Pak. j. sci. ind. res., vol. 32, no. 3, March 1989

PRODUCTION OF BIOGAS FROM DRIED BANANA PEELINGS

Misbah-ul-Hasan, Ali Sher Bhatti and Mateen Muhammad Khan

Fuel Research Centre, PCSIR, Karachi-39

(Received December 28, 1988; revised February 18, 1989)

The dried banana peelings provided sufficient amount of biogas to make the process economically feasible. The composition of the biogas included approximately 70% methane. It was also found that banana peelings mixed with cowdung increased the yield of biogas.

Key words: Banana peelings, Biogas.

INTRODUCTION

Pakistan being an energy defecient country needs to exploit all its possible resources for energy generation. In this context renewable sources of energy can play an important role. Pakistan has an abundance of agricultural wastes which can be used as an important energy source by conversion into biogas. These agriculture wastes are converted into biogas by microbial action in sufficient yields to make the process economically viable. Several reports have been published, utilizing animal manure as a substrate for biogas production [1-7]. The cow dung and bird dropping, have been traditionally used for the generation of the biogas on a large scale in various countries like India, China and Pakistan. It is of interest to note that several thousand biogas plants have been installed in these Asian countries. It is reported that approximately half of the 4000 plants started in Pakistan several years ago are still in operation. The use of agricultural wastes for generation of biogas is however still in experimental stage. Conversion of bagasse, rice and wheat straws to biogas has been reported by R. Katib *et. al.* [8]. A mixture of rice straw and cow dung has also been reported to result in the improvement of biogas production [9]. The use of these agricultural wastes for energy generation will have the additional advantage of reducing the environmental pollution and garbage disposal problems of the country. To our knowledge there has been no report on the use of fruit wastes such as banana peelings for the generation of the biogas. Since banana is produced in Pakistan on a large scale, it is desirable to examine the possibility of use of banana peeling for production of biogas. In this paper the results of experiments for the generation of biogas from dried banana peelings are reported.

MATERIALS AND METHODS

Fresh banana peelings were collected and dried under sun for 15 days. They were crushed into powder of 60 mesh. A slurry of 240 g banana peeling powder in 3 litre of water was prepared. The slurry which was prepared in a 5.0 litre beaker was mixed thoroughly and left open in air for 48 hours to allow the slurry to undergo aerobic fermentation. The pH of the slurry was adjusted to 7.0 by addition of sodium carbonate. In some experiments ammonium phosphate were added to the banana peelings powder while in others cow dung were added. The exact composition of the substrate is shown in Table 2.

After 48 hours the slurry was transferred into 3 bottles of one litre capacity each, which were all connected to a five litre gas collection bottles. The gas was collected by the downward displacement of water (Fig. 1).

The slurry bottles were shaken daily two times and the

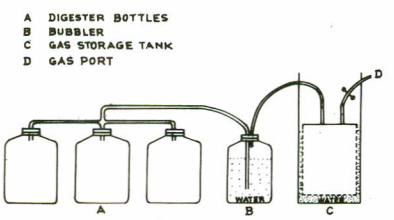


Fig. 1. Laboratory set up of a biogass digester.

amount of gas collected each day was recorded. The maximum and minimum temperature of each day during each experiment was also recorded. The average temperature calculated for each experiment is also shown in Table 2.

The analysis of the biogas was performed by gas analyzer using orsat technique [10]. The percentage of methane gas was obtained by difference and confirmed by flamability test [11]. It may be mentioned here that no inoculum was needed for any of the experiments to generate biogas from banana peelings. This is in contrast to generation of biogas from crop residues where generally an inoculum is needed to start the biodegradation process.

The FT-IR spectra were recorded on Perkin Elmer Model 1800 Spectrometer in a KBr disc. The proximate and elemental analysis were determined by a LECO MAC and CHN-600, instruments respectively.

