CHARACTERISATION OF COSTA RICAN FEED SAMPLES USING THE GAS PRODUCTION METHOD

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Introduction

In Costa Rica sugar cane tops are widely used as a roughage for ruminants. Identifying and providing suitable supplements is one way of boosting the productivity of local feeding systems. Tree fodders are possible supplements, being potentially rich in fermentable protein and carbohydrate, but this potential is not always achieved due to variable composition and the effects of anti-nutritive factors.

Proximate analysis can be a poor indicator of nutritive value. The in vitro gas production technique is in part susceptible to the effects of anti-nutritive factors and is sensitive to interactions between feeds, which are not measured by other techniques. There are two potentially important types of interactions between roughages and tree fodders, firstly tree fodders provide protein to supplement roughages which are generally N deficient. Secondly, highly fermentable carbohydrate may stimulate the fermentation of less fermentable fibre. This study was undertaken to characterise a sample of sugar cane tops and four tree fodder supplements, and investigate the suitability of the supplements.

Materials and methods

The four tree fodder supplements were Ramio, Leucaena, Cratylia and Guacimo.

Feeds were fermented individually (four replicates) and as sugar cane + supplement mixtures (in duplicate) at the following rates of supplementation: 0.2, 0.4 and 0.6 of the total feed. Feeds and mixtures were fermented in N-rich and N-free media using 10 ml of a fourfold diluted inoculum prepared from fresh rumen fluid. Feeds were fermented for 96 h, with readings taken every 3 h initially and longer intervals as fermentation slowed. After 96 h residues were recovered by filtration, dried and weighed.

Cumulative gas production data was calculated on a per g DM substrate basis, corrected for gas produced from a no substrate control. Dry matter dissappearance (DMD) during fermentation and the ratio of gas produced per g DMD was calculated.

A N deficiency index for 48 h incubation was calculated as follows:

$$\text{N deficiency index} = \frac{100 \times (\text{gas produced in N-rich medium} - \text{gas produced in N-free medium})}{\text{gas produced in N-rich medium}}$$

Results

Figure 1 illustrates the gas production characteristics of individual feeds in the N-rich medium. Sugar cane was rapidly and highly fermentable, probably due to its (presumably) high soluble sugar content. Of the supplements, Ramio had the highest gas production, but interestingly Guacimo the highest DMD. DMD and gas production ratio data is given in Table 1. A low ratio of gas production to DMD may indicate that more of the degraded carbohydrate was being trapped in microbial biomass rather than released as VFAs. Hence Cratylia and Guacimo may particularly stimulate microbial growth. Cratylia was the least fermentable supplement.

Table 1 Dry matter dissappearance (DMD), gas production per g DMD for individual substrates fermented for 96 h in N-rich medium and N deficiency index at 48 h incubation

Feed	Proportional dry matter dissappearance (DMD)	Gas production (ml) per g DMD	N deficiency index at 48 h
Sugar cane	0.70	381	58
Ramio	0.59	380	21
Leucaena	0.55	331	3
Cratylia	0.46	299	
Guacimo	0.64	308	9

Figure 2 illustrates the gas production properties of individual feeds in the N-free medium. Leucaena and Cratylia were largely unaffected by the medium, as illustrated by their low N defficiency index scores. This indicates that these supplements supply sufficient protein to facilitate the fermentation of their carbohydrate fraction. Ramio, and to a lesser extent Guacimo, were N-deficient although this was due in part to their relatively fermentable carbohydrate fraction. As expected, sugar cane was very N-deficient and was only fermented very slowly without a supply of N.

Figures 3, 4, 5 and 6 illustrate the ability of the four supplements to alleviate the N-deficiency of sugar cane tops. Ramio was unable to alleviate the N-deficiency completely, producing a maximum response at about 0.6 of supplement. Leucaena and Cratylia were both able to provide sufficient N. The response to Leucaena and Cratylia decreased at supplementation proportions over about 0.4. Cratylia appeared to be a particularly effective supplement in providing N. Guamico behaved similarly to Ramio.

Figure 7 compares the gas production characteristics of sugar cane supplemented with 0.2 of each supplement fermented in the N-rich medium. The virtually identical characteristics indicated that any differences between the four supplements would probably not relate to the supply of fermentable carbohydrate at this level of supplementation.

