter for the production of biogas. Animal waste is also being converted into methane gas in Taiwan [5]. The use of chicken and pig manure, sewage sludge, kelp and cattle wastes, as substrate for the production of methane gas was studied by various workers [6-10]. Lane [11] studied the production of methane gas from waste fruit by anaerobic fermentation.

Pakistan produces 50 million metric tons of crop residues, animal and poultry wastes a year. A portion of these residues and wastes is at present being used as a fuel. Recently the Appropriate Technology Development Organization [12] and the Energy Cell, Government of Pakistan have started popularization of biogas plants.

This paper deals with the conversion of buffalo dung into methane gas and utilization of the by-products as feed and fertilizer.

EXPERIMENTAL

The substrate used for the production of biogas on pilot plant scale was buffalo dung collected fresh from the campus of PCSIR Laboratories, Lahore.

Construction of the biogas plant. The complete design of the biogas plant is shown in Fig. 1. A tank (A 1.75 m square and 2.10 m deep was built underground. The walls of the tank were built with burnt bricks and mortar, and base was covered with concrete. All the vertical and horizontal joints of masonary were completely filled with mortar. Two angle irons 38 cm/long/ and 5 cm wide (B) were fixed in the wall of the tank 1.2 m above the base and protruding about 10 cm inside the tank. An inlet concrete pipe (C) 2.4 m long and 15.2 cm dia was fixed in a slanting position in such a way that its lower end opened into the tank about 30 cm above the bottom. The upper end of the pipe was connected with 0.92 cu.m feeding tank (D) built above the ground with

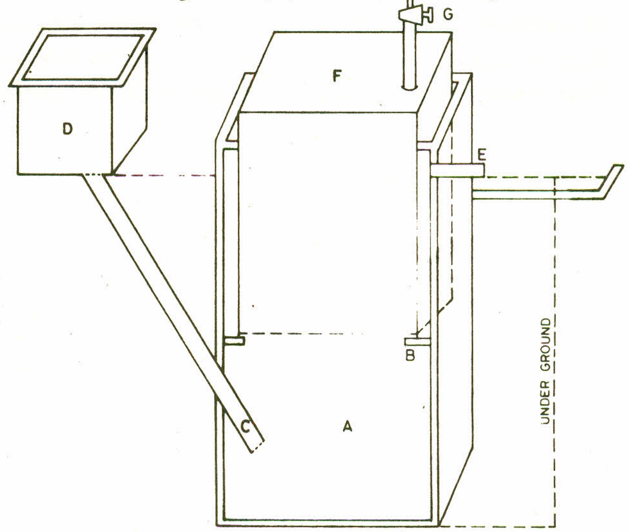

Fig. 1. Design of biogas plant. (A. Tank for fermentation of slurry; B. Angle iron fixed in the wall of tank for supporting gas holder; C. Concrete pipe inlet; D. Tank for mixing water in gober; E. Concrete pipe out-let; F. Steel drum collecting bio-gas. G. Gas volve).

bricks and mortor and used for preparing dung slurry. Another concrete pipe (E) 62.0 cm long and 15.2 cm dia was fixed on the edge of the tank (A) for discharge of the effluent. A 2.0 cu.m hollow drum (F), fabricated from 3 mm thick iron sheet, with its edges welded with a steel rod, fixed with a valve (G) on its top for outlet of the gas, was used as the gas holder. It rested on the angle iron (B) fixed in the wall of the tank.

Operational procedure. Initially 3600 kg of fresh dung were diluted with water for adjusting its total solids 10 %. The slurry was charged through inlet pipe (C) and the tank was filled up to the level of an outlet pipe (E). After an initial incubation time of 3 weeks, evolution of biogas started and the steel drum was lifted up according to the volume of gas collected. Fresh dung (72 kg) diluted with water to 10 % TS and charged daily after 3 weeks of starting the experiment. pH of the fermentation medium was maintained at 7.5 ± 0.2 by adding lime water. The volume of gas collected was recorded daily. The experiment continued from 15th November 1979 to 16th June, 1980, but the loading of dung was stopped 50 days before terminating the experiment. The effluent or the digested material was collected and analysed.

Procedure for crop response to the effluent. Sixteen experimental plots (15.0 sq m each) were cultivated by broadcasting barseem seed (50 g/plot) in standing water in October. Biogas plant effluent was applied to eight plots at the rate of 40.5 litre/plot with canal water after every two weeks. The rest of eight plots were not supplied with the effluent but were irrigated with canal water at the same intervals. All the sixteen plots were harvested after 30 days interval at the same time. The weight of green fodder obtained from each plot was recorded. The average yield/ha/cut of the crop with and without effluent treatment was calculated.

Analytical. Nitrogen in the buffalo dung and the slurry (effluent) was estimated by the micro-Kjeldahl method using K_2SO_4: $CuSO_4$: SeO_2 (9:1:0.02) catalyst. Moisture, ash and lipids were determined by the AUAC [13] methods. The pH of the medium was recorded with a glass electrode. The digestibility of the slurry was estimated by lowering the sample, in a nylon gab, into the rumen of a fistulated cow.