RESULTS AND DISCUSSION

The results of proximate and elemental analysis of dried banana peelings powder are given in Table 1. The proximate analysis of dried banana peelings powder showed a higher percentage (63%) of volatile matter and

Table 1. The proximate and elemental analysis of banana peelings powder %.

(a) Proximate analysis of banana peelings powder %	
Moisture	8.70
Ash	13.7
Volatile matter	63.0
Fixed carbon	23.3
(b) Element analysis %	
Carbon	38.92
Hydrogen	5.45
Nitrogen	2.39
Sulphur	0.6
C/N	16.6

23.3% fixed carbon while the percentage of the ash was found to be 13.7%. The rather large percentage of ash shows that the inorganic mineral matter in banana peelings is quite high. The elemental analysis showed 39% of carbon, 5.4% hydrogen and 2.3% of nitrogen. This gives a C/N ratio 16.6% which is quite suitable for production of bio-gas by bacterial action. The fourier transform infrared spectrum of the powder is shown in Fig. 2. The characteristic peaks in the FT-IR spectrum appear at 3360, 2960, 2920, 1730, 1650 and 1050 cm^{-1}. The peaks at 3360 and 1050 cm^{-1} are rather very broad and may be assigned to OH and C-0 stretching frequencies of alcohol respectively. The peaks at 2920 cm^{-1} and small shoulder at 2920 cm^{-1} may be due to CH_2 and OH stretching vibrations. The small shoulder peak at 1730 cm^{-1} is due to carbonyl groups. The strong peak at 1650 cm^{-1} is also due to oxygen containing functional groups. It is of interest to note that all these peaks are also present in an FT-IR spectrum of pure starch (Fig. 4). So it can be inferred that banana peelings contain

Table 2. The composition of substrate and the amount and composition of biogas obtained from banana peelings powder.

Experiment No.	Compsition of substrate	Amount of biogas generated (ml)	Mean Temp. (°C)	Gas yield ml/g	Composition of biogas %	
1.	240g Banana peelings	3090	25.0	12.9	CO_2	28.80
					O_2	2.60
					Unsaturated hydro-carbon	0.60
					CO	1.00
					CH_4	67.00
2.	240g Banana peelings, 2g ammonium phosphate	3230	25.3	13.4	CO_2	30.0
					O_2	2.6
					Unsaturated hydro-carbon	Nil
					CO	Nil
					CH_4	68
3.	225g Banana peelings, 15g cowdung	3740	32.4	15.6	CO_2	25.0
					O_2	5.0
					Unsaturated hydro-carbon	Nil
					CO_2	Nil
					CH_4	70
4.	240g Banana peelings, 30g cowdung	3910	30.8	16.3	CO_2	25.0
					O_2	0.4
					Unsaturated hydro-carbon	Nil
					CO	1.0
					CH_4	73.6
5.	240g Cowdung	4100	30.1	17.1%	CO_2	22.9
					O_2	Nil
					Unsaturated hydro-carbon	0.1
					CO	Nil
					CH_4	77

mainly carbohydrates such as starchy materials. The amount and composition of substrate used alongwith the amount and composition of biogas produced in each experiment is given in Table 2.

The production of gas was complete in 20 days. In second experiment, 2 grams of ammonium phosphate was added to the substrate to increase the percentage of nitrogen. The total yield of biogas was 3.23 litres (13.4 ml/g). The percentage of methane in this gas was 66%. Thus no significant increase in the amount of biogas formed or in the percentage of methane gas was obtained. This is however expected since C/N ratio of banana peelings powder is 16.6 and it is known that addition of nitrogen is needed only when C/N ratio is higher than 40. A lower C/N ratio in

