DIGESTIBILITY AND VOLUNTARY INTAKE OR DERINDED SUGAR CANE STALK WITH AND WITHOUT ADDITION OF CANE TOPS[1]

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25 Brown Swiss x Zebu steers of 170 kg mean live weight were used in three different experiments on basal diets of sugar cane supplemented with molasses/urea and rice polishings. The treatments in experiment 1 were ratios of tops: stalk of. 100:0, 75:25, 50:50, 25:75 and 0:100. Consumption index increased and digestibility decreased as the proportion of tops was increased. In the second experiment, the treatment were ratios of derinded stalk to tops of 100:0, 92.5:7.5, 85:15, 77.5:22.5, 70:30, 62.5:37.5 and 55:45, with two subtreatments consisting of chopping the tops finely or coarsely. Voluntary consumption index was significantly higher with the coarse chopped cane as composed with the fine chopping but there was no effect on digestibility. Increasing the proportions of tops tended to increase voluntary intake but had no effect on digestibility. In experiment 3, 8 animals were used in a 4 x 4 latin square design to compare chopped cane stalk, chopped cane stalk plus tops in the ratio 75:25, derinded cane stalk and derinded stalk plus tops. Digestibility was significantly higher and voluntary intake lower for derinded compared with whole can. stalk end for the treatment without tops compared with when tops were included.

Key words: sugar cane, processing, cattle, digestibility

In an earlier paper(Ferreiro and Preston 1976), it was shown that the addition of chopped cane tops to the basal ration of chopped cane stalk, led to increases in voluntary intake and live weight gain but to poorer feed conversion,. A similar effect was reported by James (1973) in Barbados when chopped tops were added to derinded sugar cane stalk.

It is known that the digestibility of tops is significantly less than that of chopped or derinded stalk (Montpellier and Preston 1977a,b,) However, according to data reported from Barbados (CIDA 1973) there was no difference in DM digestibility between derinded cane stalk alone or plus 25% of chopped tops (70 and 69% respectively).

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The objective of this experiment was to obtain more information on the effect on digestibility and voluntary intake of giving different amounts of tops with chopped cane stalk (experiments 1 and 2); and to compare the effect of a fixed proportion of tops (25%) in combination with either chopped whole stalk or derinded stalk.

Materials and Methods

Treatments and Design:

Experiment 1: A production function design was used to compare ratios of stalk:tops of 100:0, 75:25, 50:50, 25:75 and 0:100. Each treatment was applied to four animals.

Experiment 2: A production function design was used to compare ratios of derinded stalk and chopped tops of 100:0, 92.5:7.5, 85:15, 77.5:22.5, 70:30, 62.5:37.5 and 55.45. For each ratio there were two sub-treatments which consisted of chopping the tops coarsely (particles of 10 mm) or finely (particles of 3 to 5 mm) using a high speed forage chopper. A different animal was used on each level of tops, while the two sub-treatments were applied to the same animal in successive periods,

Experiment 3: Eight animals in two balanced 4 x 4 latin square designs were used to evaluate the following treatments: (A) chopped sugar cane stalk; (B) sugar cane stalk with chopped tops in the ratio of 75:25; (C) derinded stalk; and (D) derinded stalk and chopped tops in the ratio 75:25.

Animals: Brown Swiss x Zebu steers of approximately 150 kg live weight were used in all three experiments.

Diets:

Experiment 1: The entire sugar cane plant was divided into stalk and tops and both fractions chopped in a high speed forage chopper (see Preston et al 1976). The rations were prepared by mixing tops and stalk in the proportions indicated in the experimental design and then adding a solution of urea/molasses (176 g urea and 589 g final molasses/kg of mixture) at the level of 50 g/kg of fresh sugar cane. All the animals received 40 g/d of minerals. No protein supplement was given.

Experiment 2: The derinded cane stalk was prepared according to the method described by Preston et al (1976). Supplementation with urea/ molasses was the same as in experiment 1, but rice polishings (500 g/ animal/d) was also given together with the minerals.

Experiment 3: The derinded or chopped stalk, alone or with chopped tops, were supplemented with molasses/urea (176 g urea/kg of mixture) at the rate of 50 g/kg of fresh cane. The animals also received 500 g/d of rice polishings and 40 g id of minerals.

