VOLUNTARY INTAKE AND LIVE WEIGHT GAIN OF CATTLE GIVEN CHOPPED SUGAR CANE AND SOLUTIONS OF MOLASSES CONTAINING DIFFERENT CONCENTRATIONS OF UREA[1]

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18 Zebu steers were given free access to chopped whole sugar cane and solutions of molasses/urea in the range 25 to 100 g urea/kg. In addition, each animal received daily 600 g of cotton seed cake and 100 g of minerals. The experiment lasted 168 days. The principal effect of increasing the concentration of urea in the molasses was to reduce linearly the intake of the molasses/urea mixture t from 62 to 11% of the diet DM as urea concentration rose from 2.5 to 15%) with concomitant increases inn consumption of sugar cane. In turn, this change in diet composition was associated with a tendency towards a greater rate of live weight gain and hefter feed conversion. There were related changes in the rumen fermentation pattern, characterized by tendencies towards higher molar proportions of propionic.- acid at the expense of butyric acid. The protozoal population did not seem to be related with either daily intake of urea or the relative proportion of the diet urea, by the molasses. With the feeding system, used in this experiment it appears that the digestible dry matter in sugar cane is used more efficiently for productive purposes than that in molasses. Daily intake of urea showed a quadratic relationship with urea concentration in molasses ($Y = 5.5 + 44.3X - 2.59X^2$), with maximum intakes at concentrations between 60 and 100 g urea/kg molasses.

Key words: Sugar cane, cattle, urea, molasses

In one of the first experiments on the fattening of cattle with chopped whole sugar cane (Preston et al 1976), urea was added to the sugar cane as a concentrated solution in final molasses (283 g urea/litre of molasses). However, as was pointed out by Ferreiro and Preston (1976) there are advantages, from the point of view of management, in giving the urea/molasses mixture on a free choice basis in one feeder, while the chopped sugar cane is given in another.

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The success of such a feeding procedure depends obviously on the ability of the animal to consume sufficient of the urea/molasses solution to satisfy its requirements for nitrogen.

Ferreiro and Preston (1976) reported that the daily intake of urea and overall animal performance was best on the solution with the highest concentration of urea (100 g/kg).

The objective of the experiment described here was to determine the effect on voluntary intake and animal performance of a wider range of concentrations of urea and molasses. Studies on the pattern of rumen fermentation were also carried out.

Materials and Methods

Treatments and Design: The treatments were six concentrations of urea (25, 50, 75, 100, 125 and 150 g urea/kg molasses). The content of final molasses (88° Brix) in the mixtures was constant at 700 g/kg, the balance being water. There was one group of three animals on each treatment. Statistical analysis was by adjusting regression lines to the data according to the method of least squares.

Procedure: Eighteen Zebu steers 2 years old and weighing 240 kg were used. They were housed in pens (2 x 3 m) with concrete floors in a roofed building open at the sides.

Diets: Each group of animals had free access to chopped whole sugar cane and to one of the solutions of molasses/urea. These were given in separate feeders. A mineral mixture (equal parts of salt and bone meal) was given at the rate of 100 g/d and cotton seed cake at 600 g/d per animal. These supplements were added to the sugar cane once daily in the morning. Processing of the sugar cane was in a stationary forage chopper (Gehl, Wisconsin) to a particle size between 10 and 20 mm.

Measurements: The animals were weighed every 14 days; feed intake was recorded daily, After 130 and 168 days of the experiment, samples of rumen fluid were taken by stomach tube to determine parameters of rumen fermentation and protozoal population. The methods used for determination of VFA and protozoa have been described by Gonzalez and MacLeod (1976) and Leng et al (1976).

Results and Discussion

Overall mean values for live weight change and for feed intake during the total experimental period are summarised in table 2. The rate of live weight gain from day 0 to 60 and 60 to 120 and for the total period is shown in figure 1. During the first 60 days, live weight gain was negatively related with percentage of urea in molasses and positively related in the second period. Overall performance data for the 120 day period showed a tendency towards an increase of live weight gain with increase in urea concentration.

