Rumen physiology, feed intake and live weight gain by bulls consuming sugarcane tops as basal diet supplemented with local available resources

Fisiología ruminal, consumo y ganancia de peso en toros consumiendo puntas de caña como dieta base y recursos disponibles localmente como suplemento

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Abstract

Two experiments were conducted with cattle consuming sugarcane tops (SCT) to determine the effect of Taiwan grass (TG), urea, poultry litter (PL) and a slow intake supplement (SIS) on feed intake, rumen physiology and live weight gain (LWG) in the dry season. In the first experiment, 25 young Zebu bulls (260 kg ± 6), kept under individual confinement conditions, and were distributed into five treatments with five replicates per treatment under complete randomized design. The bulls were fed with SCT alone (T1); SCT mixed with 20% TG (T2); SCT and 10% PL (T3); SCT with 0.8% urea (T4) or SCT plus 1.5 kg SIS (T5). In Experiment two, five ruminally cannulated Zebu steers (430 kg ± 27) used in a Latin square 5x5 trial were fed the same diets as the Experiment group. The steers were used to measured rumen in situ dry matter degradability (DMD), pH, volatile fatty acid (VFA) and

Resumen

Se realizaron dos experimentos en bovinos consumiendo puntas de caña (SCT) para determinar el efecto de pasto Taiwán (TG), urea, pollinaza (PL) y un suplemento de consumo lento (SIS) sobre el consumo, parámetros ruminales y la ganancia de peso vivo en la época seca. Primer experimento: 25 toretes Zebú (260 kg ± 6) fueron estabulados en forma individual bajo un diseño completamente al azar, en cinco tratamientos con cinco repeticiones cada uno. Los toretes fueron alimentados solamente con SCT (T1); SCT mezclada con 20% TG (T2); SCT mezclada con 10% PL (T3); SCT con 0.8% urea (T4) o SCT y 1.5 kg SIS (T5). En el segundo experimento, cinco toros provistos de cánulas ruminales (430 kg ± 27), distribuidos bajo un cuadrado latino 5x5 fueron utilizados para medir el efecto de las dietas del experimento uno sobre la concentración de ácidos grasos volátiles (VFA), amonio (NH₃), pH
ammonia (NH₃) concentrations. T4 had the highest SCT intake and T5 the highest total dry matter intake. The lower total organic matter intakes (OMI) were in T1 and T2 and the highest total OMI was in T5. The highest fractional degradation rate of SCT was observed in T5. The NH₃ concentration in T1 was not enough to maximize DMD. T5 showed higher NH₃ and VFA concentrations in comparison with other treatments. Overall LWG was increased by supplementation (from 0.050 in T1 to 0.130, 0.330, 0.380 and 0.850 kg/d in T2, T3, T4 and T5, respectively). Sugarcane top diets are deficient in both nitrogen and energy content. The use of nitrogen supplements (PL and Urea) increased the degradation of forage and LWG of young bulls fed SCT. Supplementation with both nitrogen and energy nutrients (SIS) had the highest response in degradation and LWG in bulls fed SCT.

**Key words**

Sugarcane tops, bulls, degradability, supplementation.

**Introduction**

Ruminant livestock production, from small tropical farmers, is based predominantly on animals grazing natural pastures, which have often low nutritive value especially during the dry season. Grasses grow rapidly during the summer, but later become fibrous, coarse, and highly lignified which decrease their digestibility. This results in loss of palatability and ineffective utilization of the pastures by the animals, thereby causing nutritional stress [Owen and Jayasuriya, 1989].

As a result of these adverse conditions in the dry tropics, animals can lose weight and body condition mainly during the dry season. This situation represents a heavy economic loses for cattle farmers [Pigden and Bender, 1978; Tilman et al., 2002]. Because the ability of ruminal microorganisms to degrade fiber, ruminants can then derive nutrients from products or by-products of other local agricultural and industrial processes and can be used to improve the nutrition of ruminant livestock during the dry season as strategic
supplementation for low quality forage [Hennessy and Williamson, 1990; Duarte et al., 1996].

Although, natural pastures are scarce during the dry season, there is usually an abundance of crop residues, which have potential to be used as feeds. One such crop residues are sugarcane tops, which are the immature growing portion of sugarcane and they are cut in the sugarcane cleaning process. Consequently, these materials are generally left in the field where they act as a soil fertilizer. Sugarcane tops are about 25% of the whole plant [Gooding, 1982]. Therefore, SCT represent a huge source of potential forages for ruminants [Naseeven, 1988]. And is a considerable amount of biomass that could be used as feed for ruminants. However, SCT cannot be offered as a sole source of feed due to its low nitrogen content. Therefore there is a need for a supplement that corrects the deficiencies of SCT in cattle. The principal objective of this study was to measure the effect of urea, poultry litter, Taiwan grass and slow intake supplement as supplements for beef cattle consuming SCT in the dry season.

Material and methods

Location: The study was conducted at the commercial property ‘Suchitlan’ Ranch, located in Comala, Colima, Mexico with a latitude 19° 23’ north, 103° 41’ longitude west and at 1 400 m above sea level. Koppen’s climate classification is Aw1(w) with rainy season from July to October, and an average precipitation of 1000 mm a year. The average temperature is 25°C.