Discussion

The gas production technique is still undergoing development and validation; all conclusions are to some extent tentative and it has still to be established how feed properties described relate to animal responses. Nevertheless, on the basis of the data presented above, the feeds can be partially characterised and suggestions made on the relative merits of the four supplements.

Sugar cane tops were rapidly and extensively fermentable, and N deficient. Supplementation with fermentable protein was required to balance the fermentable carbohydrate and protein supplies. On the basis of their ability to provide fermentable protein the supplements were ranked:
Cratylia > Leucaena > Gaucimo > Ramio.
Levels of supplementation to achieve balance between fermentable protein and carbohydrate (i.e. where the response curve starts to level off) were about 0.4 for Cratylia and Leucaena, 0.6 for Guacimo and Ramio, although these may be over-estimates (i.e. lower supplementation levels may be optimal in practice) as no allowance was made for the ability of ruminants to recycle urea to the rumen. As sugar cane was rich in highly fermentable carbohydrate there did not appear to be any major advantage in providing a supplement with this property. In terms of gas production the supplements were ranked:
Ramio>Guacimo>Leucaena>Cratylia.
This was (apparently coincidentally) the reverse of the ranking based on their ablitity to provide protein, but based on some of our recent findings in Nepal it appears to be protein supply which is of major importance to performance as guaged by farmers.

Ranking by DMD was:
Guacimo>Ramio>Leucaena>Cratylia.
This may indicate that Guacimo stimulated the production of microbial biomass and hence the supply of microbial protein, although this is highly speculative.

This study made no attempt to examine the samples for possible anti-nutritive factors; it is highly likely that the four tree fodders contain such factors which could affect their ranking and use. Mixtures of tree fodders have also not been investigated, but may be applicable.

Conclusions

The supplements were ranked: Cratylia > Leucaena > Gaucimo > Ramio on the basis of their ability to supply fermentable protein. Maximum levels of supplement to achieve a balanced ration appeared to be 0.4 for Cratylia and Leucaena, 0.6 for the other two species.

