THE EFFECT OF PROPIONIC ACID ON PATTERN OF RUMINAL FERMENTATION

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Four bulls of 250 kg LW in a latin square design were used to test the effect of partially neutralised propionic acid on the voluntary intake of fresh sugar cane. Additions of propionic acid were 0, 10, 20 or 30 g/kg fresh cane. Periods were of 14 days duration. In addition the daily pattern of eating was measured on days 6 and 8, and rumen parameters on days 10 and 14 of each period. There were no effects of treatment on DM intake. Differences in protozoal biomass were attributed to mixing within the rumen rather than as a true effect on protozoal populations. There were no significant effects on total VFA concentrations . The proportion of propionate tended to rise, and that of acetate to fall with increasing dietary propionate. Rumen pH tended to be higher with propionate supplementation. It is concluded that the results do not support the hypothesis that sugar cane/urea fed animals are short of glucose precursors.

Key words: Cattle, sugar cane, propionic acid, voluntary intake, rumen fermentation

It has been suggested that in diets of sugar cane the principal limitations on animal performance are amino acids and gluconeogenic precursors (Leng & Preston 1976) and that these are related to the low voluntary consumption observed on diets based on cane. Silvestre et al (1976) and Preston et al (1976) have observed significant responses to supplementation with maize and rice polishings respectively. However, since these supplements are neither unconfounded as sources _ protein, nor as precursors of glucose it is difficult to draw conclusions as to the exact nature of the response observed.

The purpose of this experiment was to test the hypothesis that glucose precursors were limiting in diets based on sugar cane and urea. This was carried out by supplementing the diet with propionic acid, an established glucose precursor (Annison and Armstrong 1970).

Materials and Methods

Treatments and design: 4 animals approximately 250 kg in weight and fitted with rumen cannulas were used in the experiment. Each experimental period lasted 14 days and the design adopted was a latin square balanced for residual effects (Cochran and Cox 1 957). The basal diet was chopped whole cane fed ad libitum with the addition of 10 g of urea per kg of fresh cane; the urea was dissolved in water (20% w/v). Salt and minerals were also supplied ad libitum. The propionic acid solution was made up as follows: - 50 g propionic acid, 2.5 g sodium hydroxide made up to 100 ml with distilled water. The treatments were A) Control: B) 10 gof propionic/kg fresh cane): C) 20 g of propionic /kg of fresh cane: D) 30 g propionic/kg fresh cane.

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Procedure: The first 9 days of each experimental period were used to adapt the animals to the diets: days 10 and 14 were used for collecting samples of rumen liquour. Samples were taken 1 hr before feeding, 3 hr after feeding and 6 hr after feeding. Protozoal biomass (as packed cell volume)in the samples was determined immediately using the methods of Leng, et al (1976) as was pH. Samples were subsequently acidified and stored in a deep freeze until determination of molar and total volatile fatty acids (VFA) could be carried out by gas liquid chromatography. Caproic acid was used as an internal standard to determine total VFA.

Measurements were taken of voluntary consumption throughout the experiment and patterns of consumption during the first 8 hr after feeding on days 6 and 8 of each experimental period.

Results and Discussion

Table 1:
Voluntary intake and pattern of consumption the various diets tested.

	Level of propionic acid, g/kg			
kg DM	0	10	20	30
Feed intake, kg DM /day				
Cane	3.70	3.60	3.44	3.14
Urea	0.160	0.163	0.155	0.124
Propionic acid	-	0.163	0.276	0.464
Minerals	0.060	0.060	0.060	0.060
Total DM	3.92	3.99	3.93	3.80
DM, 8 hr %[1]	48.50	59.25	58.50	44.25

[1] Pattern of consumption - consumption of DM in first 8 hours after feeding expressed as % of total DM consumption in 24 hr .

The pattern and mean consumption of dry matter for the treatments tested are shown in table 1. There were no significant differences in either of these parameters. The results for pH are shown in figure 1: the only significant differences were observed at 3hr ($P < .01$) and 6hr ($P < .01$) after feeding. This could be attributed to the high pH observed on the treatment with 30 g of propionic acid/kg of cane at 3hr and the low pH observed in the control at 6 hr. The variation in general was within the range observed by Priego (1974). However, increased propionic level in the diet appeared to increase rather than decrease the pH.

