

PROCESSING OF SUGAR CANE: EFFECT OF DERINDING AND COARSENESS OF CHOPPING ON ANIMAL PERFORMANCE AND RUMEN FERMENTATION

F A Montpellier², R E Valdez³ and T R Preston⁴

*Centro de Investigación y Experimentación Ganadera
Chetumal, Quintana Roo, Mexico*

12 Zebu bulls of 180 kg live weight and 1.5 years of age were used randomised design with 4 repetitions of the following treatments: (A) sugar cane stalk which had been derinded to give particle size 5 mm; (B) whole stalk chopped very finely using a high velocity forage chopper (5 to 10 mm); and (C) stalk chopped with a machete (larger than 20 mm). Each ration was completely by adding one part of chopped sugarcane tops to 3 parts of processed stalk (fresh bests), together with a solution of molasses/urea (283 urea/litre) at the rate of 50 ml/kg of cane (including the tops). The animals also received 500 g/d of rice polishings and mineral; and water free choice. In the 98 days experiment there were no differences in daily gain (range 518 to 607 g) which could be attributed to the treatments. Voluntary consumption index was higher for the derinding treatment compared with machete and there was a tendency for feed conversion to be better with fine grinding than derinding. In the second experiment three Swiss X Zebu steers of 200 kg live weight fitted with rumen cannulas were used to determine the rumen fermentation pattern of the same treatments in compared in experiment 1. The design was a 3 x 3 latin square with one replication. There were significant differences between derinding and chopping with machete pH was higher the molar proportion of butyric acid lower and with a tendency for propionic acid to be higher for chopping with machete. There was no relationship between pH and any of the VFA nor between the different proportions of VFA. There were significant changes in all parameters during the day: the pH and the proportions of acetic acid fed, while propionic increased for 5 hr after the morning feed. The exception was butyric acid which showed no significant change due to time of sampling.

Key words: Sugar cane, processing, cattle, rumen fermentation, growth

In an experiment reported by Silvestre et al (1976), it was concluded that particle size as between fine and coarse chopping sugar cane stalk had no significant effect on animal performance. However, there were changes in the fermentation pattern in terms of a higher proportion of butyric acid with fine grinding; there was no significant difference in molar proportions of acetic and propionic acids.

The objective of the experiment described here was to extend this comparison to include derinded cane stalk. Two experiments were carried out; the first was a feeding trial and the second a study of rumen fermentation parameters using fistulated animals.

¹ Financed partially with funds provided by International Development Research Centre

² Present address: Secretaria de Recursos Hidraulicos, Comision de Rio Panuco, Tampico, Mexico

³ Present address: Banco de Credito Rural Peninsular SA, Chetumal, QR, Mexico

⁴ Scientific Adviser to CIEG

Materials and Methods

Experiment 1:

Treatment and Design: The treatments were the following methods of processing the sugar cane stalk (which was later mixed in proportions of 3:1 with chopped cane tops): (A) derinding (model C4 Canadian Cane Equipment, Edmonton, Canada); (B) grinding finely with a Chetumal forage chopper (see Preston et al 1976); and © chopping by hand with a machete. There were 4 animals in individual pens on each treatment.

Animals: 12 Zebu bulls of approximately 180 kg live weight and 1.5 years of age were used.

Procedure: The methods for processing the sugar cane stalk been described by Preston et al (1976) and Montpellier and Preston (1977). The final size of particles for the three treatments respectively was 5 mm`5 to 10 mm and 20 mm . The tops were chopped in a Chetumal machine to approximately 20 to 30 mm. After mixing the tops with the stalk, a solution of urea in final molasses (283 g urea/litre) was added at the level of 50 ml/kg of fresh cane (including the tops). These mixtures were given twice daily at 8 a.m. and 3 0 m. with the aim of providing approximately 10% more than expected consumption. All the animals received 500 g/d of rice polishings given as the first feed in the morning before the sugar cane. There was free access to clean water and to a mineral mixture (50! salt 47% rock phosphate and 3% trace minerals).

Measurements: The animals were weighed every 7 days; daily gain was calculated by regressing live weight on number of days on trial. Voluntary intake was determined daily while feed conversion was calculated as the regression of cumulative feed intake on live weight.

Experiment 2:

Treatments and Design: The treatments were similar to those described in experiment 1 as was the composition of the diet except that 1000 g/d of rice polishings was given instead of the 500 g used in experiment 1. The design was a single 3 x 3 latin square with periods of 14 days during the last 5 of which, samples were taken of rumen fluid.

