THE EFFECT OF RETENTION TIME ON BIOGAS PRODUCTION FROM SLURRY PRODUCED BY CATTLE FED SUGAR CANE[1]

A Boodoo, C Delaitre and T R Preston[2]

Animal Production Division, Ministry of Agriculture, Natural Resources and the Environment, Reduit, Mauritius

A study was made of different retention times employed in the anaerobic fermentation of slurry from cattle kept on slatted floors and fed sugar cane and molasses/urea. A standard 200 lib. oil drum with a plastic lining was used as a digestor. The treatments were different retention times of 10, 20 and 40 d and there were two determinations at each of these times. The slurry was obtained from the exit sluice of a feedlot with a slatted floor. The digestor was filled to the level of the overflow pipe (approximately 190 kg) with slurry. Amounts of 18.5, 9.25 and 4.62 kg fresh slurry ware added daily for the respective retention times of 10, 20 and 40 d. Each experiment lasted for a complete cycle, ie 10, 20 or 40 d according to the treatment.

Daily gas production fell slightly fro. 53 to 48 litres/d, as retention time was increased from 10 to 40 d. The amounts of gee produced per unit of dry matter and per unit of organic matter entering the digestor showed a linear increase with retention time. The maximum value was 300 litres of biogas/kg organic matter entering the digestor. The air temperature during the experiment warded from 21 to 30° and the temperature of the gee at the time of measurement from 23 to 40°.

Key Words: Biogas, sugar cane, retention time

The continuing energy crisis has reawakened interest in the anaerobic fermentation of animal and vegetable waste to produce methane. The early work reported from India was mostly concerned with the utilisation of fresh and dried manure from cattle and other species (see Freeman and Pyle 1977). The comprehensive programme being carried out at the Rowett Research Institute in Scotland has used as raw material the effluent arising from poultry, pig and cattle units managed intensively (Robertson et al 1975). However, this work relates to temperate country conditions and diets.

There do not appear to be data from tropical countries on the conversion of slurry from intensive cattle enterprises into biogas.

This paper reports results from a study of different retention times employed in the anaerobic fermentation of slurry from cattle kept on slatted floors and fed mostly sugar cane and its by-products.

---

[1] This work was supported in part by funds provided by the UNDP/FAO project MAR/75/004

[2] FAO Consultant to MAR/15/004; present address: Escuela de Medicina Veterinaria y Zootecnia, University of Yucatan, Merida, Mexico; and Centro Dominicano de Investigacion Pecuaria con Cana de Azucar, CEAGANA, Apartado 1256, Santo Domingo, Dominican Republic

Materials and Methods

Design of Digestor: A standard 200 litre oil drum with a plastic lining was used as a digestor. It was fitted with a central feed pipe reaching almost to the bottom of the drum which was placed vertically, while an overflow pipe was set at about a 45° angle in the side of the drum near the top. Gas was collected by a pipe attached to the top of the drum and leading into a smaller inverted drum suspended in a water seal.

Treatments and Designs: The treatments were different retention times of 10, 20 and 40 days and there were two repetitions of each of these tines.

Procedure: The slurry was obtained from the exit sluice of a feedlot with partially slatted floors. The cattle were being fed a basal ration of chopped whole sugar cane and molasses containing 5% urea both of which were made available on a free choice basis. They also received 1 kg/d of a protein/ starch based concentrate. For these experiments, the digestor was filled to the level of the overflow pipe (approximately 190 ± 2 kg) with slurry and either 18.5, 9.25 or 4.62 kg fresh slurry was added daily for the respective retention times of 10, 20 and 40 d. Samples were taken daily of the fresh and digested slurry for analysis.

Measurements: Each experiment lasted for 1 complete cycle i.e. 10, 20 or 40 d according to the treatment. Gas production was measured at intervals of about 24 hr by volume displacement; the temperature of the gee being recorded and the volume corrected to a standard temperature of 20° over 24 hr. Both the fresh and digested slurry were analysed for dry matter (DM), organic ; matter (OM) and nitrogen (N) by standard procedures.

Table 1:
Composition of input slurry and of digested effluent (x ± SEx)

	Retention time, d		
	10	20	40
Input of slurry, kg/d			
Fresh basis	18.5	9.2	4.8
Dry matter	.61	.36	.17
Organic matter	.50	.29	.14
Composition of input slurry			
DM, % of fresh	3.30±.47	3.9±.5	3.90±.36
OM in DM, %	82.4±1.3	81.8±.7	83.81±.67
N in DM, %	1.84±.04	1.9±.1	1.7±.14
Composition of digested effluent			
DM, % of fresh	2.82±.48	2.0±.3	1.93±.19
OM in DM, %	76.3±1.98	76.9±.8	74.9±.9
N in DM, %	2.27±.07	2.0±.2	2.0±.15

Results and Discussion

The composition of the fresh and digested slurry is given in Table 1. The production of biogas for the different retention times is given in Table 2. Gas production per unit of DM or OM fed into the digestor showed a linear relationship with time (Figure 1, regressions B and C), showing that, from 10-40 d retention time, the rate of degradation was constant (given by the slopes of regressions B and C). The slight reduction in total daily production with time (regression A) was due to the more rapid (i.e. in less than 10 d) initial fermentation, which is implied by the fact that the intercepts for regressions B and C are not zero. A retention time of 40 d gave a gas production of 300 litres/kg DM fed into the digestor (Table 2).