Fig. 1 Gas production characteristics, individual feeds in N-rich medium

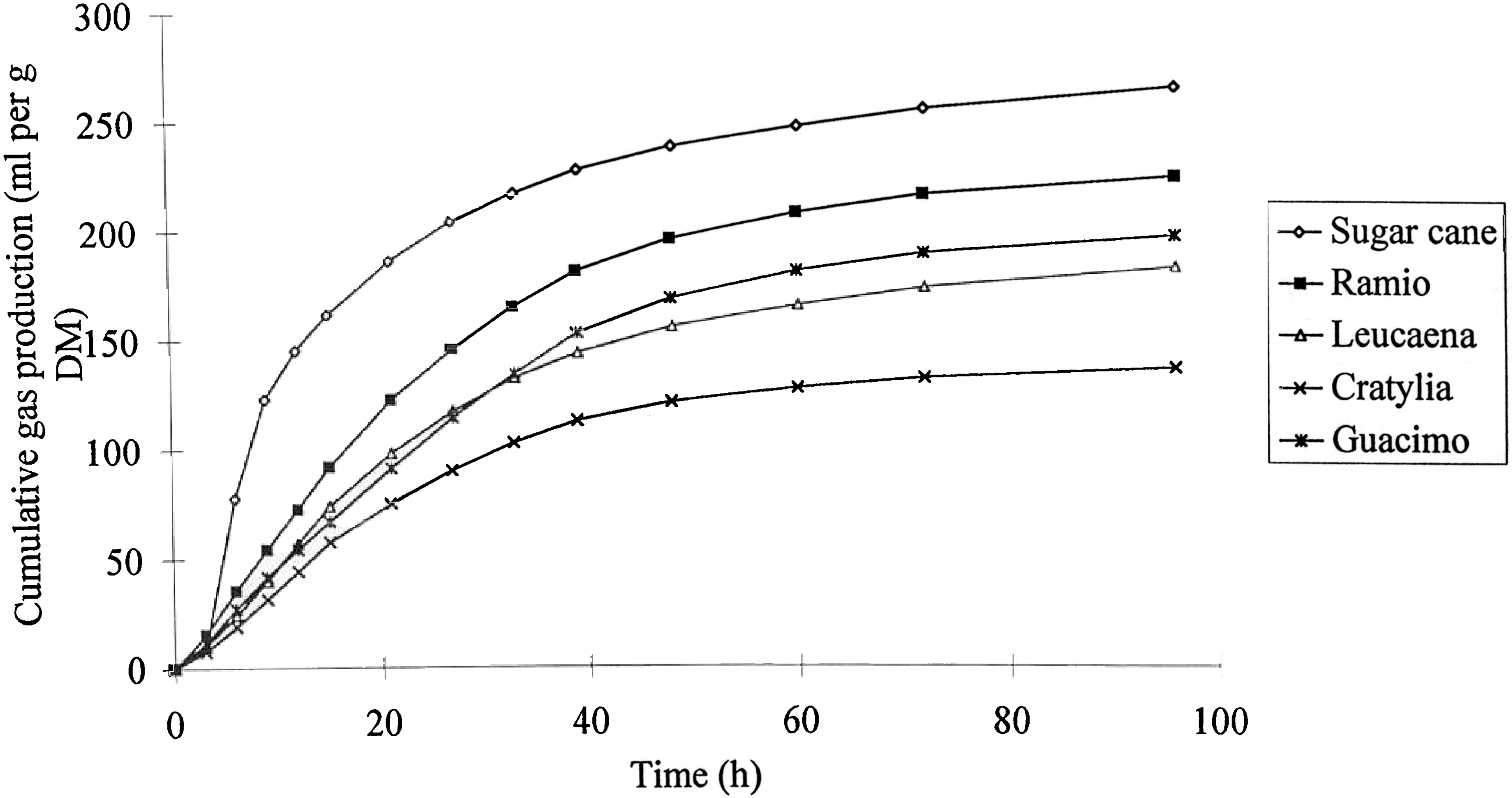

Fig. 2 Gas production characteristics, individual