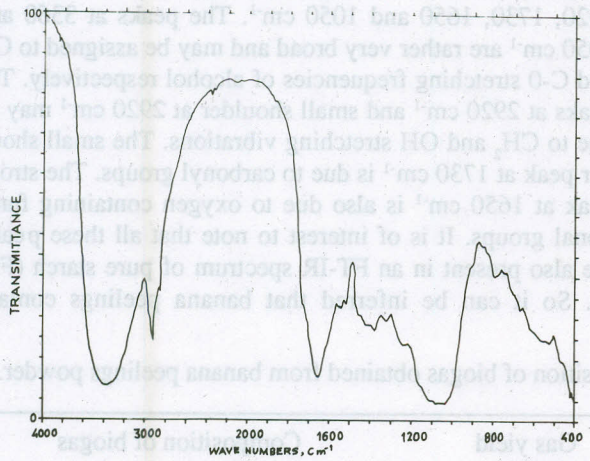
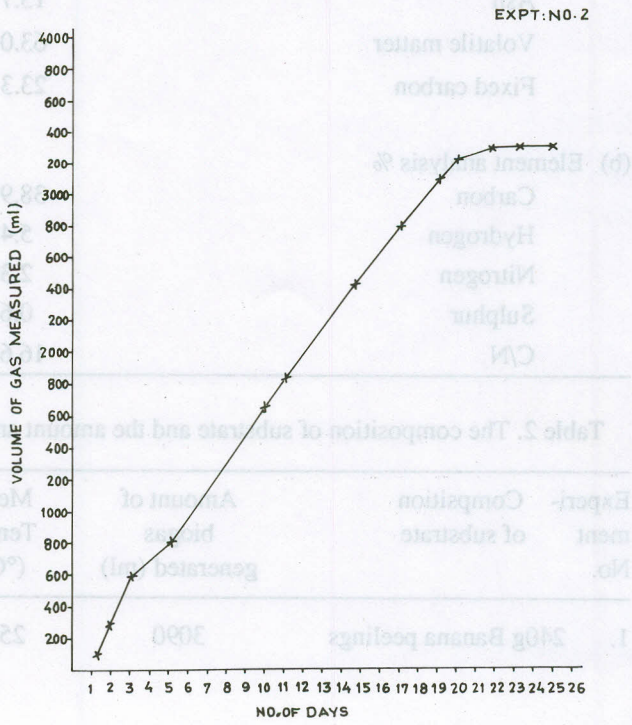
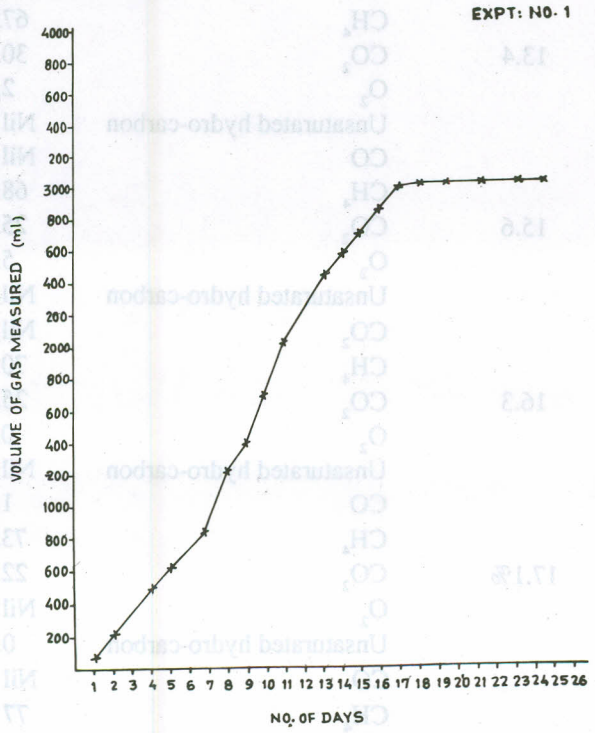