These observations indicate that a period of adaptation is required for the higher concentrations of urea in molasses. This adaptation was also apparent in the data for voluntary intake of sugar cane and molasses/urea (see figure 2). The former increased more rapidly, and the latter declined more slowly, with increase in urea concentration, in the second than in the first part of the experiment (table 2).

Figure1:
Relation between time on experiment and live weight gain response to urea concentration in molasses

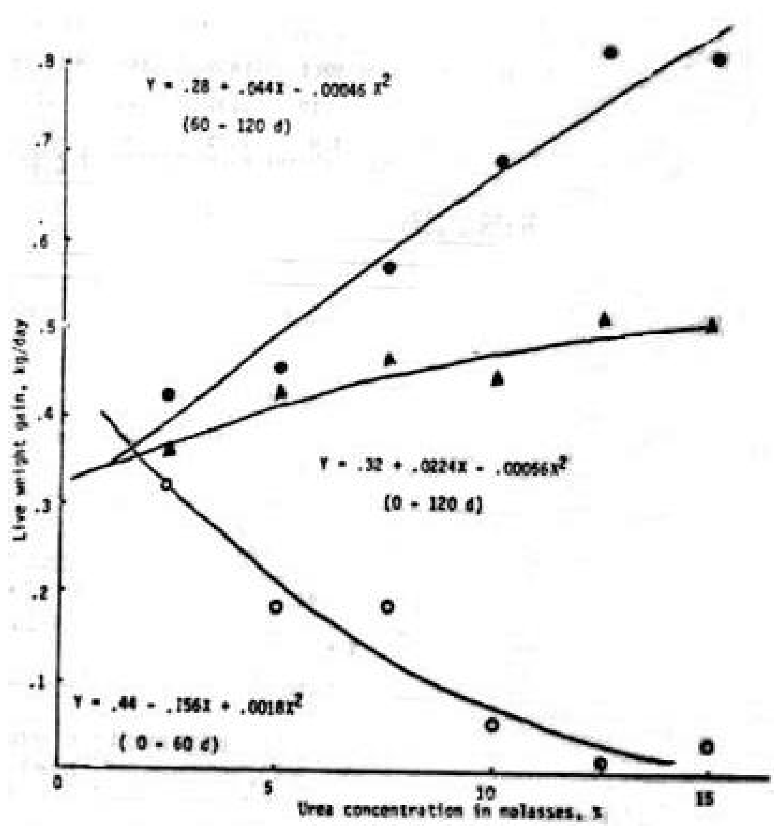


Table 1 :
Mean values for live weight change and feed intake (168 day trial)

	Urea in molasses, g/kg					
	25	50	75	100	125	150
Live weight, kg						
Initial	239.0	215.0	230.0	234.0	214.0	231
Final	307.0	285.0	300.0	303.0	299.0	309
Daily gain	.427	.431	.434	.491	.531	.486
Intake, kg/d						
Sugar cane	7.4	9.6	12.2	13.2	16.5	17.10
Urea	.087	. 160	. 210	.131	.113	120
Molasses	3.5	3.2	2.8	1.75	.90	.80
Total DM	4.85	5.27	5.53	4.73	4.87	4.85
Conversion[1]	11.33	12.3	12.9	9.65	9.19	10

[1] Kg DM/kg gain

Table 2:
Regression of intake (Y = kg/d) on urea concentration in molasses (X = %)

	Regression equation	r^2
Sugar cane[1]		
0 to 56 days	Y = 4.0 +.50X	.87
56 to 114 days	Y = 5.6 +.90X	.95
Molasses/urea[1]		
0 to 56 days	Y = 4.46 -.26X	.27
56 to 114 days	Y = 4.13 - 21X	.99

[1] Difference between slopes for 0 to 56, and 56 to 114 days is significant at P <.022 for sugar cane and P <.033 for molasses/urea

Over the experiment as a whole, there were highly significant relationships between consumption of sugar cane which increased, and of the solution of molasses/urea which decreased, as the concentration of urea in the molasses mixture was increased (see figure 3). These relationships are combined in figure 4 which shows the regression (r^2 =.98) of proportion of the diet dry matter represented by molasses, as a function of the urea concentration of the molasses.