Procedure: Brown Swiss X Zebu steers of 200 kg live weight fitted with rumen cannulas were used. The samples of rumen fluid were taken at 7:15 a.m. and there after at intervals of 30 minutes until 10:15 and then at intervals of 1 hr until 14:15. The rice polishings and half the sugar cane were given after the samples were taken at 8:15 while the second feed of sugar cane was given at 13:45.

Measurement. pH was determined immediately the fluid was removed from the rumen. Part of the sample was preserved with mercuric chloride for subsequent analysis for VFA according to the method described by Gonzalez and MacLeod (1976).

Results and Discussion

Experiment 1:

There were no significant differences in daily gain or feed conversion which could be attributed to the treatments (table 1). Feed consumption index was less for chopping with machete than with derinding.

The level of performance in this experiment was similar to that reported by Preston et al (1976) if the same level of supplementation with rice polishings is compared (.495 kg/d for derinded cane and .589 kg/d for chopped cane). In the trial reported by Preston et al there was an indication of poorer performance on the derinding treatment. The authors commented that there had been a certain loss of leaf on the derinding treatment, due to some of it remaining attached to the rind when the entire plant was passed through the separating machine. It is known that the leaf apparently contributes decisively in terms of ensuring an adequate voluntary intake (Ferrerio and Preston 1976; Alvarez and Preston 1976).

Table 1:

Mean values for gain in live weight, feed intake and feed conversion (4 steers in individual pens per treatment during 98 days)

	Derinded stalk	Chopped Stalk		SE _x
		Fine	Coarse ¹	
Live weight, kg				
Initial	183.3	184.8	185.0	
Final	283.8	243.5	240.3	
Daily gain	.518	.607	.543	
Intake, kg/d				
Fresh cane ²	12.5	12.3	11.1	
Final molasses	.47	.44	.40	
Urea	.162	.150	.140	
Rice polishings	.50	.50	.50	
Total DM	4.63	4.46	4.12	
Consumption index ³	2.30 ^a	2.17 ^b	2.10 ^c	±.054
Conversion ⁴	8.34	7.30	7.94	±.52

¹ By machete

³ Intake of DM (kg/d)/100 kg LW

² Mixture of 75% stalk and 25% tops

⁴ Intake of DM/gain in LW

^{abc} Means without letter in common differ at P<.05

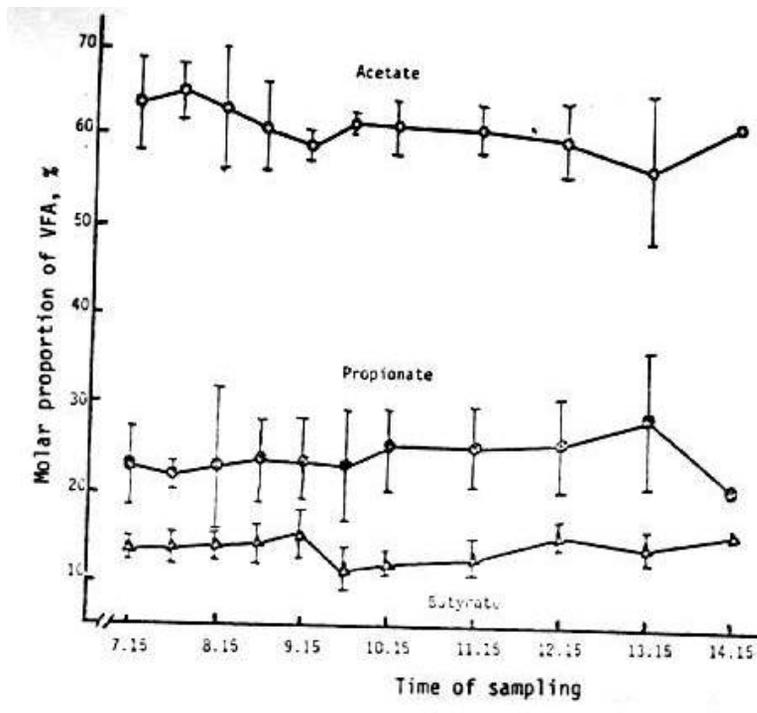


Figure 1a:
Changes in molar proportions of the VFA with time after feeding
(machete treatment)

In the present experiment the composition of the ration was more controlled since only the stalk was passed through the derinding machine, the chopped tops being added subsequently in equal proportions for the three treatments. Thus the fact there was no significant difference in animal performance between derinded stalk and chopped stalk in this experiment may be related to the fact that the proportion of leaf was constant on all treatments.