General procedure:

The procedure for determining digestibility was the same as was outlined by Montppellier and Preston (1977a). In all three experiments data were collected on the Brix and dry matter content of the different sugar cane fractions using a hand refractometer for Brix measurement and determining dry matter in an oven at 70° for 48 hr.

Experiment 1:

As the proportion of tops in the ration was increased, digestibility first decreased and then increased in a curvilinear form; the opposite tendency was noted with respect to voluntary consumption index which increased with proportion of tops in the ration (figure 1 and table 1). Data on Brix and dry matter in the different fractions of sugar cane are given in table 2. Brix (total sugars) in the juice was twice as high for stalk as for tops, and similar differences were apparent when the Brix values were expressed on a dry matter basis. The content of dry matter was similar for both fractions.

Figure 1:
Relation between proportion of tops and digestibility and voluntary intake (experiment 1)

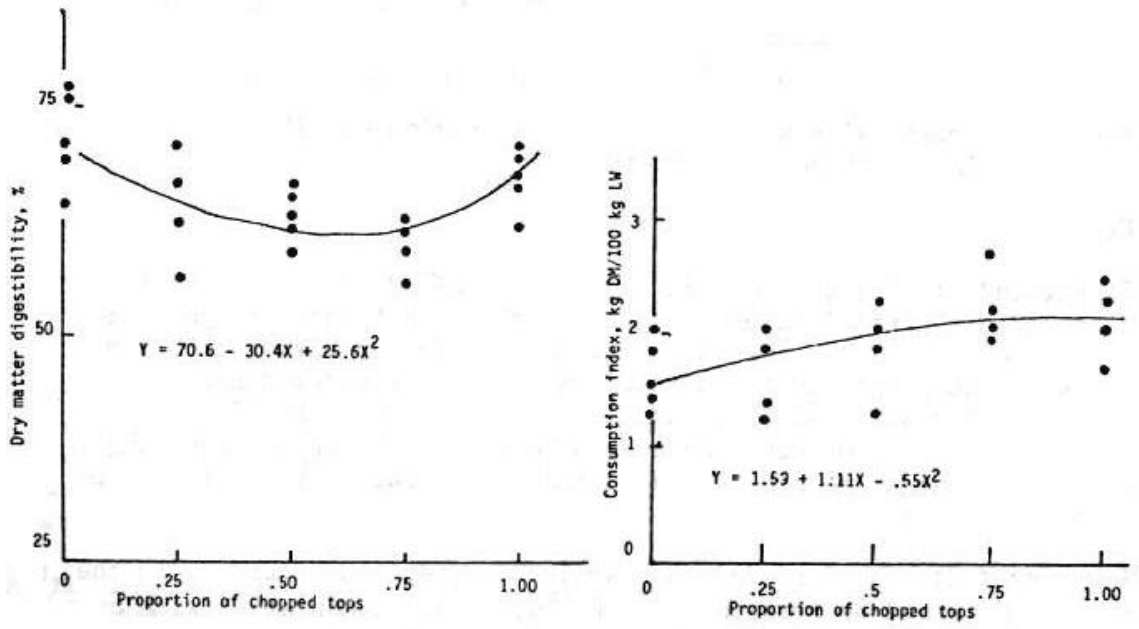


Table 1:
Mean values (± SE) for consumption index and dry matter digestibility (experiment 1)

Ratio (fresh basis) stalk:tops	Digestibility of DM	Consumption index[1]
	%	
100:0	70.7 ± 2.68	1.68 ± .17
75:25	63.9 ± 2.98	1.67 ± .20
50:50	62.9 ± 1.23	2.00 ± .17
25:75	61.0 ± 2.70	2.30 ± .15
0:100	61.1 ± 1.24	2.03 ± .17

[1] Daily intake of DM (kg)/100 kg live weight

Table 2:
Mean values (± SE) for dry matter (DM) and Brix ° in the different fractions of sugar cane (experiment 1 and 2)

		Tops	Whole stalk	Derinded stalk
Expt 1				
	Brix in juice	9.41 ± .48	18.23 ± .25	
	Brix (DM basis)[1]	25.64	48.67	
	Percent DM	26.28 ± 1.61	27.25 ±.25	
Expt 2				
	Brix in juice	7.0 ± .23		21.47 ± .46
	Brix (DM basis)[1]	24.8		57.33
	Percent DM	22.0 ± 2.19		27.2 ± .43

[1] Calculated as: $\frac{(100 - \%\ DM)\ Brix\ in\ juice}{\%\ DM}$

Experiment 2:

The effect of the particle size of the tops on digestibility and voluntary consumption index was analysed by the "t" test for paired observations (table 3). There were significant differences in voluntary intake due to the degree of processing of the tops, with higher values being recorded on average for coarse chopping (2.13) compared

with fine chopping (2.0 kg DM/100 kg live weight). There was no effect of processing on dry matter digestibility.