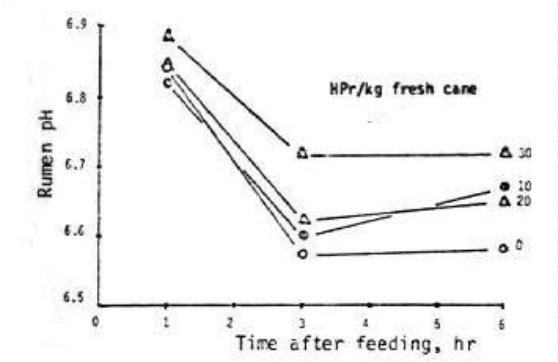

Figure 1:
Rumen pH in relation to pto time after feeding

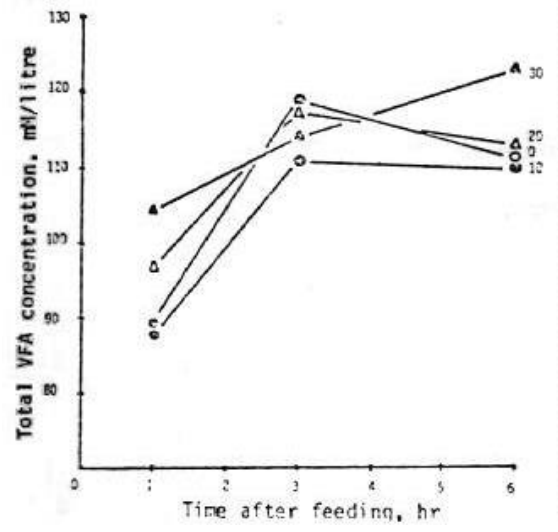

Figure 3:
Total VFA concentration and time after feeding

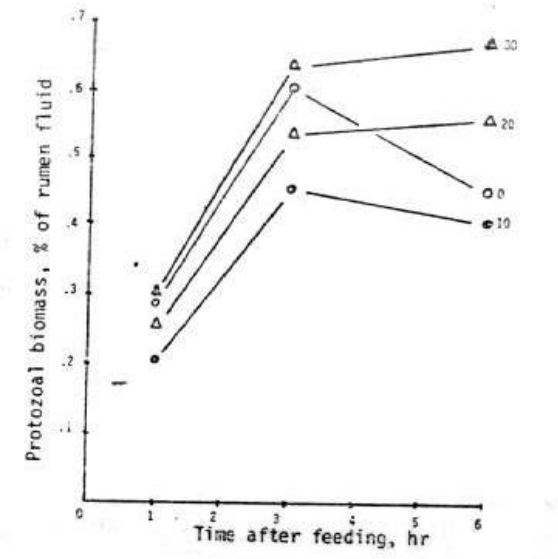

Figure 2:
Protozoal biomass in relation to time after feeding

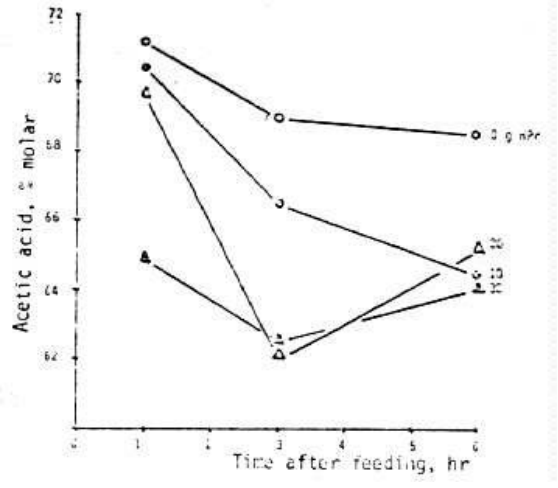

Figure 4:
Molar percent acetate and time after feeding

Figure 2 shows the changes which occurred in protozoa1 packed cell volume during the sample periods. The only significant differences observed were at 6 hr after feeding ($P<0.01$).The increasing level of protozoal biomass observed from l hr before to 6 hr after feeding are probably due to an increase in the ra+e of ruminal contractions (Priego and Leng 1976), leading to improved mixing and. sampling in the rumen, and not to any inherent increase in protozoal number. In any event there was insufficient time for these organisms to grow to such numbers in view of their relatively slow turnover rate (Hungate 1966).