The daily intake of urea showed a curvilinear relationship with its concentration in the molasses (figure 3) maximum values being recorded in the range 50 to 100 g/kg concentration. The effects on voluntary intake of sugar cane and molasses, as a result of varying the concentration of the urea in the molasses, are in agreement with findings reported by Ferreiro and Preston (1976).

Table 3:
Parameters of rumen fermentation in samples taken 3 hr after feeding (after 168 days on experiment)

	Urea concentration in molasses, g/kg					
	25	50	75	100	125	150
pH in rumen fluid	7.0	7.1	7.3	7.1	7.1	7.3
Molar VFA, %						
Acetic	51.9	53.6	54.7	50.7	50.7	48.2
Propionic	23.3	31.4	30.8	32.9	34.5	35.8
Butyric	24.9	15.0	14.7	16.0	14.8	16.0
Protozoa						
Packed cell volume, % rumen fluid	.20	.16	.58	.58	.19	.63
Holotrichs, X 10^{-5}/ml	.68	.13	-	.13	.50	.25
Entodinia, X 10^{-5}/ml	2.0	3.5	.19	.94	1.6	.75

Figure 5 shows the relationship between rate of live weight gain and feed conversion, as the dependent variables, and dally intake of urea and proportion of the ration dry matter in the form of molasses as the independent variables. Animal Performance was significantly negatively related to proportion of molasses in the diet but not to daily intake of urea. The conclusion from these data is that animal performance on a sugar cane/molasses diet decreases as the amount of dietary energy in the form of molasses increases. These findings are also supported by the results reported by Alvarez et al (1976), and Silvestre et al (1976), and indicate that the digestible energy in molasses is utilised with less efficiency than that in sugar cane (digestibility increases with increasing proportion of molasses in a sugar cane diet: Paulino et al 1976).

The controlling effect on voluntary intake of the two components of the diet, exerted by the urea concentration in the molasses, reflects presumably the unpalatability of the urea. Nevertheless, the fact that daily urea intake was least on what presumably was the most parable mixture (containing 2.5% urea), indicates that the animal was unable, or did not wish, to consume more of this mixture in order to ingest the quantity of urea required for most efficient digestion. The data on rumen fermentation parameters are variable (figure 6 and table 3) which can probably be explained by the sampling method of using a stomach tube. Nevertheless certain tendencies are apparent.

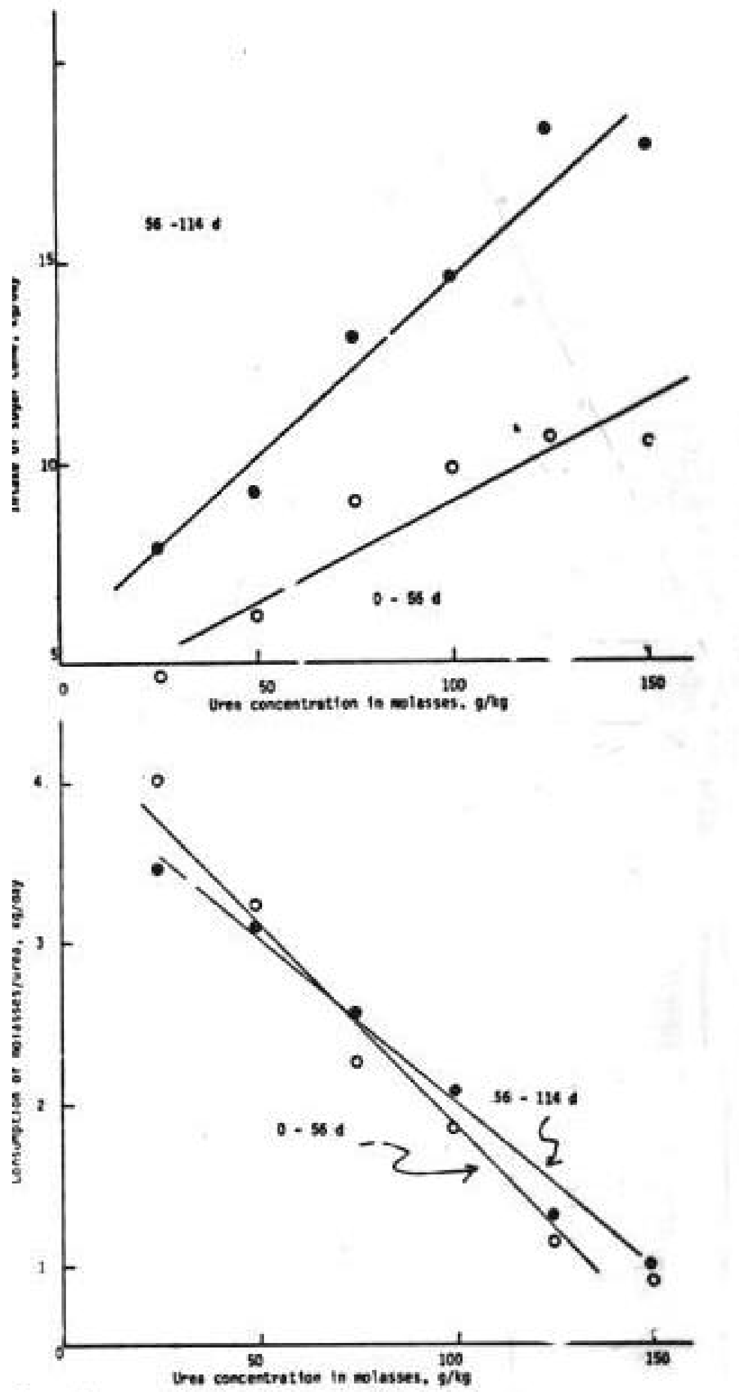
Table 4:
Analysis of variance for effect of urea treatment and sampling time on molar proportions of VFA in rumen fluid (samples taken 130 days after of start experiment)