feeds in N-free medium

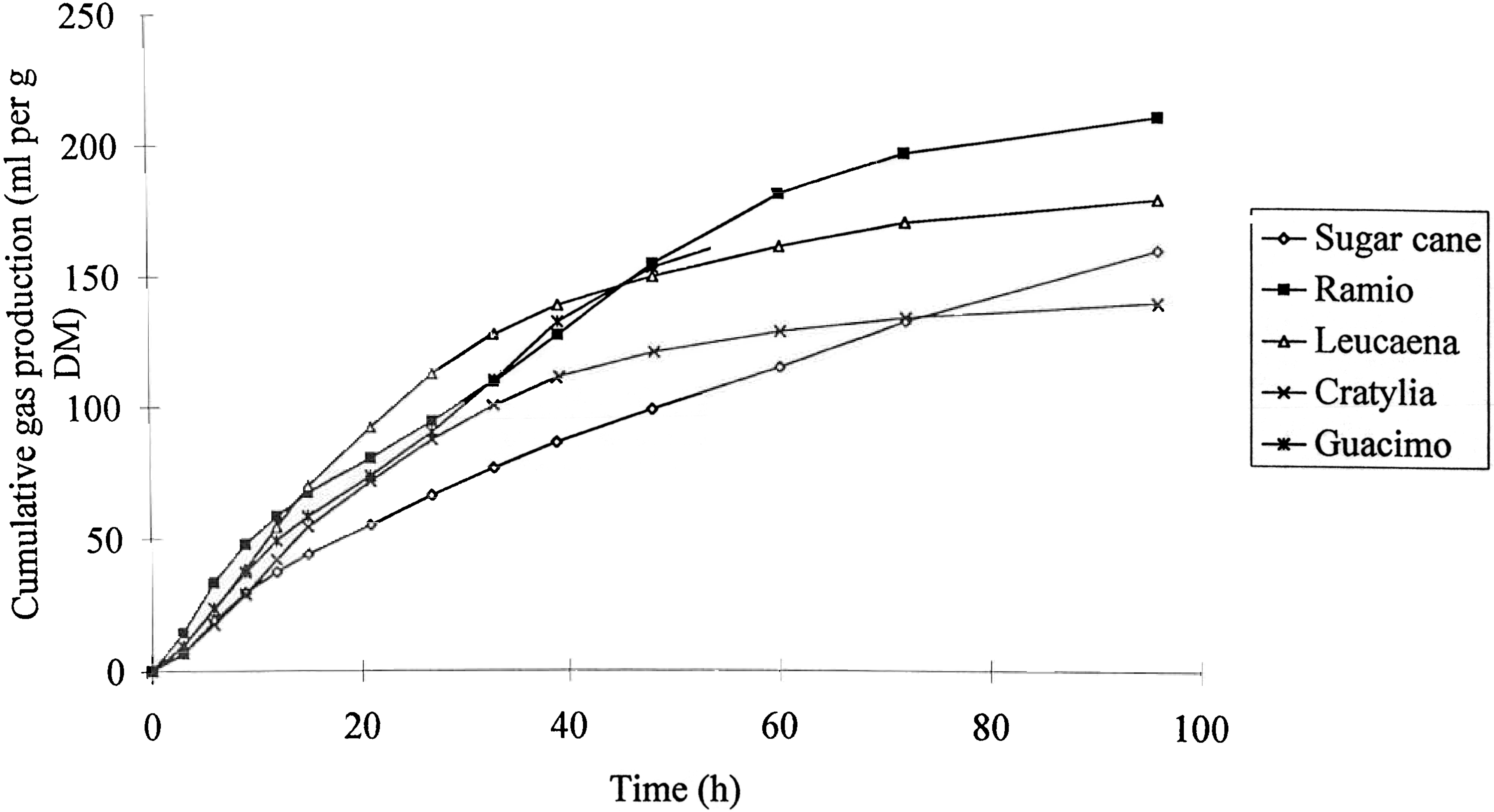

Fig. 3 Sugar cane + Ramio: N-rich - N-free gas production after 48 h

