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Short Communication

Mesophilic and thermophilic methane fermentation of *Euphorbia tirucalli*

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Introduction

Euphorbia tirucalli, a shrub well adapted to Sahelian-type semi-arid zones, produces an abundant biomass (Declerck *et al.* 1985) and could be widely grown in rural areas because of ease of cutting, regrowth and high-propagation ability, instigating anti-erosive action and regenerating programmes. During this work, methanization of *Euphorbia tirucalli* was tested at mesophilic (37°C) and moderate thermophilic (48°C) conditions in batch digesters fed at 5% of dried matter.

Materials and methods

Plant preparation. Three different plant pretreatments were tested: coarse chopped, ground and dried and ground material.

Inoculum. Mixed populations of microorganisms from bovine rumen juice were first adapted in converting the solid waste to methane and CO_2. Two months were necessary to obtain a suitable inoculum at 37°C and 48°C. Dilution rate of the inoculum was 30% (v/v) in tap water.

Experimental equipment. The anaerobic batch digesters were 2-l glass jars. The top of the vessel was fitted with a rubber plug through which passed a gas exit line. Gas production was measured by collection in water-displacement bottles. The digesters were maintained at 37°C or 48°C in a water bath.

Analysis. Methane and volatile fatty acids were measured by gas chromatography (Garcia *et al.* 1982).

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Results

Methanization of *Euphorbia tirucalli* was performed with different amounts of dried matter content (data not shown). Best results were obtained with 5% (w/v) dried matter. This dilution of dried matter was used throughout this work.

Coarse chopped raw material

Under the mesophilic conditions, methane in the biogas reached 50% (v/v) only by day 24 (Fig. 1A). It did not exceed 65%. The average daily yield was 0.24 l/l/d (Table 1), and reached its maximum on day 28 with 0.63 l/l/d.

At 48°C, a 50% (v/v) content of methane in the biogas was reached on day 8 with a maximum of 68% on day 19 (Fig. 1B). The average yield was 0.78 l/l/d. Maximum production was 1.06 l/l/d (Table 1).

