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E. Aranda [a], G. D. Mendoza [a], G. R. Bárcena [a], J. Ramos [a] & F. Castrejón [a]

[a] Colegio de postgraduados, Programa de Ganadería, Montecillo México, Km 36.5 Carr. México-Texcoco, Estado de México, 56230, México

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Influence of Sugar Cane Intake on Digestibility and Ruminal Fermentation in Crossbreed Steers Fed Stargrass

E. Aranda, G.D. Mendoza[a], G.R. Bárcena, J. Ramos, F. Castrejón[b]

Colegio de postgraduados, Programa de Ganadería
Montecillo México, Km 36.5 Carr.
México-Texcoco, Estado de México, 56230 México

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Abstract

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An experiment was conducted to study effects of feeding different levels of sugar cane on ruminal fermentation and fiber digestion in crossbreed steers fed with stargrass mixtures when sugar cane (SC) and stargrass (SG) are fed together to four crossed ***(Bos taurus x Bos indicus)*** *steers (455 kg BW) with ruminal canula. A Latin square design experiment was used to test different levels of chopped sugar cane intake (0, 0.9, 1.6 and 1.8% BW) with stargrass fed* ***ad libitum****. Intake of SG reduced linearly (P<0.05) as SC feed level increased. Ruminal digestibility of DM, NDF and ADF did not change (P>0.05), although CP was increased linearly. Total ADF digestibility increased with higher intake of SC.* ***In situ*** *NDF digestibilities of SG and SC were not affected (P>0.05) by treatments. Molar proportion of butyrate was increased (P<0.01) but other VFA did not change. Results*

[a]For correspondence. Phone-Fax: 59-59-52-02-79, E-mail: gmendoza@xcolpos.mx

[2]UNAM, Facultad de Medicina Veterinaria y Zootecnia, Departamento de Nutrición Animal, Cd. Universitaria, México, D.F. 04510, México.

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indicated that sugar cane can be used as a complementary forage with stargrass, showing a substitutive effect without altering ruminal fermentation or digestibility of the diet.

Key words: Sugar cane, stargrass, intake, digestibility, rumen fermentation.

Introduction

Nutritional strategies to improve ruminant production in the tropics have been developed to compensate for seasonal variation in forage quality and availability. Sugar cane is an important resource during the dry season because of its greater dry matter yields than other forages (Conrad *et al.*, 1990). However, feeding ruminants with sugar cane based diets does not allow maximum performance because of constraints on ruminal digestion and fermentation (Leng, 1989). Sugar cane is an important source of soluble sugars at 30 to 40% of DM (Gooding, 1982), but fiber digestibility is the main constraint to sugar cane utilization by ruminants (Leng, 1989). In addition, cell wall digestion may also be restricted by the acidic rumen pH caused by soluble sugar fermentation in the rumen (Sutton, 1979).

Since sugar cane has been used as a complementary dry season forage in the tropics (Aranda *et al.*, 1997), the objective of this experiment was to study effects of feeding different levels of sugar cane on ruminal fermentation and digestibility in steers fed stargrass.

Materials and Methods

Four crossed steers *Bos taurus x Bos indicus* (455 kg BW) fitted with rumen and T duodenal cannulae (Tygon 1.9 cm i.d.), were used in a 4x4 Latin Square design. Treatments consisted of chopped sugar cane mixed with 1% urea offered at 0, 1, 2 and 3% of BW. Chopped stargrass was fed *ad libitum*. Steers received sugar cane at 8:00 h, stargrass at 12:00 h and 2 kg of a protein supplement at 13:00 h. Water and a mineral premix (Ca, 10%; P, 12%; S, 1.5%; Mg, 2%; K, 2%; Co, .0015%; Cu, .07%; Fe, .15%; I, .005%; Mn, .25%; Se, .0008%; Zn, .25%) were offered *ad libitum*. The supplement contained (DM basis): Rice polishing 10%, dehydrated poultry litter 50%, flash dried blood meal 10%, bovine rendered meat meal 10% and cane molasses 20% (92.3% DM, 22.6% CP, 55.1% NDF and 21.8% ADF).

Brix degrees in sugar cane were determined with a refractometer (Banda and Valdez, 1976) and showed a range of 16.6 to 21.0, which represents between 30 to 40% soluble sugars in DM. Sugar cane composition was: 32.0% DM, 2.2% CP, 48.1% NDF, 32.5% ADF, 50.7% *in situ* DM digestibility; and the stargrass: 29.2% DM, 8.1% CP, 81.8% NDF, 50.6% ADF and 34.1% *in situ* DM digestibility.