There was a tendency for intake to increase with proportion of tops in the ration and although neither of these trends was significant the relationship was much stronger for coarse (b =.63 ±.56; r =.45) than for fine chopping (b =.25±.51; r =.21). There were no obvious trends for digestibility of dry matter which varied in the range of 64 to 74% for coarse chopping of the tops and 64 to 72% for fine chopping

Table 3 :
Consumption index and DM digestibility (experiment 2)

Ratio Stalk: top (fresh basis)	Consumption index[1]		DM digestibility, %	
	Coarse[2]	Fine[2]	Coarse	Fine
100:0	1.95		70.67	
92.5:7.5	1.9	1.91	66.1	67.51
35:15	1.97	1.76	66.17	72.33
77.5:22.5	2.5	2.35	71.6	67.22
70:30	2.17	2.11	63.96	69.78
62.5:37.5	1.94	1.88	67.24	71.27
55:45	2.3	2.03	74.3	63.8
Overall mean	2.13	2.00	68.22	68.65
Mean difference - SE	.12 ± .045		-.42 ± 2.71	
Significance Level	<.03		NS	

[1] Daily intake of DM (kg)/100 kg live weight
[2] Refers to degree of chopping of the tops

Experiment 3:

Mean values for intake of the different diet components are set out in table 4 for both replications. Voluntary consumption index and dry matter digestibility are given for individual treatments in table 6 and for the principal effects in table 7. The effect of including the tops with the cane stalk, whether this was chopped whole or derinded, was to reduce digestibility from 67 to 63 approximately and to increase voluntary consumption index from 1.9 to 2.2. There were also marked effects due to derinding of the stalk which gave rise to higher digestibility (67 vs 63) but a lower voluntary intake (1.85 vs 2.14).

Table 4:
Mean values for feed intake in experiment 3 (kg/day)

	Whole stalk		Derinded stalk	
	Without tops	With tops	Without tops	With tops
Sugar cane stalk				
Rep 1	12.0	11.2	12.6	11.2
Rep 2	13.2	11.8	14.3	12.0
Sugar cane tops				
Rep 1		3.72		3.73
Rep 2		3.93		4 00
Molasses				
Rep 1	.36	.44	.38	.45
Rep 2	.39	.47	.43	.48
Urea				
Rep 1	.105	.132	.111	.131
Rep 2	.115	.138	.125	.140
Minerals				
Rep 1	.035	.037	.036	.038
Rep 2	.037	.036	.036	.037
Total DM				
Rep 1	4.10	5.00	3.94	4.52
Rep 2	4.45	5.13	4.22	4.74

All animals also received 500 g/d of rice polishings

Table 5 :
Dry matter and Brix in sugar cane in experiment 3 (X ± SE)

		Cane stalk	
	Tops	Whole	Derinded
Dry matter, %			
Rep 1	25.4 ± .94	28.2 ± .77	24.6 ± .49
Rep 2	23.7 ± 1.75	26.6 ± .38	22.8 ± 1.18
Brix in juice			
Rep 1	9.43 ± .97	17.5 ± .79	18.0 ± .50
Rep 2	8.85 ± 1.16	17.2 ± 1.01	17.8 ± 1.09
Brix (DM basis) [1]			
Rep 1	27.5 ± 1.45	44.6 ± 2.36	55.3 ± .73
Rep 2	28.3 ± 2.49	47.7 ± 3.16	60.6 ± 3.11

[1] Calculated as: $\frac{(100 - \%DM)\ \text{Brix in juice}}{DM\ \%}$

Mean values for dry matter and Brix in the different fractions of the sugar cane during the trial are set out in table 6. Dry matter content was higher for the chopped whole cane stalk (27.4) compared with derinded stalk (23.7) or tops (24.6). Brix in juice was similar for derinded and whole stalk, with values twice those recorded for the tops.' When Brix was expressed on a dry matter basis then the highest values were recorded for derinded stalk (60.0) followed by whole stalk (46.1), with the lowest value being recorded for the tops (27.9).