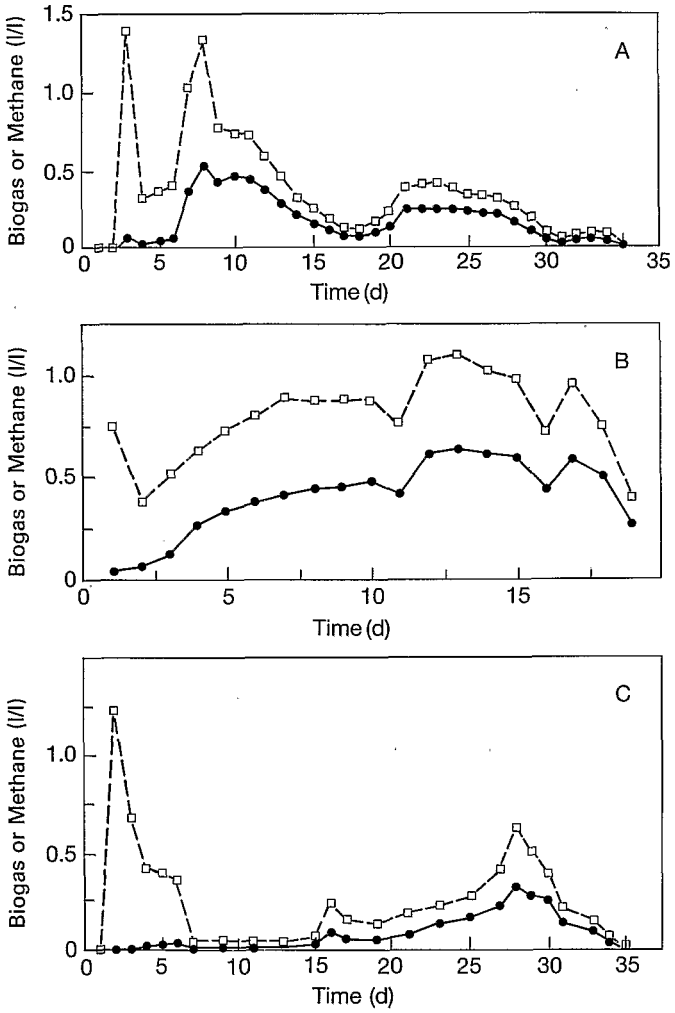

Fig. 1 Biogas (□) and methane (●) production from (A) chopped raw material (37°C), (B) chopped raw material (48°C), and (C) ground raw material (37°C).

Table 1 Comparative yields of biogas in mesophilic and moderate thermophilic conditions

	Mesophilic (37°C)			Thermophilic (48°C)		
	Yields			Yields		
State of material	Average (l/l/d)	Maximum (l/l/d)	Retention time (d)	Average (l/l/d)	Maximum (l/l/d)	Retention time (d)
Chopped	0.24	0.63	35	0.78	1.06	19
Ground	0.37	0.77	35			

Ground raw material

Fermentation of ground raw material at 37°C resulted in a high acidification stage during the first days of incubation (Fig. 1C). Buffering the medium with $NaHCO_3$ was necessary to initiate methanogenesis. Maximum yield of biogas was 0.77 l/l/d. The average yield was 0.37 l/l/d with 55% (v/v) of methane in the biogas on day 9 (Table 1).

Under thermophilic conditions, $NaHCO_3$ was also added to neutralize acids in the medium. However, methanogenesis was reduced with only 30% (v/v) of methane in the biogas (data not shown).

Dried and ground raw material

Yield of biogas was very low with this plant preparation in mesophilic and thermophilic conditions (maximum yield 0.24 l/l/d, retention time 70 days) so that these results are not reported.

Discussion

The results of this work show that *Euphorbia turicalli* is a suitable biomass for biogas production. Methane fermentation of this shrub can be realized in mesophilic conditions with ground raw material or in thermophilic conditions with chopped raw material (Table 1). However, the gain observed at moderate thermophilic conditions of methanogenesis as compared to mesophilic (from 0.37 to up to 0.78 l/l/d) is large enough to advocate this route for use in tropical zones, as the energy balance is the same as that of the mesophilic route in temperate climates.

Fermentation of *Euphorbia tirucalli* gives yields of biogas comparable to other agro-industrial wastes (Cooney & Wise 1975; Varel *et al.* 1977; Labat *et al.* 1984; Stoppok & Buchholz 1985), and could be a plant of choice in Sahelian areas for methanogenesis since this shrub is well adapted in poor soils (Verstraete 1985; Declerck *et al.* 1985). Based on estimations of Lake Beringo (Kenya), i.e. 80 000 plants/ha yielding 20 dry metric tons/year for *Euphorbia tirucalli*, the annual methane production of a continuous digester will be around 3000 m^3 methane/year (equivalent to approx. 3000 l of fuel-oil) with 100 metric tons of valuable compost per year.

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Summary

Methanization of *Euphorbia tirucalli* was determined under mesophilic and moderate thermophilic conditions. Three different plant pre-treatments were tested: ground, coarse chopped and dried and ground material. The batch digesters were fed at 5% dilution of dried matter. During a 35 days test, the best daily yield (0.78 l/l/d) was obtained with the chopped raw material under moderate thermophilic conditions.

Résumé

*Fermentation méthanique mésophile et thermophile d'*Euphorbia tirucalli

La méthanisation d'*Euphorbia tirucalli* a été réalisée en conditions mésophile et modérément thermophile. Trois différents pré-traitements de cette plante ont été testés: simple fragmentation, broyat, séchage puis broyage. Les digesteurs ont été alimentés avec 5% de matière sèche en batch. Lors d'une expérimentation de 35 jours, le meilleur rendement (0,78 l/l/j) a été obtenu avec les fragments de plante en condition thermophile modérée.