Experimental periods consisted of a 14 d adaptation followed by 7 d of sample collection. Ruminal fluid was collected from the ventral sac 0, 4, 8 and 12 h postprandial and its pH was measured immediately. 100 ml of ruminal fluid were acidified with 1 ml of 6 N HCl and stored at -20C for further analysis. Volatile fatty acids (VFA) were determined by gas chromatography (Varian Model 3800) in samples prepared with metaphosphoric acid (Erwin *et al.*, 1961). Ammonia-N was measured by the indophenol method (McCullough, 1967).

Feed, duodenal and fecal samples were collected over four days. Feed and fecal samples were oven-dried (55C, 24 h) and ground to pass a 1 mm screen and composited by steer. The DM and nitrogen (N) were analyzed as per AOAC (1980) and NDF and ADF were determined according to Van Soest *et al.* (1991) using alpha amylase in the supplements. Acid insoluble ash was used as internal indigestibility marker (Van Keulen and Young, 1977).

In situ disappearance of NDF from sugar cane and stargrass were measured by incubating 5 g of sample ground to pass a 1 mm screen in polyester bags (10x5 cm; 40° pore size). Duplicate bags were incubated at 12, 24, 48 and 72 h in each steer in each period. Degradation rates of potentially digestible sugar cane and stargrass were estimated with a linear model by regressing the natural log of the percentage of the potentially digestible fraction *vs* time, considering the extent of digestion to be that measured at 72 h incubation. Results were analyzed with the GLM procedure of SAS (1988), testing linear effects of sugar cane intake as a percentage of body weight.

Results and Discussion

As more sugar cane was offered, its intake increased linearly ($P<0.01$) upto 2% of BW, whereas the stargrass was reduced ($P<0.05$)

showing a substitutive effect (Table 1). Ruminal digestibility of crude protein was increased which was associated with the urea supplementation. Total tract digestibility of ADF increased linearly ($P<0.01$). The neutral (NDF) and acid (ADF) detergent fiber intakes as well as ruminal and total tract digestibility of DM, CP, NDF and ADF were not affected by sugar cane intake (Table 2).

In situ disappearance of NDF was not affected by sugar cane level (Table 2). Ruminal pH did not show negative effects. Molar proportion of butyrate increased with sugar cane intake. Other VFA were not affected by cane level while ammonia N increased linearly

Table 1
Effect of sugar cane level on intake and digestibility

Item	Sugar cane intake (% BW)				
	0	0.9	1.6	1.8	SEM*
Dry matter intake, kg/d					
Sugar cane	0.0[a]	1.3[b]	2.3[c]	2.6[c]	0.46
Stargrass	7.0[a]	7.3[a]	6.7[a]	5.9[b]	0.36
Supplement	1.8	1.8	1.8	1.8	-
Total	8.8	10.4	10.8	10.3	0.29
Daily intake					
Crude protein, g/d	1.0	1.1	1.2	1.2	0.08
NDF, kg/d	6.7	7.6	7.5	6.7	0.04
ADF, kg/d	4.0	4.5	4.5	4.0	0.03
Ruminal digestibility, %					
Dry matter	49.6	50.4	51.4	52.4	3.2
Crude protein	62.6[ab]	60.8[a]	64.3[ab]	65.8[b]	3.3
NDF	55.7	53.3	52.7	54.7	3.9
ADF	40.6	45.3	47.9	49.1	3.4
Total tract digestibility, %					
Dry matter	54.0	53.3	57.6	60.3	3.1
Crude protein	65.6	61.3	66.7	67.1	5.1
NDF	56.7	55.9	55.5	55.0	4.3
ADF	41.0[a]	45.7[ab]	48.3[b]	49.2[b]	2.6

[a,b]Means with no common superscript in a row differ ($P<0.05$).
*Standard error of the mean.

($P<0.01$), but only for the 9 h sample which is associated to the urea added in the sugar cane (Table 2).

Though 1, 2 or 3% sugar cane was offered actual intakes were restricted to 0.9, 1.6 and 1.8% of BW. Even when steers received 3% BW of sugar cane, maximum intake when forage is not restricted would be between 1.6 and 1.8% of sugar cane. Similar response has been observed when other tropical forages were supplemented with sugar cane (Ffoulkes and Preston, 1979, Gonzalez *et al.*, 1989). Aranda *et al.* (1997) found similar reductions in sugar cane intake