	df	Mean Square	"F"	Significance
Acetic acid				
Urea	5	16.8	.62	P <.69
Time	3	97.9	3.62	P <.02
Residual	15	27.0		
Propionic acid				
Urea	5	26.4	2.05	P <.13
Time	3	97.3	7.55	P <.001
Residual	15	12.9		
Butyric acid				
Urea	5	75.7	3.69	P <.02
Time	3	5.9	.29	P <.91
Residual	15	20.4		

There were significant effects (table 4) due to increasing urea concentration on molar proportions of propionic acid (P <.13), which rose, and butyric acid (P <.02) which fell. Sampling time also influenced the molar VFA pattern, with increases (P <.001) in propionic acid and decreases (P <.02) in acetic with time after feeding; there was no effect of time on butyric acid. Presumably this was due to the indirect effect of the urea causing a substitution of molasses by the sugar cane. There was no apparent relationship between dietary treatment and population of protozoa.

The effect of molasses in decreasing the molar proportion of propionic acid and increasing that of butyric acid has been reported by other workers, e.g. when molasses replaced grain (Clark 1971) or sugar cane (Ravelo et al 1976).

Figure 2:
Relation between time on experiment and feed intake response to urea concentration in molasses



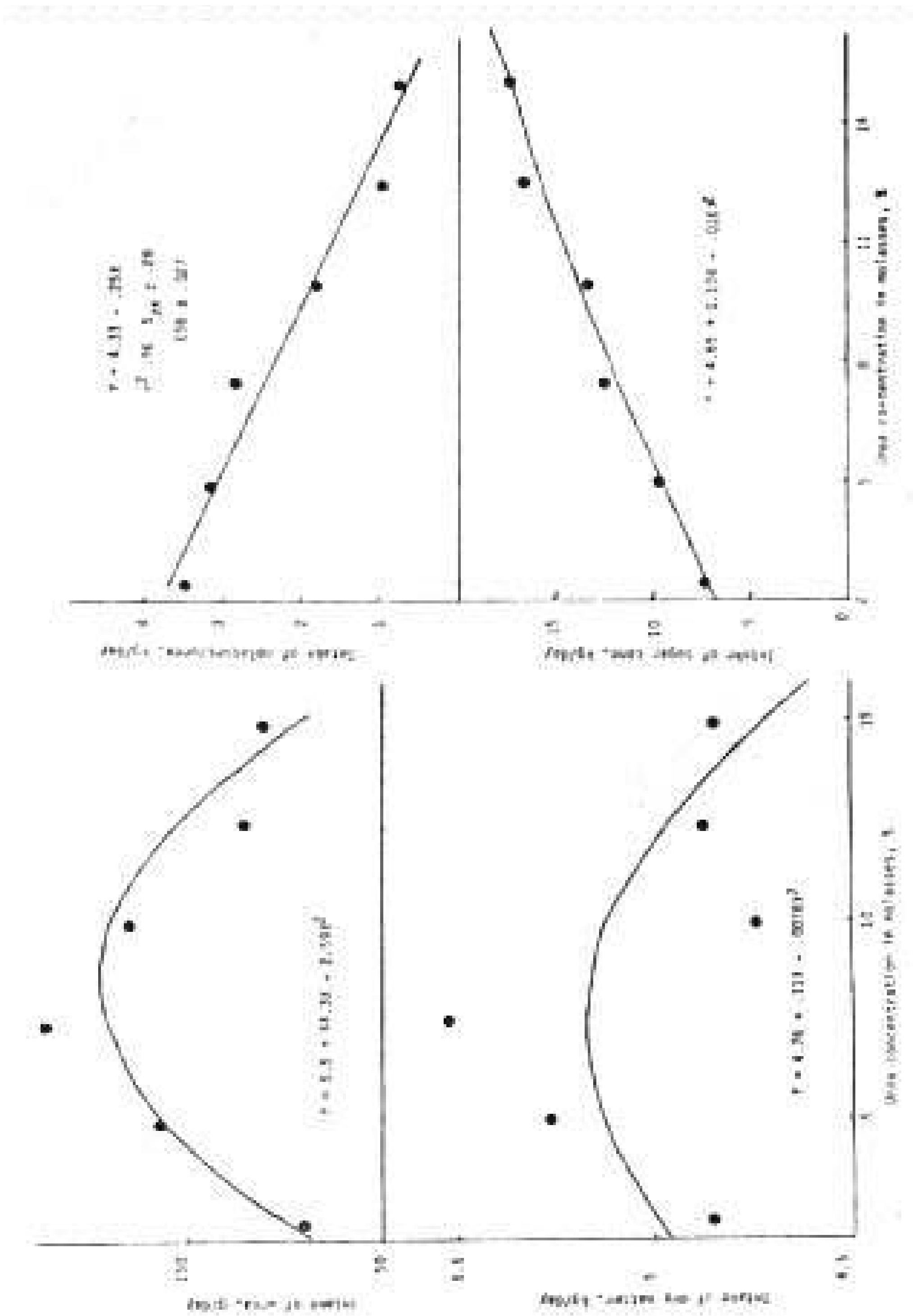


Figure 3:
Relation between urea concentration in molasses and intake of diet components

Figure 4:
Urea concentration in molasses and proportion of diet dry matter consumed in the form of molasses

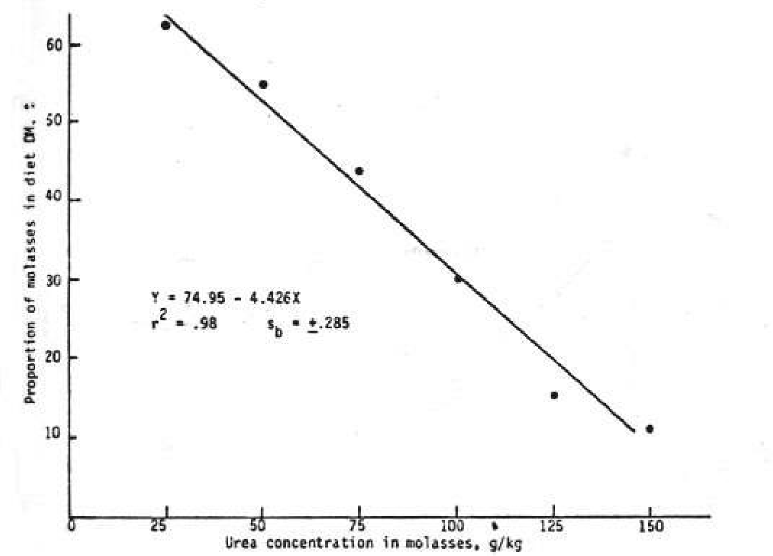


Figure 5:
Relation between animal performance and daily intake of urea, and proportion of diet dry matter as molasses