Table 6:
Mean values for consumption index and DM digestibility for individual treatments in experiment 3

	Whole stalk		Derinded stalk		SEx	Significance level
	Without tops	With tops	Without tops	With tops		
Consumption index[1]						
Rep 1	2.06^{b}	2.40^{a}	1.90^{b}	2.27^{a}	.088	<.03
Rep 2	1.89^{bc}	2.15^{bc}	1.80^{c}	2.00^{b}	.064	<.04
DM digestibility, %						
Rep 1	64.0^{b}	60.7^{c}	69.3^{bc}	63.0^{b}	1.00	<.005
Rep 2	64.1^{b}	62.5^{b}	70.8^{b}	65.8^{b}	1.34	<.02

[1] Daily DM intake (kg)/100 kg live weight
^{abc} Means on same line without common superscript differ at P <.05

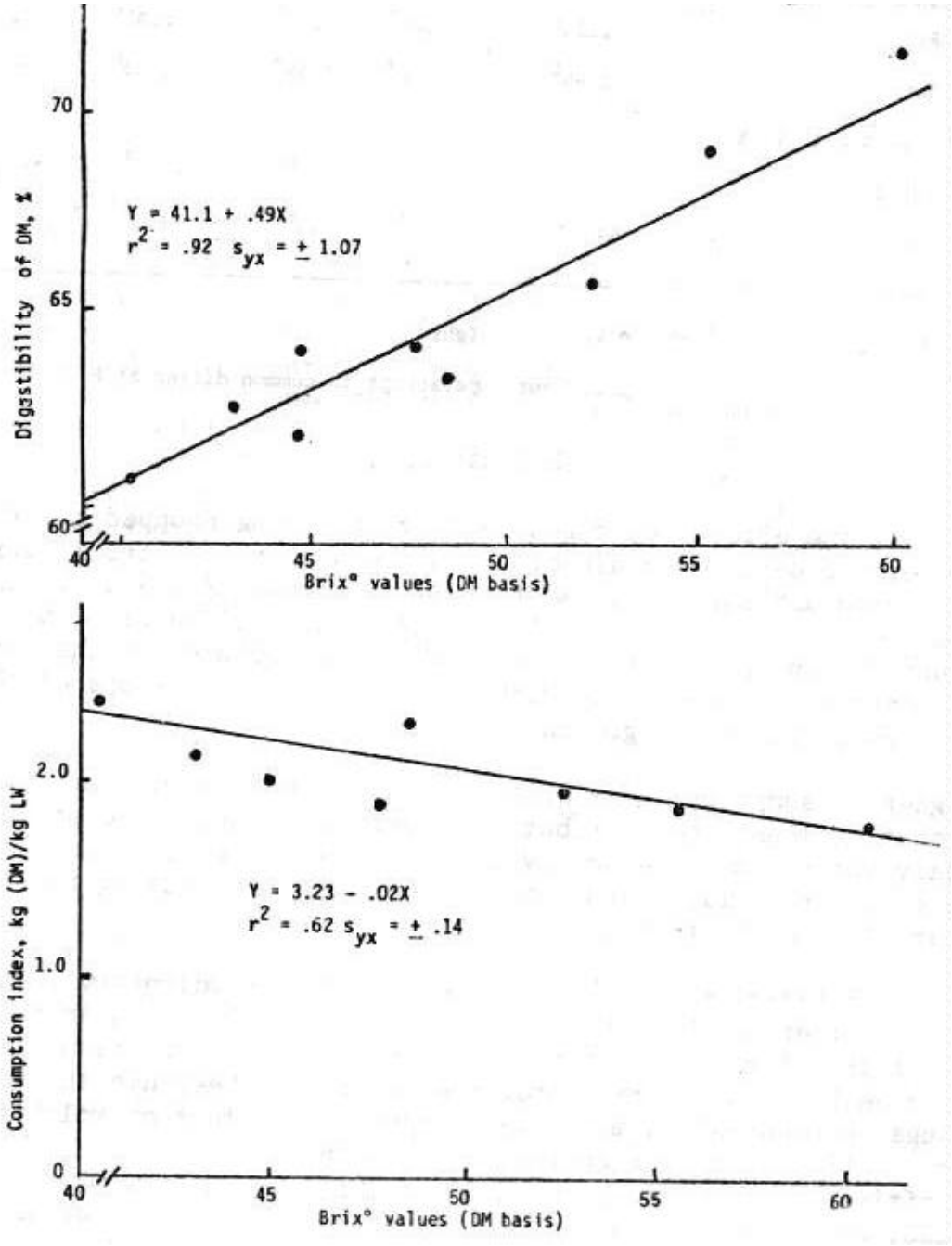
Table 7:
Consumption index and DM digestibility for principal effects in experiment 3