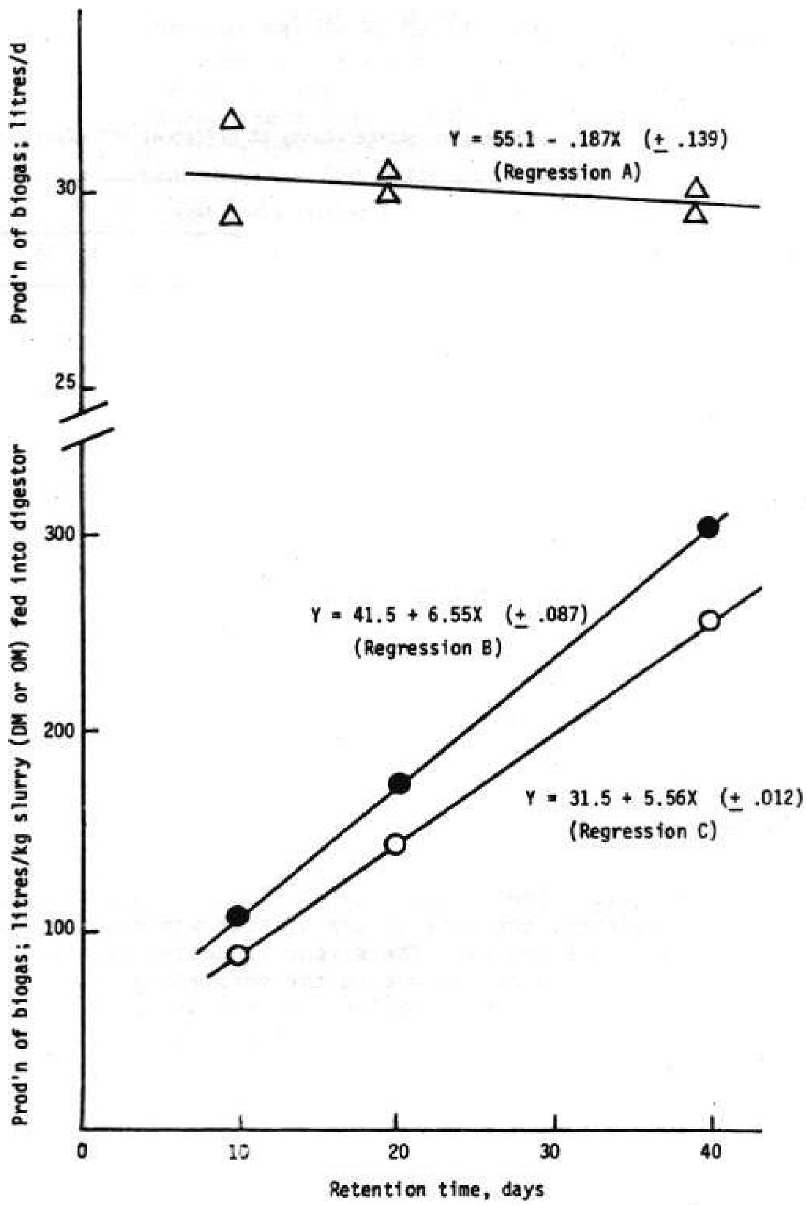
Table 2:
Mean values (± SE) for biogas production from cattle slurry at different retention times

	Retention time, days		
	10	20	40
Production of biogas[1]			
Litres/d			
Replicate 1	59.1±4.4	52.4±3.3	47.7±2.9
Replicate 2	47.2±3.3	50.7± 2.2	47.5±2.9
Mean	53.2	51.4	47.6
Litres /kg	87	143	254
Litres/kg OM	106	174	303
Mean temperature			
Gas at measurement			
Replicate 1	39.7	36.6	23.0
Replicate 2	36.3	35.2	27.6
Outside air			
Replicate 1	30.8	28.8	21.4
Replicate 2	29.0	27.0	24.3

[1] Volume adjusted to temperature of 20°

It is interesting to note that the temperature of the gas at the time of measurement was, on average, about 36°; some 6° above the air temperature. As the optimum temperature for digestion is considered to be about 35° (Meyrell1976), the recirculation of the gas through the digesta would perform the dual role of mixing the digesta and raising its temperature, Both effects should help to increase the daily rate of digestion, and thus allow a reduction in retention time without loss of overall efficiency (i.e. gas produced per unit OM fed into the digestor).

Figure 1 :
Effect of retention time on production of biogas from slurry of cattle fed sugar cane and molasses; litres per kg DM (◦), per kg OM (•), and per day (△)



References

Robertson A M, Burnett G Bousfield S, Hobson P N & Summers R 1975 Proceedings 3rd International Symposium Livestock Wastes p544

Freeman C & Pyle L 1977 Methane generation by anaerobic fermentation: an annoted bibliography Intermediate Technology Publications London

Maynell J P 1976 Methane: Planning a Digestor Prism Press Dorset UK

Received 15 February 1979