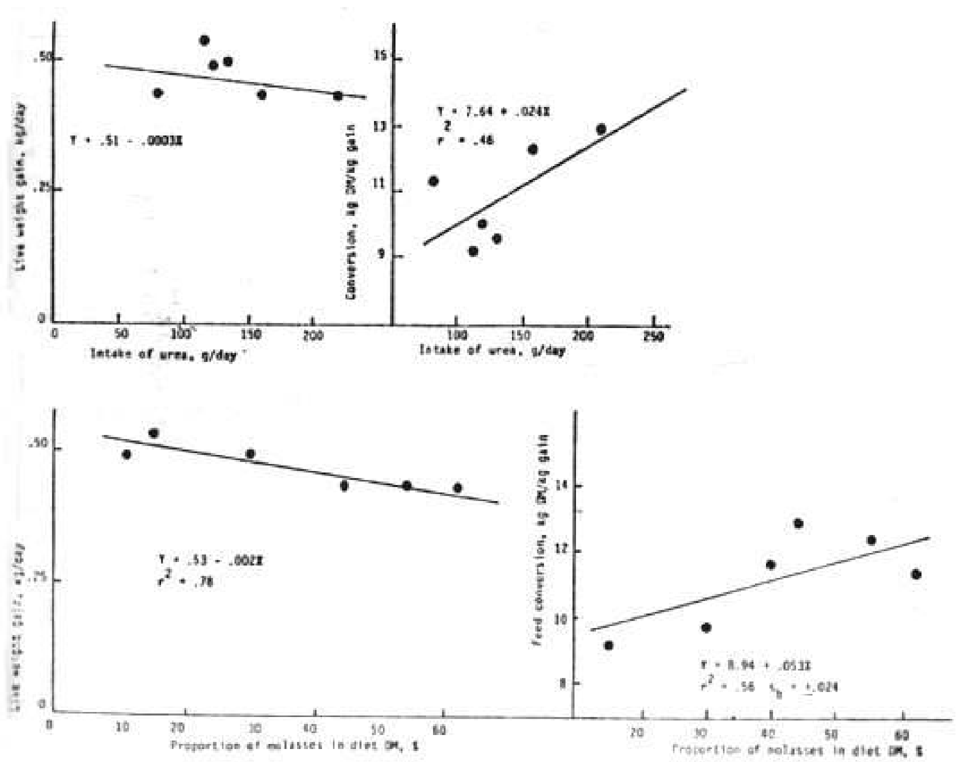


Figure 6:
Rumen fermentation pattern according to urea concentration in molasses and time of sampling