	Effect of tops		Effect of derinding		SEx
	Without	With	Without	With	
Consumption					
Rep 1	1.98^{b}	2.34^{a}	2.23^{a}	2.09^{b}	± .033
Rep 2	1.85^{b}	2.08^{a}	2.02^{a}	1.90^{b}	± .028
DM digestibility, %					
Rep 1	66.6^{a}	61.9^{b}	62.4^{b}	66.2^{a}	± .71
Rep 2	67.5^{a}	64.2^{b}	63.3^{b}	68.3^{a}	± .95

[1] Daily intake of DM (kg)/100 kg live weight
^{abc} Means within main effects without superscript in common differ at P <.05

Relationships between dry matter digestibility and voluntary intake as functions of the Brix values on a dry matter basis are set out in figure 2. Digestibility was positively related and voluntary intake negatively related with Brix.

Figure 2:
Relation between Brix in cane (dry matter basis) and digestibility and voluntary intake (experiment 3)



Discussion

In general, the effects on digestibility of adding chopped sugar cane tops to either derinded stalk or chopped whole stalk, are in agreement with data already published for digestibility of the different fractions of sugar cane (Montpellier and Preston 1977a,b). The increase in voluntary consumption index when tops were included in the ration (experiments 1 and 3)conforms with the earlier observations of Ferreiro and Preston (1976) in growth trials.

The higher consumption index when the tops were chopped coarsely indicates that at least one attribute of sugar cane tops is to stimulate voluntary intake, due presumably to the longer fibres, having a direct effect on rumen motility and, as a consequence, increasing the rate of turnover of rumen contents.

The negative relationship in experiment 3 between voluntary intake and Brix (the latter can be equated with total sugars) indicates that perhaps another effect of the tops is to bring about a dilution of the sugar concentration in the total feed. It has been hypothesised that high sugar concentration may have a depressing effect on voluntary intake to osmotic factors (Ferreiro and Preston 1976). The positive relationship between digestibility and Brix is to be expected, as sugars are completely fermented in the rumen while the fermentation of sugar cane fibre is incomplete (between 20 and 30% according to Valdez and Leng 1976).

Conclusions

The results of these experiments support the conclusion that it is essential to include a proportion of tops in rations based on sugar cane, if maximum voluntary intake is to be achieved, The reduction in overall nutritive value of the diet, due to including tops is relatively small, and is more than compensated by the increase in intake of digestible dry matter (e.g. from 1.26 kg of digestible DM/ 100 kg live weight/day to 1.40 in experiment 3).

The normal ratio of tops to stalk in whole sugar cane is in the range of 25:75 to 30:70, which appears to be close to the point of maximum response. In the greater part of the year there should be no problems in maintaining this ratio, however, in extreme dry season conditions when the sugar cane is completely mature, the proportion represented by the tops (which tend to become dry and wither under these conditions) may be inadequate. This was, in fact, reported by Alvarez and Preston (1976a). In such a situation it will be an advantage to utilize supplementary forage in order to maintain an adequate voluntary intake. In this respect, the legume Leucaena leucocephala which has been found to be well adapted to the tropics (Alvarez and Preston 1976b) could play a useful role. This particular plant has excellent forage characteristics, due to its growth habit (it is a shrub combining leaf and lignified stems) while at the same time the leaf is an excellent protein source, which can replace part of the protein supplement (i.e. the rice polishings) with considerable economic advantage (Alvarez and Preston 1976b).

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