

EFFECT OF FEEDING FREQUENCY AND SUPPLEMENTATION WITH WHEAT BRAN ON VOLUNTARY INTAKE AND RUMEN FUNCTION OF CATTLE FED SUGAR CANE

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The effect of frequency of feeding on the voluntary intake of chopped whole sugar cane was measured in an experiment of Latin square design. Four Zebu bulls, fitted with permanent rumen cannulae and of about 300 kg, were used. The treatments were (A) chopped whole sugar cane (plus urea/ammonium sulphate) given once daily; (B) chopped whole sugar cane offered freshly chopped four times (at four hourly intervals); (C) and (D) as (A) and (B) respectively, but supplemented with 0.5 kg/d wheat bran. Voluntary intake of cane after 4, 8, 12 and 24 h after feeding (or after first feeding) was measured with all groups. Rumen pH and VFA levels were measured at -1, 3, 7, 11 and 15 h relative to feeding (first feeding), as well as rumen fluid volume and fluid flow rates (using polyethylene glycol marker) on the last day of the 10 day periods.

There was no effect of frequency of feeding or supplementation with wheat bran on the voluntary intake of cane, rumen pH, VFA levels or VFA proportions. Feeding four times daily tended to decrease rumen volume (from 37 to 29 ± 3.1 l; $P = 0.10$) and increase fluid turnover rate (from 1.25 to 1.90 remaining constant (45 and 46 ± 4.7 l/d). Supplementation reduced rumen volume from 38 to 28 ± 3.1 l ($P = 0.05$) tending (not significantly) to increase fluid flow rate from 41 to 50 ± 4.7 l/d ($P = 0.23$), and turnover rate from 1.37 to 1.78 ± 0.14 vol/d ($P = 0.24$). Although total intake of cane was not affected by frequency of feeding, the pattern of intake was. The animals fed once only had consumed about 85% of their total intake by 12 h after feeding, whereas those fed four times had only consumed about 65% of their 24 h intake.

Key words: Sugar cane, cattle, frequency of feeding, rumen parameters, voluntary intake

One of the principal limiting factors in sugar cane based diets is the low voluntary intake, and generally this has been overcome by providing supplements rich in by-pass nutrients (Preston 1977; Preston and Leng 1978). Voluntary intake is closely related to rate of rumen liquid outflow on these diets (Priego et al 1977), and Hungate (1966) has argued that this parameter can be increased by increasing the frequency of feeding.

The objective of this experiment was to examine the effects on rumen function and voluntary intake of giving a sugar cane diet once or four times daily in the presence or absence of a supplement of wheat bran.

Materials and Methods

Treatments, Animals and Design: The following dietary treatments were arranged in a 2 x 2 factorial design as part of a 4 x 4 Latin square: (A) chopped whole sugar cane given once daily at 8am; (B) chopped sugar cane given four times daily; (C) the first treatment (A) but with an additional supplement of 500 g/d of wheat bran; (D) the same as the second treatment (B) but with 500 g/d of wheat bran. Four Zebu steers with permanent rumen fistulas, weighing approximately 300 kg, were used. The experimental periods were of 10 days duration with measurements of rumen function being carried out on the last day.

Procedure: The whole sugar cane was chopped into particles of about 1 cm and at the time of feeding it was sprayed with an aqueous solution of urea and ammonium sulphate at the rate of 50 g/kg of cane. The solution contained 77% water, 18% urea and 5% ammonium sulphate (w/w). In addition, each animal received 60 g/d of a mixture of salt and dicalcium phosphate. They had free access to water at all times. The animals were tied in individual yoke stalls.

Sampling: For the animals fed four times daily the feed refusals were weighed immediately prior to the next feed; those fed only once daily had their feed weighed at the same times, in order to enable a comparison to be made of the feeding pattern.

On the last day of each period at 9am, 80 g of polyethylene glycol (Carbowax 4000)(PEG) were infused into the rumen of each animal and samples taken at intervals during the following 24 hr in order to measure the rate of disappearance of the PEG from the rumen. On the same day, samples of rumen fluid were also taken 1 hr before the first feed was given, and at 4 hr intervals subsequently. pH was determined immediately and samples preserved with concentrated sulphuric acid for subsequent analysis for volatile fatty acids (VFA). PEG was determined as described by Ruiz et al (1978) and the VFA's by gas chromatography as described by Valdez et al (1977).