RESULTS AND DISCUSSION

The chemical analysis of buffalo dung is given in Table 1. The results show small variations in the ash and nitrogen contents of the dung. These can be attributed to changes in the feed composition and other factors. However, a marked increase in the dry matter content was observed in the samples collected in the months of November, March and June. The dry matter content increased from 20 % in November 1979 to 37 % in June, 1980. This clearly indicated that the dilution rate of dung with water (1:1) mentioned in the literature [14,15] will have to be changed in view of the variations in the dry matter content of the dung. Increased supply of water would be needed to bring the solid content to 10 % level, during the periods when atmospheric temperature is high and humidity is low.

Proximate enalysis of the effluent from the biogas plant shows a decrease in the fibre content from 26.24 % to 22.34 % (Table 2) which was due to digestion of the cellulosic matter during anaerobic fermentation. The increase in nitrogen content was 133 percent and the crude protein content of the effluent ranged from 20.06 to 21.94 per cent. Thus the protein content of the slurry was almost equal to that of cottonseed cake (undecorticated). Digestibility of the effluent dry matter as such was 24 per cent.

Table 1. Proximate analysis of buffalo dung.

Composition %	Dates		
	16.11.1979	15.3.1980	16.6.1980
Dry matter	20.00	26.50	37.00
Ash*	18.83	18.64	19.50
Lipids*	1.42	1.39	1.40
Fibre*	26.24	26.86	26.80
Nitrogen*	1.43	1.28	1.45
Crude Protein*	8.94	8.00	9.06

***Dry matter basis**

Table 2. Proximate analysis of effluent.

Composition %	Dates		
	15.12.1979	17.3.1980	16.6.1980
Dry matter	10.80	10.80	10.70
Ash*	18.74	18.45	19.10
Lipids*	1.22	1.35	1.25
Fibre*	22.34	22.74	22.16
Nitrogen*	3.34	3.21	3.51
Crude protein*	20.88	20.06	21.94

***Dry matter basis.**

Table 3. Effect of effluent (Digested slurry) from biogas on the yield of crop.

Production of barseem (green fodder) kg/hactare/cut		Protein content (as % of DM)	
Without effluent	With effluent	Without effluent	With effluent
10138	11250	21.50	26.0

Note: 1. Rate of the addition of slurry = 1800 litre/hactare/day.
2. The increase observed in the production of crop = 1122 kg green fodder/hactare/cut.

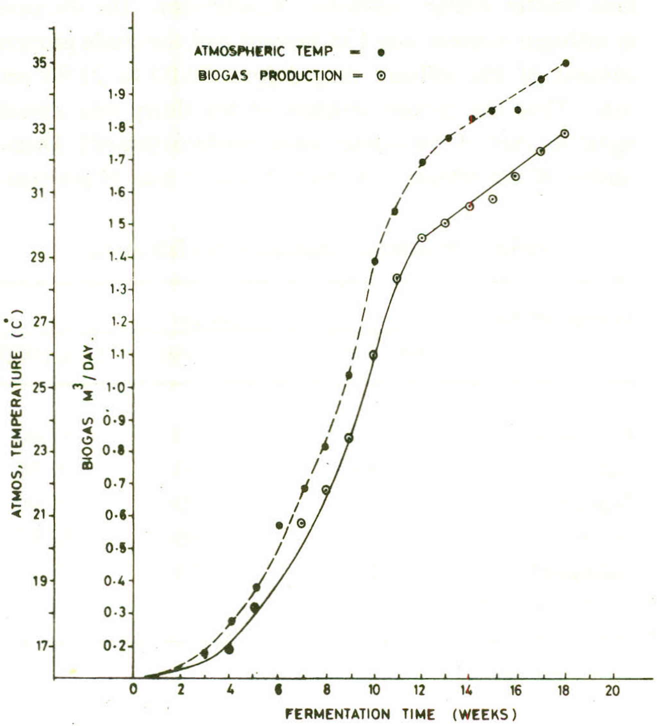

Fig. 2. Production of biogas with changes in the atmos. temperature.

This low digestibility could be due to the high mineral or lignin content of the slurry. It is hoped that mixing of the slurry with other feed constituents will improve the assimilation of the crude proteins present in the slurry.

Application of the effluent at the rate of 1800 litre/hactare/day resulted in up to 10.9 per cent increase in the yield of barseem per cut and 20.9 per cent increase in the nitrogen content of the crop (Table 3). Thus there was a qualitative as well as quantitative increase in the yield of barseem when the effluent was applied to the soil.

Production of gas. The production of biogas at pH 7.5 ± 0.2 and temperature ranging from 16.6 to 34.8^{o} is given in Fig. 2. The results indicated that after initial incubation time of about 3 weeks the production of gas increased gradually. The plant produced maximum biogas 1.78 m^3/day when the temperature was 34.8^{o}. The gas produced at this temperature was enough for domestic cooking for 4 hr daily and the gas pressure was suitable to take the gas to a distance of about 100 m away from the biogas plant in a 12.7 mm diameter G.1 pipe. The operation of biogas plant was technically feasible and could be operated with dung from two buffaloes. Further, studies regarding the improvement in design and economic aspects are in progress.

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