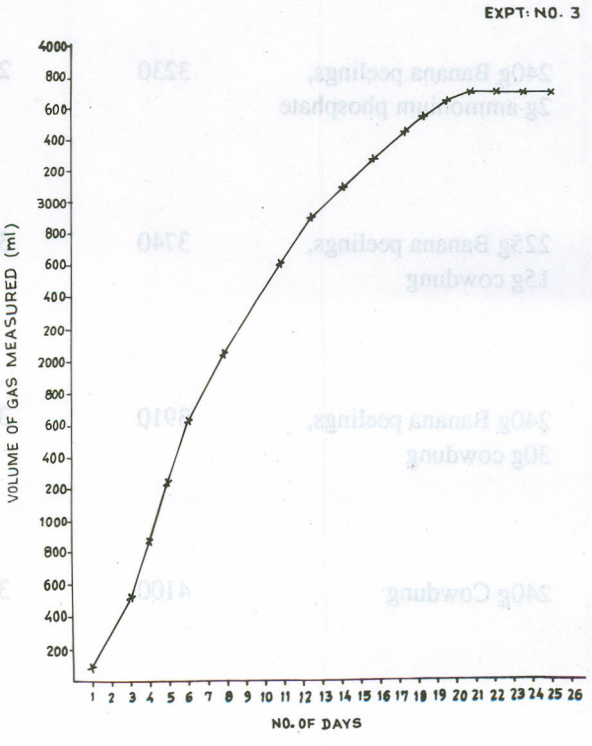
Fig. 2. FT-IR of banana peeling powder.

Figure 3 shows the volume of biogas generated VS the number of days for each of the 5 experiments.

In experiment No. 1, 240 g of banana peelings powder provided 3090 litres of biogas (12.9 ml/g). The percentage of methane was 67%.