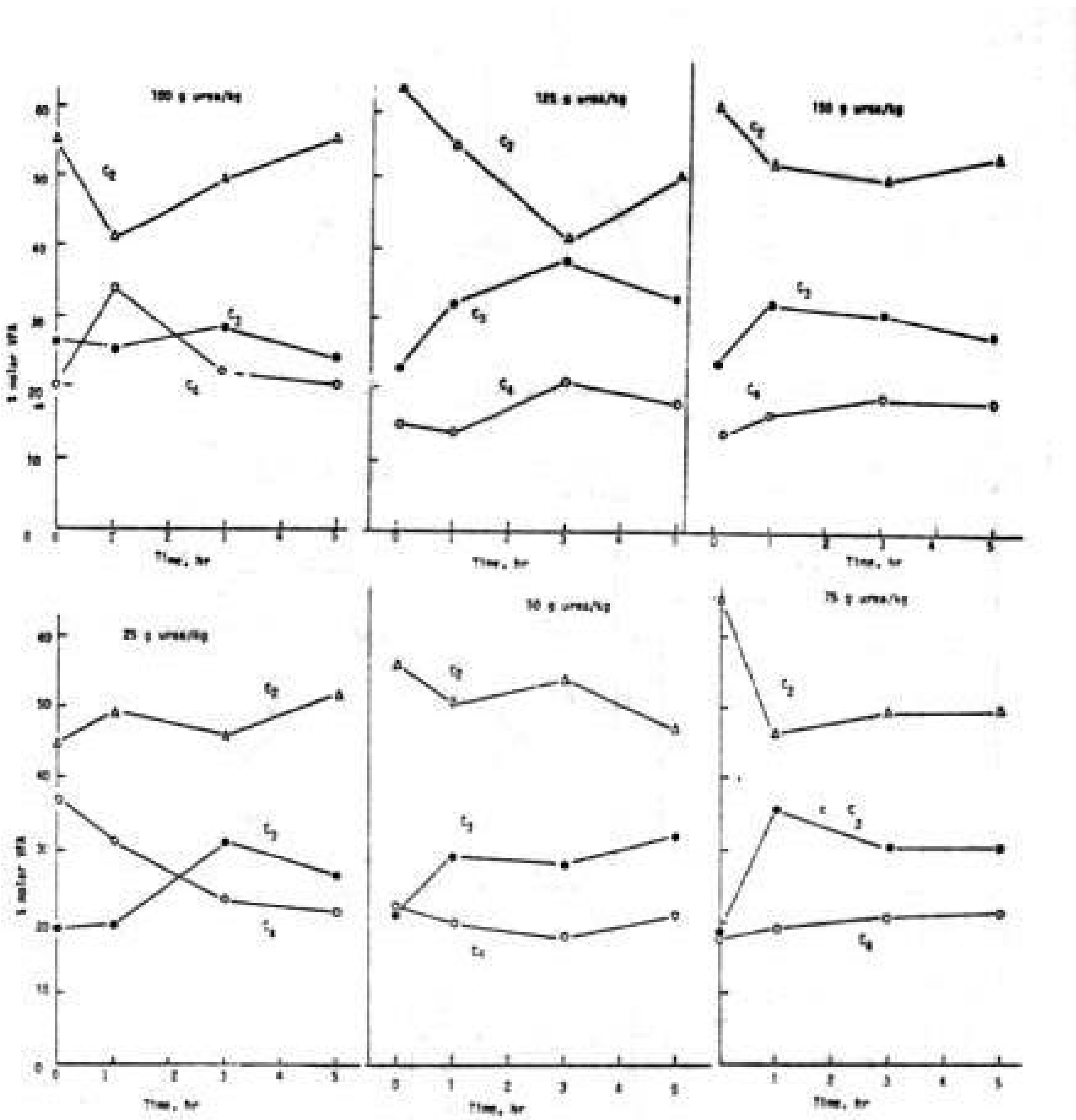


Figure 7:
Relation between proportion of diet dry matter at molasses and molar proportion of propionic acid in rumen fluid