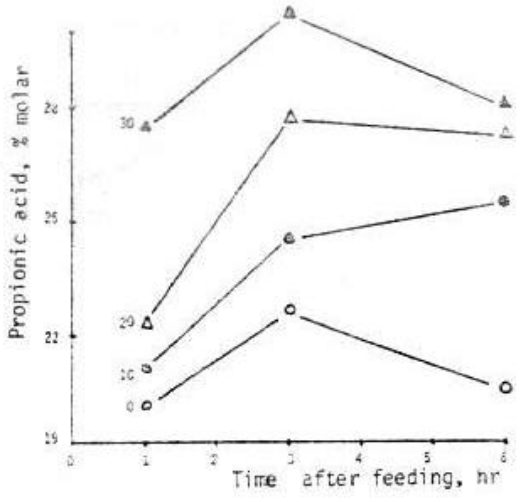

Figure 5:
Molar percent propionate and time after feeding

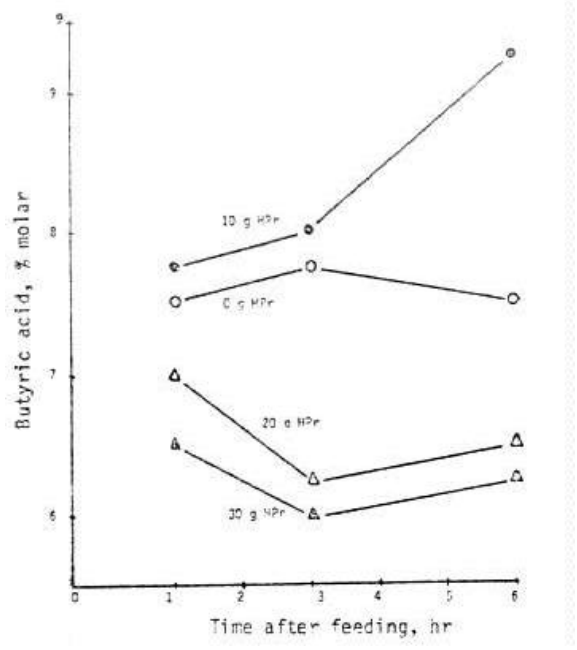

Figure 6:
Molar percent butyrate and time after feeding

Changes in total VFA are shown in figure 3. The differences were not significant although there was a tendency for the 30g propionic acid/kg fresh cane treatment to generate higher total VFA 6 hr after feeding. Molar proportions of acetic acid (figure 4) at the different sampling times were not significantly affected by supplementation of the diet with propionic acid. The only significant effect of propionic acid was observed 3 hr after feeding ($P<.05$) when molar proportions of propionic acid reflected the degree of supplementation in the diet (figure 5). No significant effects on butyric acid molar proportions were recorded (figure 6).

The relationship between VFA proportions and amount of propionic supplemented is shown in figure 7. The steadily increasing proportions of propionic acid relative to the other VFA's are clearly shown. The highest level of propionic acid supplementation represents a contribution of some 7.5 equivalents day to total rumen propionate. However without obtaining further data on ruminal liquid volume and rate of disappearance of propionate from the rumen fluid, it is impossible to draw anything other than purely speculative conclusions about the effect on propionate production in the rumen itself. Further experiments are at present being directed towards quantifying this problem. Comparable experiments carried out by Ferreiro et al (1976) showed no effect of propionic acid supplementation on either feed intake or growth rate. This would seem to support the hypothesis that a shortage of aminoacids is the first limiting factor to performance in the absence of a protein supplement.

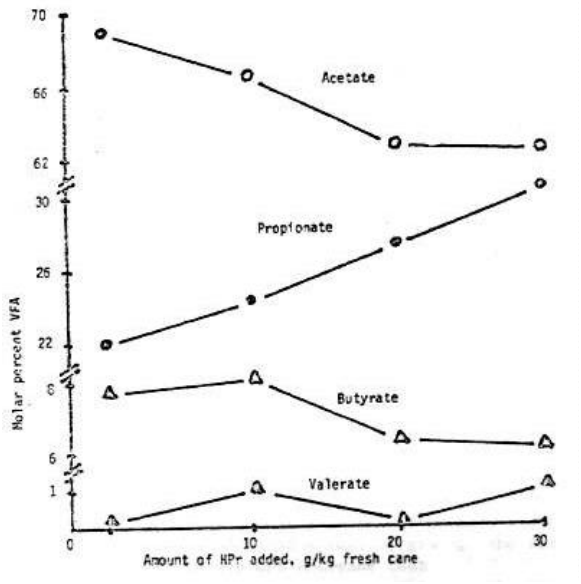

Figure 7:
Relationship between molar percent VFA and level of propionic acid added to the diet

Conclusion

It appears that supplementation with propionic acid has little effect on rumen fermentation pattern, pH or protozoal biomass. No effect of propionic acid supplementation was observed an voluntary feed intake.

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