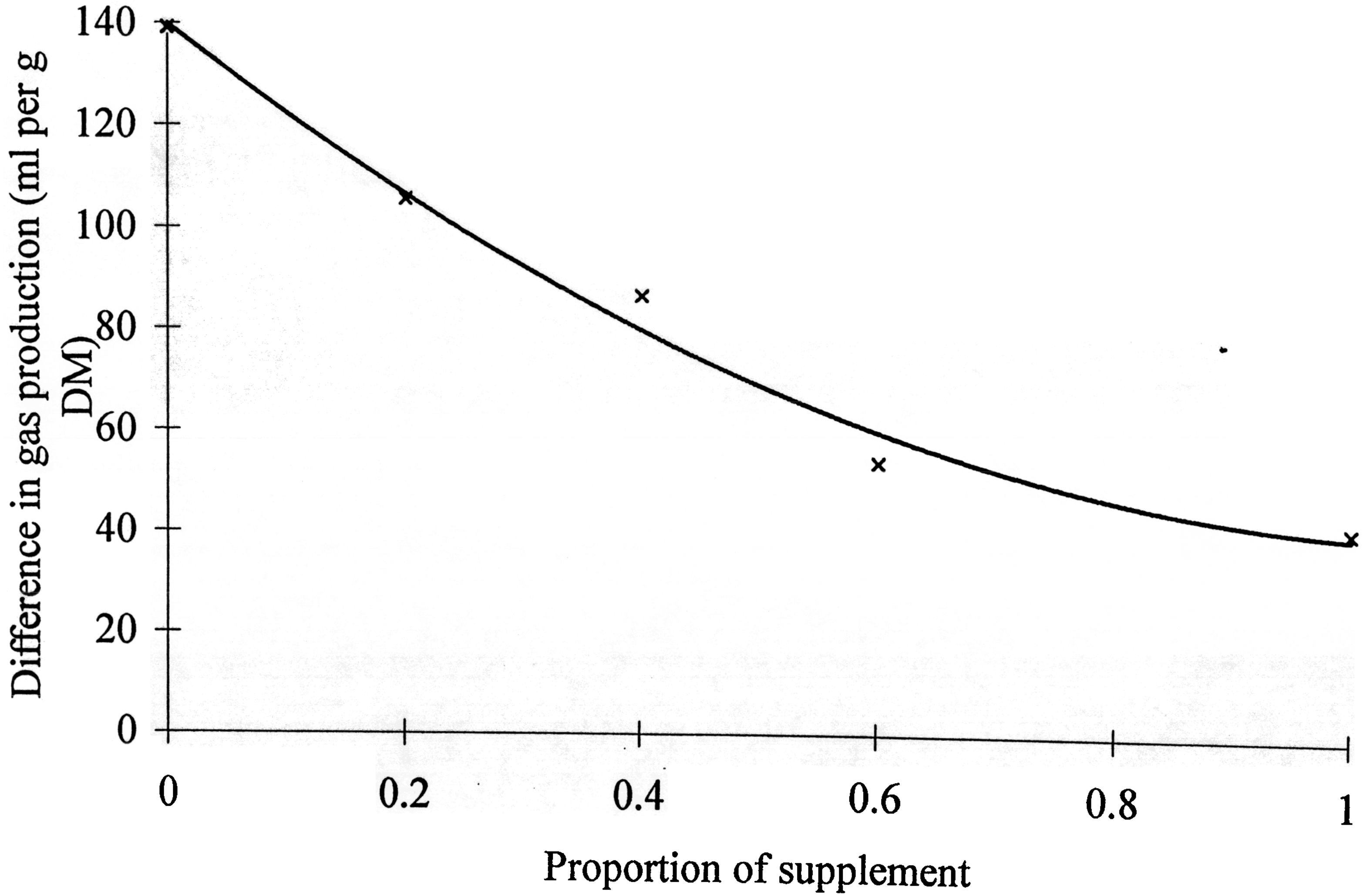

Fig. 4 Sugar cane + Leucaena: N-rich - N-free gas production after 48 h

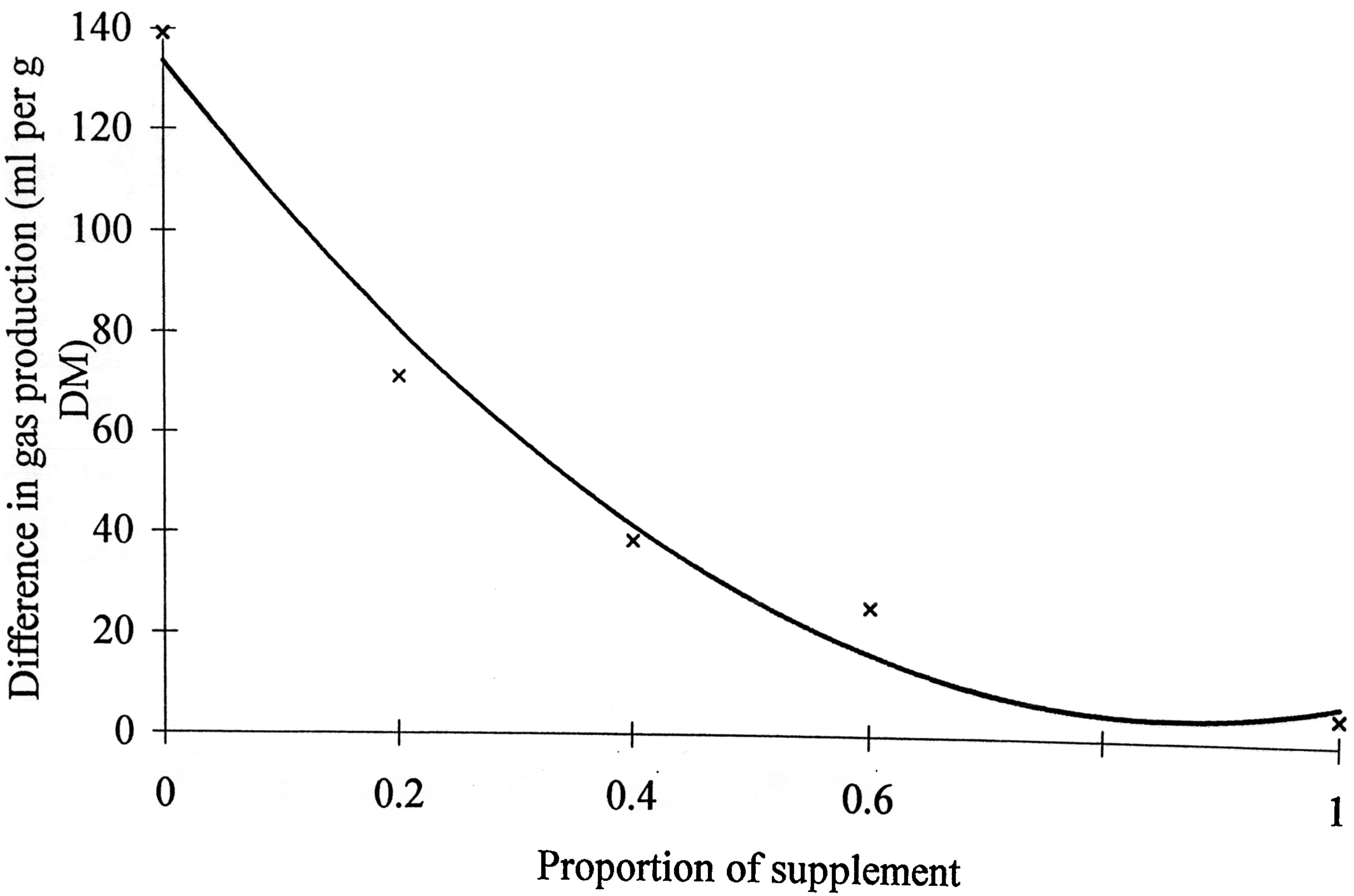

Chart7