Table 1:
Voluntary intake of dietary components according to feeding frequency and supplementation with wheat bran

Wheat bran, g/d	500		0		+ SEx (P) ¹
Feeding frequency, x/d	4	1	4	1	
Intake of DM, kg/d					
Sugar cane	3.53	3.78	3.53	3.88	0.16 (.20)
Urea	0.13	0.14	0.13	0.15	-
Minerals	0.06	0.06	0.06	0.06	-
Wheat bran	0.45	0.45	-	-	-
Total	4.18	4.44	3.54	4.09	0.17 (.05)

¹ Probability of "F" test

Results

The voluntary intakes of the different dietary components for the individual treatments are given in Table 1. Principal treatment effects on voluntary intake and on parameters of rumen function are given in Table 2.

Table 2:

Voluntary intake and rumen turnover in bulls fed sugar cane one or four times daily with or without wheat bran (main treatment effects)

	Frequency of feeding		P	Wheat bran g/d		P	SE _x
	4 x day	1 x day		0	500		
DM intake, kg/d	3.86	4.26	.06	3.81	4.30	.05	0.12
Rumen liquid volume, litres	28.8	37.3	.10	38.3	27.8	.05	3.11
Rumen flow, litres/d	45.4	45.8	.70	41.2	50.0	.23	4.71
Turnover rate	1.90	1.25	.07	1.37	1.78	.21	0.14

Total voluntary intake was higher on once, than on four times, daily feeding, and was higher in the presence, than in the absence, of wheat bran (due to the wheat bran supplement). Rumen turnover rate was faster with the greater frequency of feeding, but rumen liquid volume was smaller, with the result that daily flow rate of liquid out of the rumen was not affected by feeding frequency. The effects of supplementation were to increase turnover rate and to reduce rumen volume, with a tendency for flow rate out of the rumen to be increased. Ruiz et al (1978) found higher levels of supplementation with wheat bran (1.0 or 1.5 kg/d) to be without effect on rumen volume, but to increase fluid flow rate.

Figure 1 shows the pattern of feeding during 24 hr. As can be seen, the pattern of feeding was more uniform during the day on the four times frequency compared with giving the feed only once daily.

The changes of rumen pH on the different individual treatments during the day are given in Figure 2, while molar proportions of the VFA are presented graphically in Figure 3 and separately for each treatment in Table 3.

There were no apparent effects on rumen pH or on the molar proportions of the VFA due to either feeding frequency or supplementation with wheat bran. The patterns of change during the day were a slight fall followed by a recovery of pH, a sharp increase in propionate after the first feed of the morning, a correlated fall in acetate, and no obvious change in butyrate. These are typical of what has been observed previously in sugar cane based diets (Valdez et al 1977).

Discussion

The lack of effect of the treatments imposed (feeding frequency and supplementation with wheat bran) on pH and molar proportions of VFA, adds further evidence to the general hypothesis that it is difficult to change these parameters on sugar cane diets (Preston and Leng 1978). Variables investigated by other workers with equal lack of success were particle size of the sugar cane (Silvestre et al 1976), sources of starch and protein (Silvestre et al 1976b, 1977a,b), levels of rice polishings or cassava root meal (Priego et al 1978), levels of wheat bran (Ruiz et al 1978), addition of monensin (Lopez et al 1977) or propionic acid (Priego et al 1977).

Figure 1:
Feeding pattern of Zebu bulls given sugar cane once (Δ, \circ) or four times (\blacktriangle, \bullet) daily with or without supplementation with wheat bran