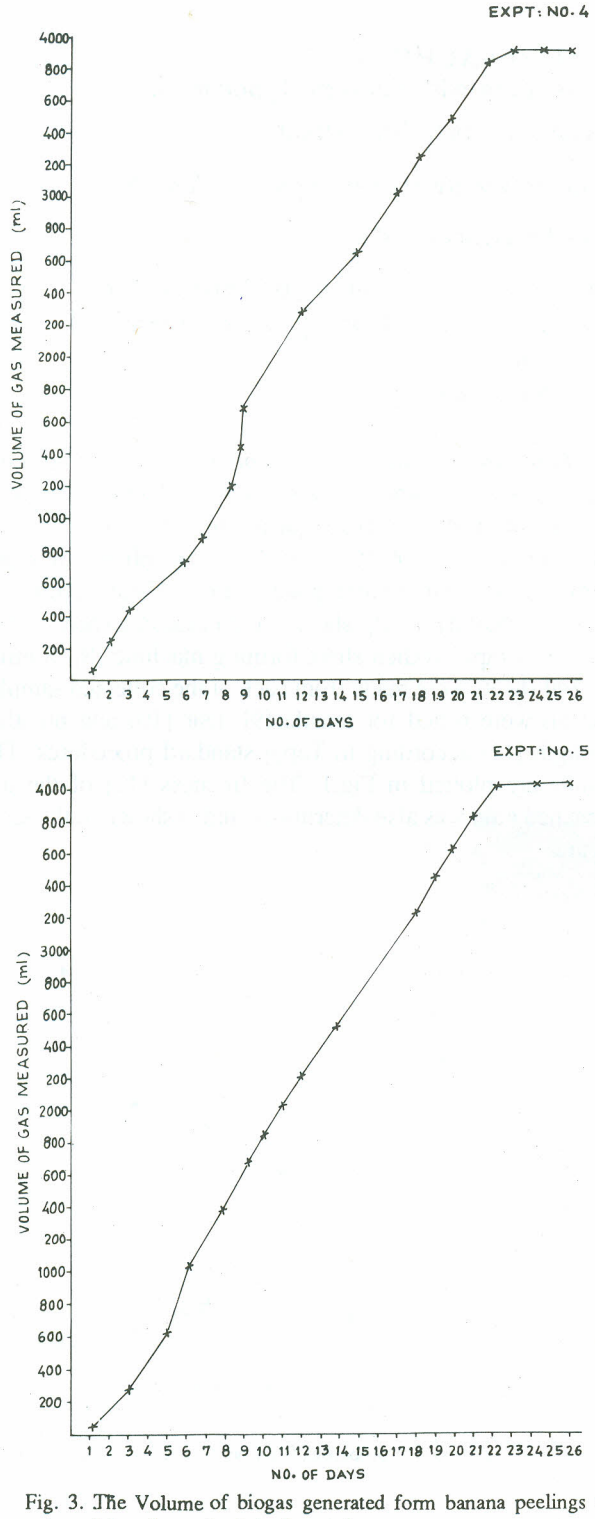


Fig. 3. The Volume of biogas generated form banana peelings v/s the number of days for each of the 5 experiments.

banana peelings indicates that there is enough nitrogen present in the substrate for its degradation. However addition of cowdung significantly increase the yield of biogas and also resulted in an increase in the percentage of methane gas. Thus in experiments number 3 and 4 where 15 and 30 g of cowdung were added to 225 and 210g of banana

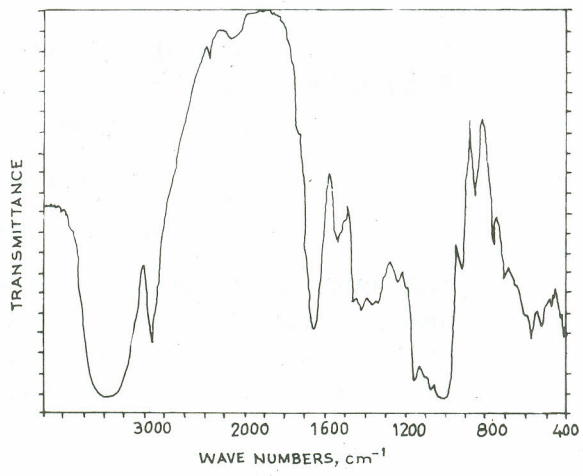


Fig. 4. FT-IR spectrum of pure starch.

peelings respectively the amount of biogas formed was 3.74 litres respectively. The percentage of methane gas in these experiments was 70 and 73% respectively. In the last experiment 240g of cowdung provided 4.1 litres of biogas (17.1 ml/g) with the percentage of methane being 77%. From the above experiment it could be concluded that a mixture of banana peelings and cowdung could provide better yields of biogas in comparison to banana peelings alone.

REFERENCES

1. H.M. Lapp, D.D. Schults, A.B. Sarline and L.C. Buchanan, Can. Agri. Eng., **17,** 97 (1977).
2. D.L. Miller, Conf. on Capturing Sun Bioconvers, Wash. Central Metrop, Studies, Washington D.C., 361-364. (1976).
3. Po, Chung, Proc. Inter. Biomass Energy Conf. (1973), pp. 16.
4. E.M. Rigor, E.D. Beltra, F.F. Penalba and P.F. Alcantara, BAI Recorder, March (1974), pp. 14.
5. *Methane Generation from Human, Animal and Agricultural Wastes* (National Academy of Sciences, Panel of Methane Generation, Washington, D.C. (1977), pp. 131.
6. K. Haga, H. Tanaka and S. Higaki, Agric. Wastes, 45 (1979).
7. P.F. Anlo, H. Tanaka and K. Haga, Philipp. J. Bio., **7,** 247 (1978).
8. R. Khatib, N.F. Usmani and S.S. Hussain, Pak. j. sci. ind. res., **30,** 777 (1987).
9. M.S. Kalra and J.S. Panwar, Agricultural Wastes, **17,** 263 (1986).
10. J. Frank, *Standard Methods of Chemical Analysis, Part B* (D. Van Nostrand Co., Inc., Princeton, New Jersey, 1965), 6th ed.
11. Zukefosse and R.B. JoeHayes, *Operational Manual Anaerobic Study Digestion* (Municipal Operation Branch, Office of Water Progress Operations, Washington, D.C., 20460, 1976).