Fig. 5 Sugar cane + Cratylia: N-rich - N-free gas production after 48 h

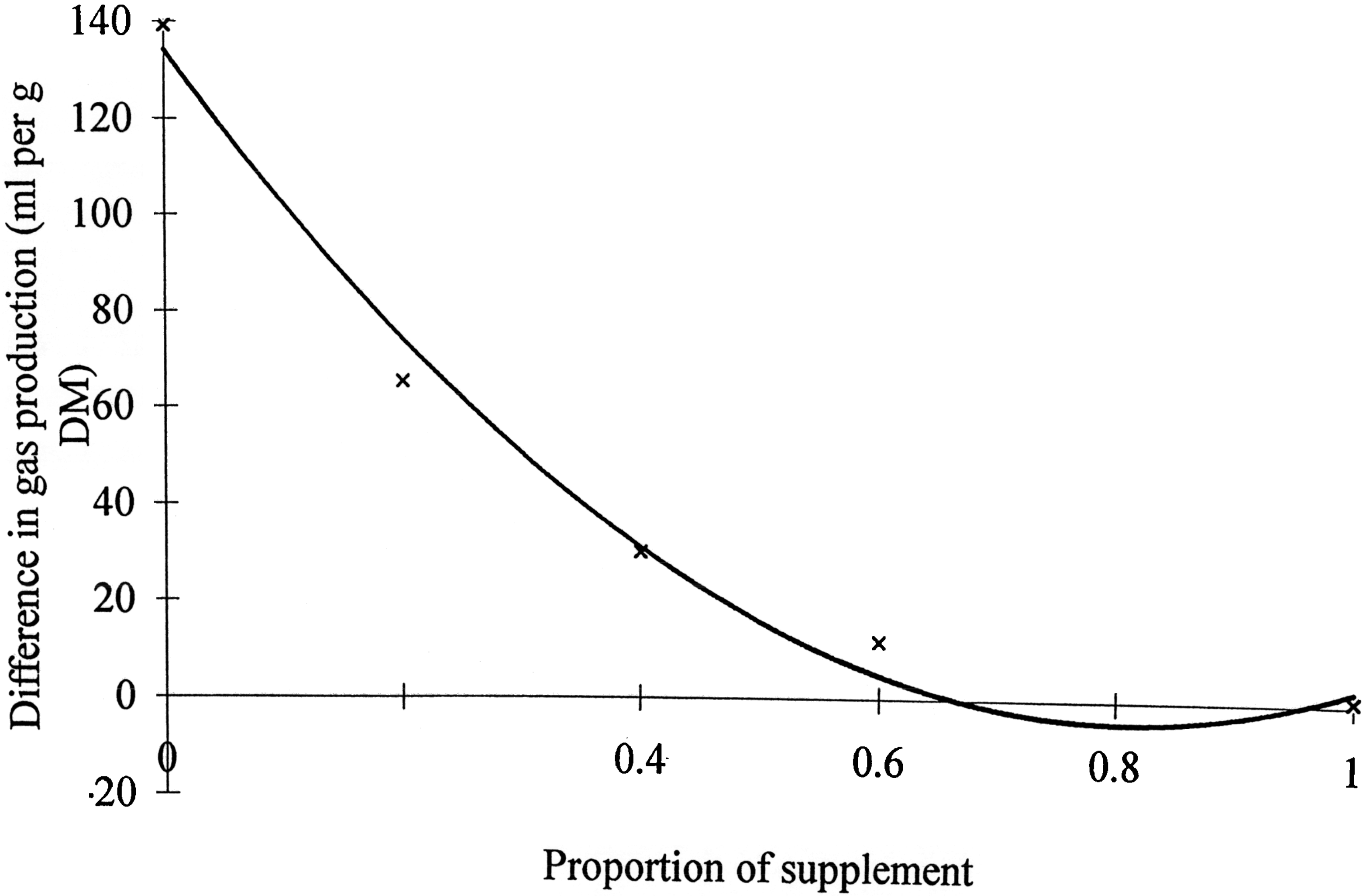

Fig. 6 Sugar cane + Guacimo: N-rich - N-free