However, we must take into account the low level of supplementation with rice polishings (500kg/d) which almost certainly acted so as to limit the utilization of the ingested energy (see Leng and Preston 1976). Thus even if there had been a greater intake of digestible energy on the derinding treatment (because of its higher digestibility; Montellier and Preston 1977), this would not have been utilized because of the low levels of supplement which were used. In an experiment reported by Gonzalez and Williams (1976) where there was some indication of better performance with derinded cane compared with chopped cane, the level of supplementation was high (1.2 kg/d of rape seed meal and dehydrated alfalfa).

The greater voluntary intake on the derinding treatment can perhaps be explained by its higher digestibility in comparison with chopped stalk (Montpellier and Preston 1976; Ferreriro and Preston 1977), together with the presence of an optimum quantity of chopped tops, to ensure adequate rumen motility.

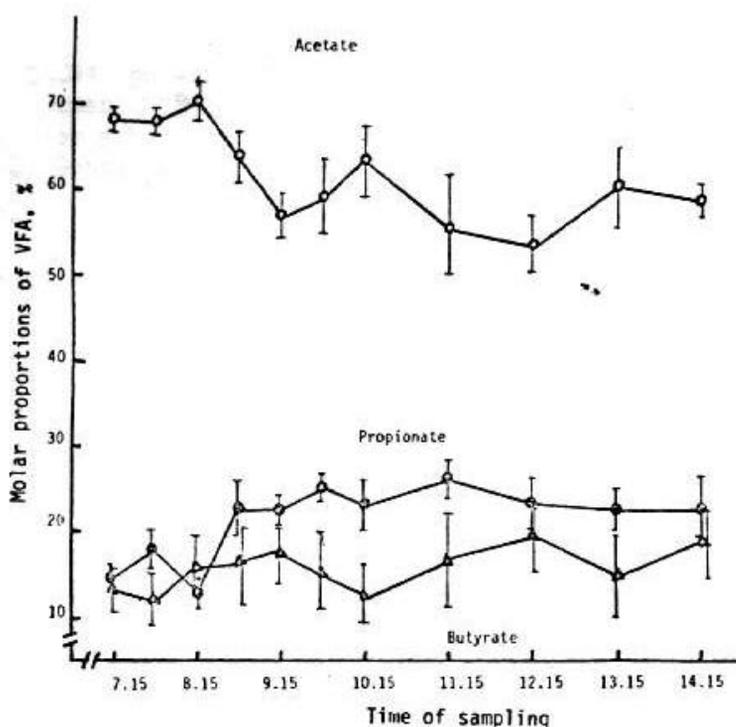


Figure 1b:
Changes in molar VFA with time after feeding (fine chopping treatment)

Experiment 2:

The effects of the treatments on rumen fermentation are given in table 2 and figure 1. There were significant differences in pH and molar proportions of butyric acid due to processing. pH was higher on the treatment with machete as compared with derinding while molar proportion of butyric acid showed the opposite effect with higher values on derinding and lower values for machete. There was a tendency for molar propionate to be higher on the machete treatment compared with derinding. In all cases, fine grinding of the stalk gave values which were intermediate. There was no indication of differences in molar percent acetic acid due to the treatment.

After the morning feed, the pH fell as did the molar proportion of acetic acid; molar propionate increased. Apparently the proportion of butyric acid was not affected by time of sampling, giving more or less a constant level during the total period of sampling. The increase in molar proportion of butyric acid, as particle size decreased is a similar tendency to that reported by Silvestre et al (1976). The changes in the pattern of rumen volatile fatty acids with time after feeding (i.e. the increase in propionate at the expense of acetate) on sugar cane agrees with the report of Alvarez et al (1977). It is also interesting to note that the higher proportion of propionic acid was encountered in the treatment that had the highest pH; despite this there was no relation between pH and molar proportions of propionic acid ($r = -0.17$).