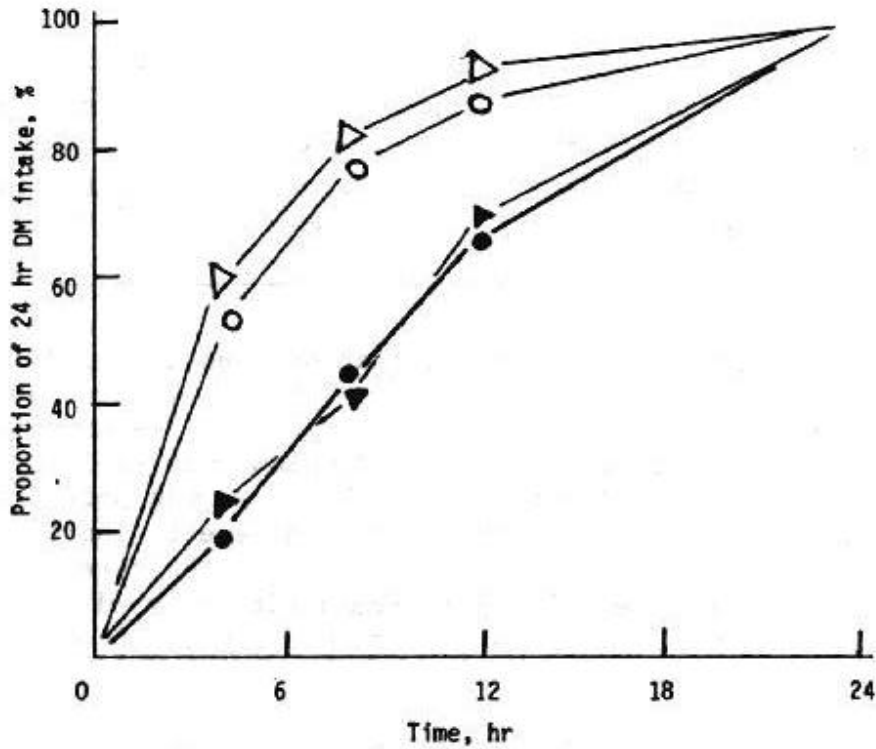


Figure 2:
Changes in rumen pH during the day in bulls fed sugar cane once (Δ, \circ) or four times (\blacktriangle, \bullet) in absence or presence of wheat bran

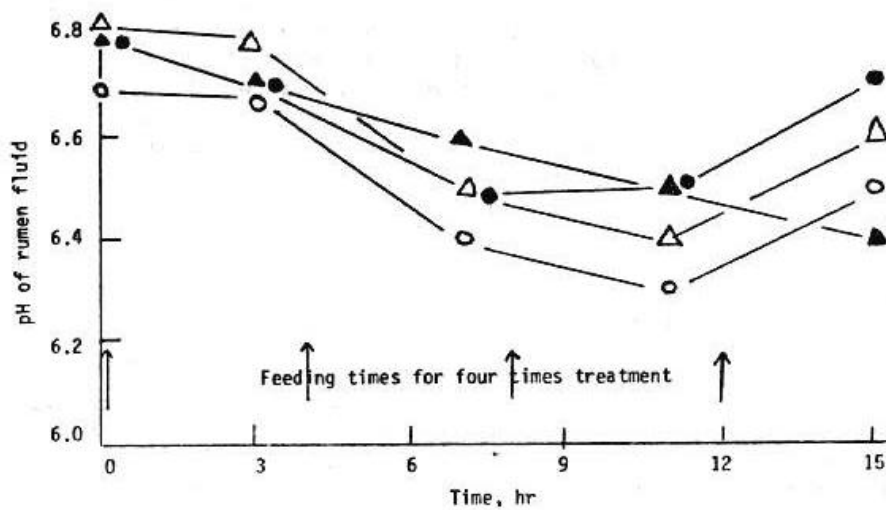


Figure 3:
 molar proportions of VFA in rumen fluid of bulls fed sugar cane once (Δ, \circ) or four times (\blacktriangle, \bullet) daily in the absence or presence respectively of wheat bran