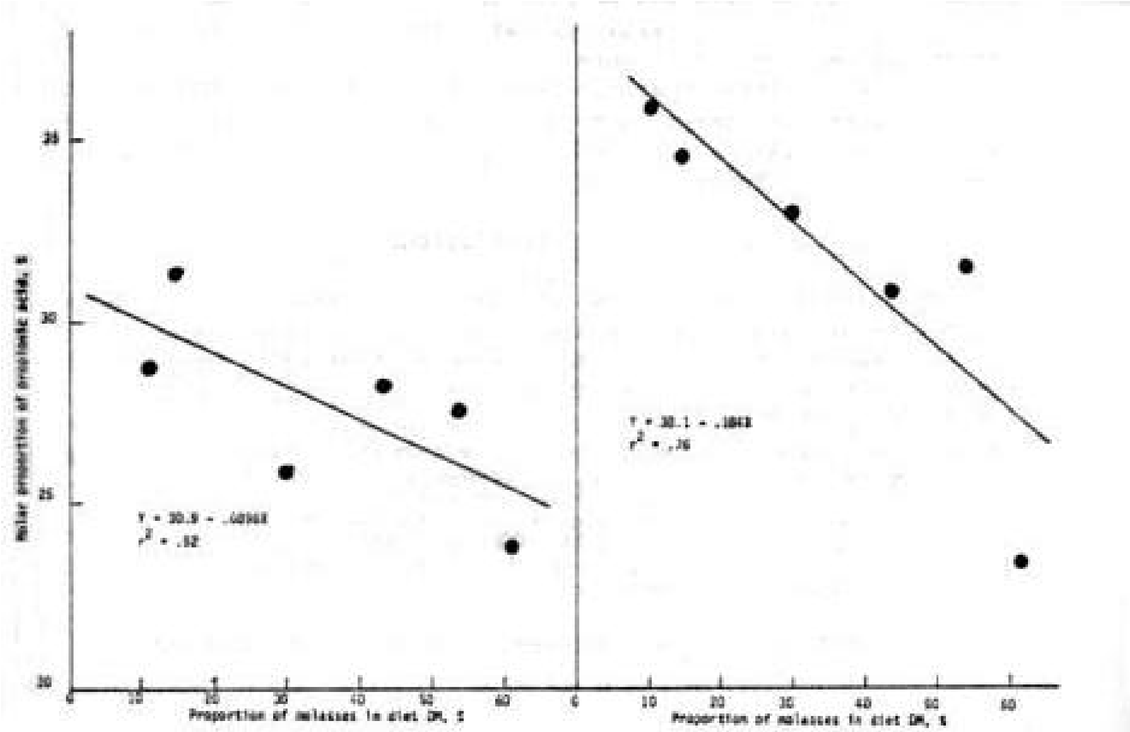
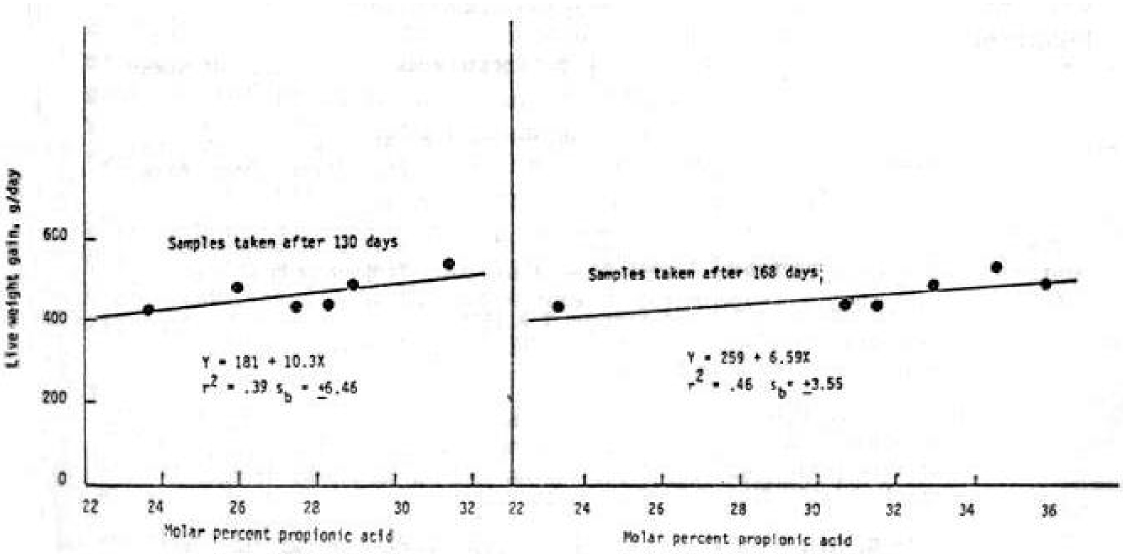


Figure 8:
Relation between molar proportion of propionic acid in rumen fluid and animal performance



There were significant negative relationships between molar percent propionic acid and proportion of molasses in the diet dry matter (figure 7) and positive relationships between propionic acid and animal performance (figure 8).

This would infer that the reason for the poorer utilization of the digestible energy in molasses compared with sugar cane may be a greater relative deficiency of glucose precursors in the former (Leng and Preston 1976).

Conclusions

On a feeding system in which cattle have free access to both sugar cane and a molasses/urea mixture, the relative proportions of the two feed components consumed can be controlled by varying the percentage of urea in the molasses. It appears that within the constraints determined by the nature of the supplements fed in this trial (urea and cotton seed meal), the nutritive value of the digestible dry matter of sugar cane is higher than that of molasses.

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