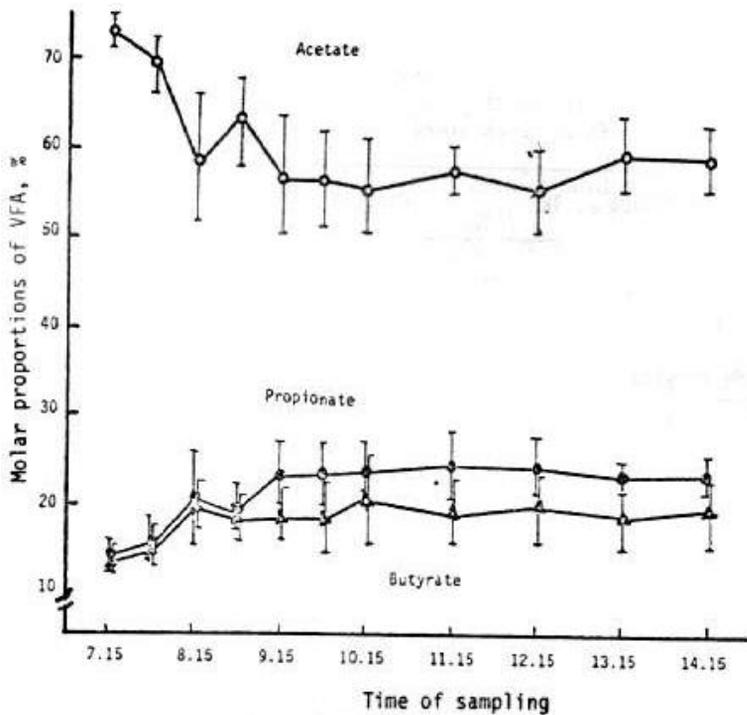


Figure 1c:
Changes in molar proportions of VFA with time after feeding
(derinding treatment)

Conclusions

The results of these experiments support those reported by Preston et al (1976) and Silvestre et al (1976); that the method of processing sugar cane has no important effect on animal performance, at least at medium levels of supplementation sufficient to support live weight gains of between 500 and 600 g/d. However, apparently there are changes in the rumen fermentation pattern with a tendency for higher proportions of propionic acid and lower proportions of butyric acid with larger particles. Although the derinded stalk is more digestible than the chopped stalk apparently other factors are limiting the utilization of the dietary energy on the former, thus cancelling the positive effects of increased energy value due to the derinding.

Table 2:

Mean values (samples taken at 7.15 10.15 11.14 12.15 and 13.15 hr; the animals were fed at 8:00 hr) for pH and molar VFA in rumen fluid

	Derinded Stalk	Chopped stalk		SE _x	Significance level
		Fine	Coarse ¹		
pH	6.60 ^c	6.63 ^{bc}	6.70 ^a	+0.02	<.002
Molar FVA, %					
C ₂	60.0	61.5	60.6	-1.83	NS
C ₃	21.9	23.4	26.0	-1.39	<.12
C ₄	18.5 ^a	15.3 ^{bc}	13.5 ^c	-1.43	<.05

¹ By machete

References

- Alvarez F J & Preston T R 1976 Studies on urea utilization in sugar cane diets: effect of level Trop Anim Prod 1:194-201
- Alvarez F J, Priego A and Preston T R 1977 Animal performance on ensiled sugar cane Trop Anim Prod 2:27-33
- Ferreiro H M & Preston T R 1976 Fattening cattle with sugar cane: The effect of different proportions of stalk and tops Trop Anim Prod 1: 178-IR5
- Ferreiro H M and Preston T R 1977 Digestibility and voluntary intake of derinded sugar cane stalk with and without addition of cane tops Trop Anim Prod 2: 90-99
- Gonzalez Elfrida & MacLeod N A 1976 Spontaneous fermentation of sugar cane Trop Anim Prod 1: 80-85
- Gonzalez L & Williams A 1976 Preliminary investigations on derinded sugar cane as a cattle feed Trop Anim Prod 1:227 abs
- Leng R A & Preston T R 1976 Sugar cane for cattle production: present constraints, perspectives and research priorities Trop Anim Prod 1:1-22
- Montpellier F A & Preston T R 1977 Digestibility and voluntary intake on sugar cane diets: effect of chopping the cane stalk in particles of different sizes Trop Anim Prod 2:40-43
- Preston T R, Carcano C, Alvarez F J & Gutierrez D G 1976 Rice polishings as a supplement in a sugar cane diets: effect of level of rice polishings and of processing the sugar cane by derinding or chopping Trop Anim Prod 1:150-162
- Silvestre R, MacLeod N A & Preston T Pi 1976 Animal performance and rumen fermentation with sugar cane chopped finely or coarsely Trop Anim Prod 1:86-92

Received 22 October 1976