Table 2
Effect of sugar cane intake level on ruminal variables

Item	Sugar cane intake (% BW)				
	0	0.9	1.6	1.8	SEM*
VFA, % molar					
Acetate	70.6	69.8	67.9	68.4	1.20
Propionate	18.0	17.3	18.0	17.3	0.60
Butyrate	11.4[a]	13.0[b]	13.4[b]	14.0[b]	0.70
Total mM	45.9	62.1	63.3	65.3	10.40
Ruminal pH					
9 h	7.3	7.2	7.2	7.3	0.07
13 h	7.3	7.1	6.9	7.0	0.05
17 h	7.0	6.8	6.9	6.9	0.05
21 h	6.7	6.6	6.8	6.7	0.06
$N\text{-}NH_3$					
9 h	3.9[a]	6.1[b]	8.5[c]	7.7[bc]	0.89
13 h	3.9	4.6	5.6	4.8	0.73
17 h	4.6	4.7	4.3	5.3	0.50
21 h	3.5	2.8	3.4	2.5	0.22
NDF sugar cane					
Digestion rate, %/h	1.1	2.2	2.2	1.7	1.30
Extent, %	24.5	25.6	26.4	20.6	5.30
NDF stargrass					
Digestion rate, %/h	3.9	3.1	2.9	3.4	1.50
Extent, %	42.0	43.8	41.2	41.2	4.00

[a,b,c]Means with no common superscript in a row differ ($P<0.05$).
*Standard error of the mean.

in sheep fed stargrass when the ration contained more than 50% sugar cane. Sugar cane intake may be limited by the low rate of NDF digestion and a mean rumen retention time between 52 to 73h (Figueira *et al.*, 1993), which is considerably greater than values of 32 to 45h reported for tropical grasses (Poppi *et al.*, 1981). Factors such as cell wall lignification may be responsible for the low digestibility and intake of sugar cane (Amjed *et al.*, 1992).

Digestibility values of the sugar cane in our study were lower than in other studies (Ffoulkes and Preston, 1979). Lower digestibility may have been caused by the low ammonia N concentrations, which could have affected microbial growth. Ammonia levels recorded here were lower than those reported in other studies using sugar cane and urea (Minor *et al.*, 1977). Previous studies indicate that rate of NDF digestion is similar with 1 or 2% urea, suggesting that other constraints related to NDF are limiting ruminal digestion of sugar cane (Aroeira *et al.*, 1993).

Total tract digestibility of NDF and ADF values were in some treatments similar than ruminal digestibility. This could be explained by a lack of steady state of the indigestible marker with unequal rates of input and output in the rumen, and the amount of NDF or ADF digested could be under- or over-estimated (Mendoza *et al.*, 1995). Other reason could be the long mean rumen retention time of tropical grasses and sugar cane with a minimum digestion in the lower tract. Fermentation patterns were similar to those observed in other sugar cane experiments (Priego *et al.*, 1977). It is concluded that feeding sugar cane up to 1.8% of body weight, together with tropical stargrass, did not show negative associative effects on intake, digestibility and ruminal fermentation in steers.

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ई. अरांडा, जी.डी. मेन्डोजा, जी.आर. बार्सेना, जे. रामोस, एफ. कैस्ट्रेजोन । स्टार घास प्राशित संकर बधियों द्वारा गन्ना भक्षण का पाच्यता और रूमेनी किण्वन पर प्रभाव ।

स्टार घास के साथ गन्ने को विभिन्न मात्राओं में मिश्रित करके चार रूमेन छिद्रित संकर बधियों (455 किग्रा) को खिलाकर रूमेनी किण्वन और आहारीय रेशे के पाचन का अध्ययन किया गया । विभिन्न दर (शरीर भार का 0, 0.9, 1.6 और 1.8%) से गन्ने की कुट्टी को इच्छानुसार स्टार घास के साथ लैटिन स्क्वायर डिजाइन में खिलाया गया । गन्ने की भक्षण मात्रा में वृद्धि के अनुसार ही रेखीय रूप में स्टार घास के भक्षण में कमी हुई । इससे अपरिष्कृत प्रोटीन में वृद्धि हुई, परन्तु शुष्क पदार्थ, उदासीन अपक्षारित रेशा (उअरे) और अम्ल अपक्षारित रेशा (अअरे) की पाच्यता अप्रभावित रही । गन्ने की अधिक मात्रा के उपभोग से सकल उअरे की पाच्यता में वृद्धि हुई। इन आहारों से स्टार घास और गन्ने के उअरे की स्वस्थले पाच्यता अप्रभावित थी गन्ने के उपभोग में वृद्धि से ब्यूटाइरिक अम्ल के मोलरी प्रतिशत में वृद्धि हुई परन्तु अन्य वाष्पशील वसा अम्ल अप्रभावित रहे । परीक्षण परिणामों से ज्ञात हुआ कि रूमेनी किण्वन और पाच्यता को प्रभावित किए बिना ही स्टार घास के साथ पर्याप्त मात्रा में गन्ने का चारा खिलाया जा सकता है ।