gas production after 48 h

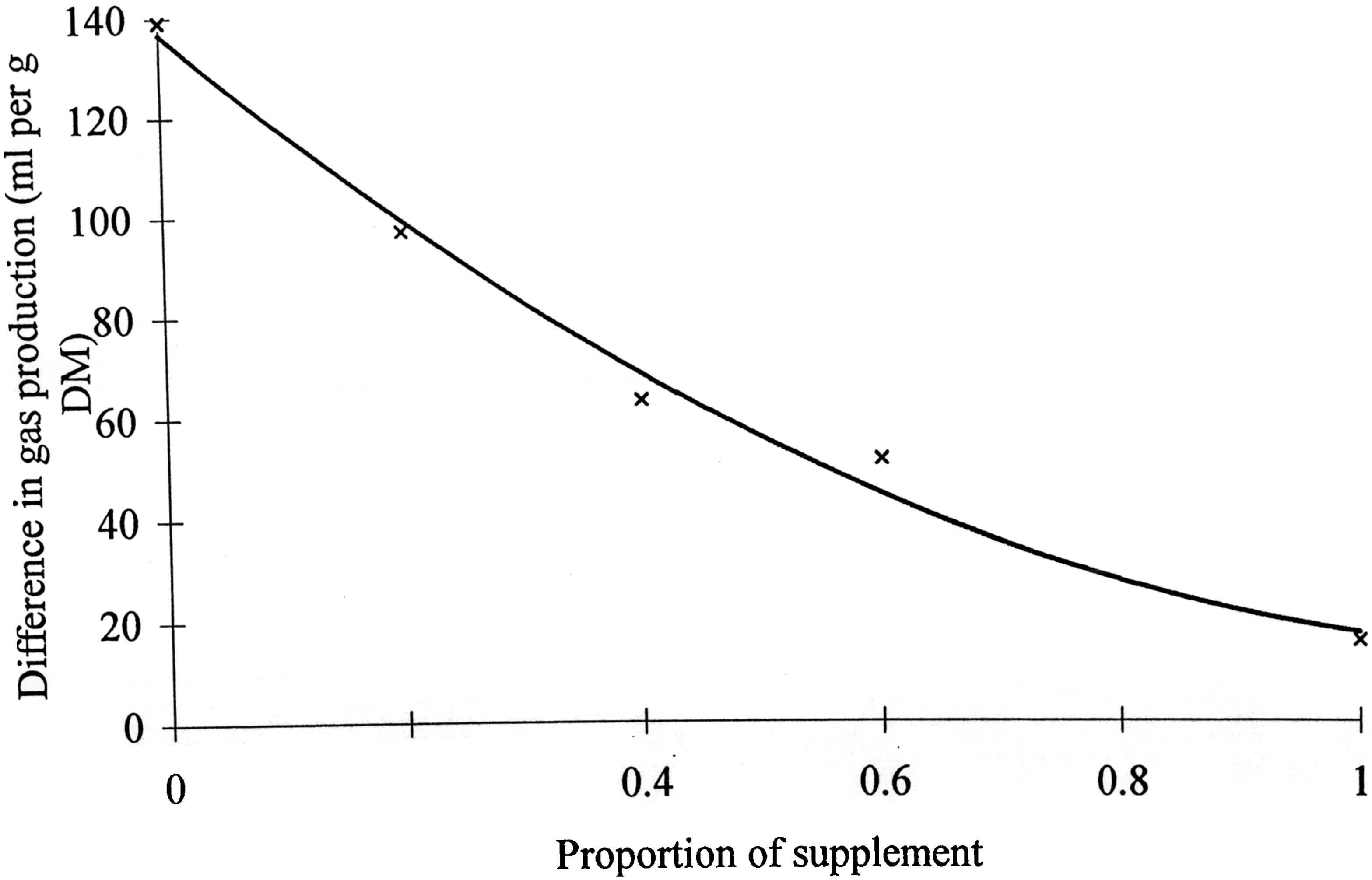

Fig. 7 Gas production characteristics, sugar cane + 0.2 supplement in N-rich medium