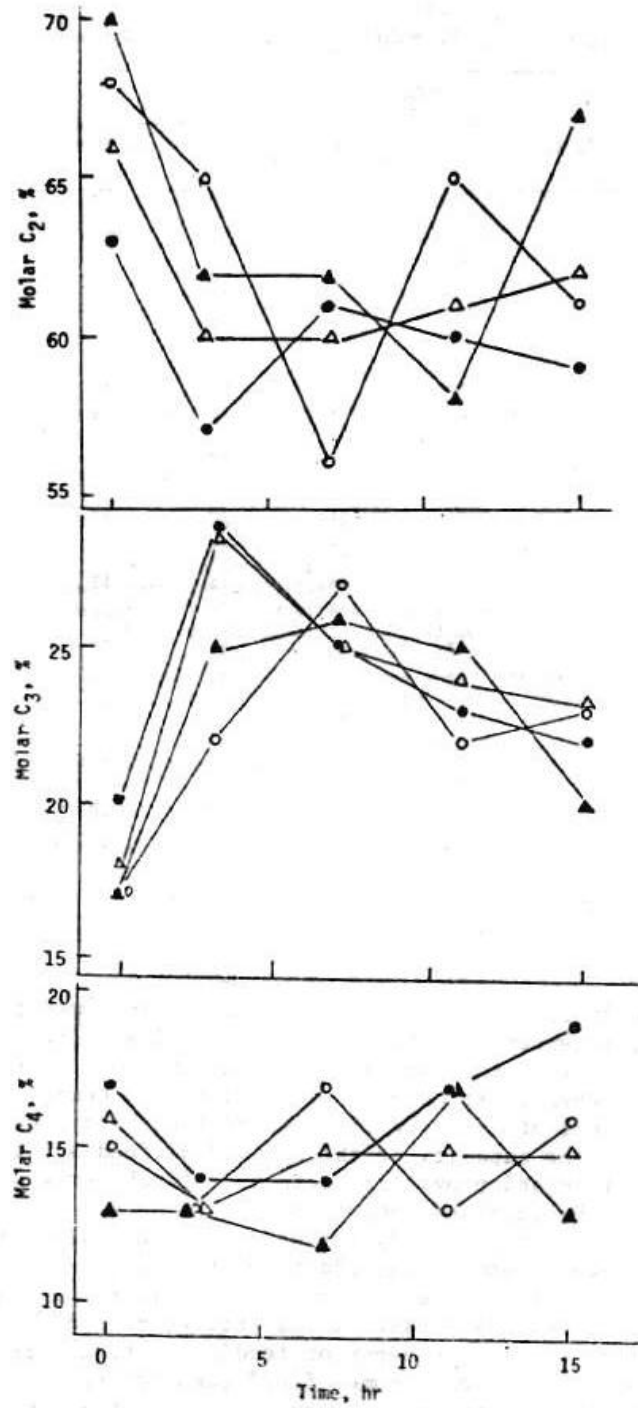


Table 3:
 Mean values for VFA molar proportions in rumen fluid during the day, according to feeding frequency with sugar cane in the presence or absence of wheat bran

Wheat bran, g/d	500		0		±SE _x	P ²
Feeding frequency ¹ , x/d	4	1	4	1		
-1 hr						
C ₂	68	63	66	70	.04	.54
C ₃	17	20	18	17	.15	.64
C ₄	15	17	16	13	.14	.57
3 hr						
C ₂	65	57	60	62	.02	.78
C ₃	22	29	27	25	.06	.43
C ₄	13	14	13	13	.01	.91
7 hr						
C ₂	56	61	60	62	.03	.57
C ₃	27	25	25	26	.11	.80
C ₄	17	14	15	12	.14	.37
11 hr						
C ₂	65	60	61	58	.02	.76
C ₃	22	23	24	25	.10	.76
C ₄	13	17	15	17	.05	.72
15 hr						
C ₂	61	59	62	67	.05	.31
C ₃	23	22	23	20	.07	.80
C ₄	16	19	15	13	.38	.04

¹ Relative to the first feed in the morning

² Probability of "F" test

In view of the failure to detect changes in rumen fermentation (VFA and pH) in this experiment and in other experiments reported in the literature, it seems that the two factors of major importance to the nutrition of the animal when sugar cane is fed as the main component of cattle rations, are: (a) the rate of turnover of rumen contents and liquid flow out of the rumen; and (b) the capacity of the individual feed supplements to escape rumen degradation and provide protein and starch for gastric digestion in the intestine (Preston and Leng 1978).

The increase in voluntary intake, rumen turnover rate and liquid flow out of the rumen caused by the addition of wheat bran to the diet, may therefore account for the effect of this supplement in increasing liveweight gain on sugar cane based diets (Silvestre and Hovell 1978).

The effect of the frequency of feeding on feed intake and rumen fermentation was not as expected. Rumen fluid turnover rate was improved by the more frequent feeding pattern, however because of a lower rumen volume, flow rate out of the rumen was not affected. In contrast to what was hypothesised, voluntary feed intake

appeared to be depressed when feeding was more frequent.

We are grateful to Dr F D DeB Hovell for sharing in the arduous task of feeding the animals late at night; to Lic Milagros Bobadilla for carrying out the analyses of PEG; and to Sergio Espejo for the measurements of the molar proportions of the VFA.

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Received 13 September, 1978