Experiment one: Twenty-five young Zebu bulls, in full confinement for 120 days were randomly divided into five treatments with five animals per treatment, and initial live weight ranging from 258 to 262 kg. Treatment 1 (T1) was fed exclusively SCT; animals in treatment 2 (T2) received a diet of 80% SCT and 20% TG; treatment 3 (T3) consisted in a mixture of SCT 90% and 10% PL; treatment 4 (T4) dietary regime was made of SCT sprayed daily with 0.8% of urea solution (50 ml of urea solution (160 g urea/l water)/kg SCT) and treatment 5 (T5) consisted of SCT supplemented with 1.5 kg/animal of SIS. The SIS was a mixture of molasses (12.0%); urea (2.0%); fish meal (4.0%); salt (3.0%); orthophosphate (2.5%); limestone (3.2%); cottonseed meal (12.0%); rice polishing (12.0%); corn (28.0%); poultry litter (8.0%); mineral salts (1.5%); ammonium sulphate (2.0%); cement kiln dust (1.8%) and animal lard (8.0%). All animals had access to water and mineral block ad libitum. The forage was offered twice daily at 08:00h and 16:00h and SIS daily at 09.00 a.m. Daily intake was measured by weighting offered and refused total dry matter. Table 1 shows the nutritive characteristics of the forages and supplements used. Cattle were weighted monthly. Dry matter (DM), organic matter and nitrogen content were determined in agreement with A.O.A.C. [1995]. Neutral-detergent fiber and acid-detergent fiber content were measured
with the technique suggested by Goering and Van Soest [1970]. Energy was estimated by calorimetry [Hill et al., 1958].

Table 1. Chemical analysis of forages and supplement used in the present study.

<table>
<thead>
<tr>
<th>Feed</th>
<th>Sugarcane tops</th>
<th>Taiwan grass</th>
<th>Poultry litter</th>
<th>Urea</th>
<th>Slow intake supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td>90.0</td>
<td>50.7</td>
<td>84.5</td>
<td>-</td>
<td>84.1</td>
</tr>
<tr>
<td>Nitrogen (%)</td>
<td>0.82</td>
<td>1.79</td>
<td>5.76</td>
<td>4600</td>
<td>342</td>
</tr>
<tr>
<td>Organic matter (%)</td>
<td>87.5</td>
<td>92.0</td>
<td>62.7</td>
<td>-</td>
<td>78.8</td>
</tr>
<tr>
<td>NDF (%)</td>
<td>73.1</td>
<td>67.8</td>
<td>45.7</td>
<td>-</td>
<td>37.8</td>
</tr>
<tr>
<td>ALF (%)</td>
<td>42.4</td>
<td>45.2</td>
<td>30.1</td>
<td>-</td>
<td>13.5</td>
</tr>
<tr>
<td>MCE (%)</td>
<td>2.15</td>
<td>2.23</td>
<td>1.79</td>
<td>-</td>
<td>2.77</td>
</tr>
</tbody>
</table>

Experiment two: Five Zebu steers with a live weight of 430 kg (± 27) kg, fitted with permanent rumen cannulae were housed in individual pens and assigned randomly to each dietary treatment of experiment one under a 5 X 5 Latin square design with 14 days duration for each period: 10 days adaptation and four days for collection samples. Feed was offered twice a day at 08:00 and 16:00 h.

On sampling day, 50 ml of ruminal fluid was collected at 0:00, 2:00, 4:00, 6:00, 8:00, 12:00, 16:00 and 22:00 h after morning feeding to measure rumen pH, NH₃ and VFA concentrations. The rumen fluid was strained through four layers of cheesecloth and the filtrate was collected in plastic bottles. The pH was determined using a portable pH meter (ORION 250-A), within 2-3 minutes of the sample being obtained. After pH determination, two to three drops of 1 N H₂SO₄ were added to decrease the pH below 2. The samples were stored at -20°C to await analysis. Rumen NH₃ concentration was determined with a portable ion selective electrode for NH₃ (ORION 250-A) inserted into 15 ml of rumen fluid. Volatile fatty acids were determined by High Performance Liquid Chromatography. Ten ml of each sample of the rumen liquor were centrifuged once at 5 000 g for 15 minutes. The supernatants were ultra-centrifuged twice at 15 000 g for 15 minutes, the supernatants were micro-filtered once using resin filter and an acro-disc (Millipore, Massachusetts, USA. Catalogue No. 9004-70-0). One ml of the final liquid was injected into the liquid chromatography equipment [Waters HPLC, Louisiana, USA].

In situ dry matter degradability: The nylon bag technique described by Ørskov and McDonald [1979] and Ørskov et al. [1980] was used for DMD determinations. The sugarcane tops were ground through a 3 mm screen (Wiley laboratory mill, Thomas
Scientific, California, USA). Three grams of SCT were weighed into separate bags and incubated for 8, 16, 24, 48, 72 and 96 h. The bags, after withdrawal from the rumen, were soaked in water for 20 minutes, washed by hand, under running water until the washing water became clear. The bags were dried in an oven at 60°C for 24 h. The bags measured 7.5 cm x 15 cm with pores of about 30-50 microns (μm) in diameter. Three bags per sample washed without incubation in the rumen were used for the determination of zero time washing losses. In situ disappearance was determined according with the equation of Ørskov and McDonald (1979): 

\[ p = a - b \cdot \frac{c}{1 + (t/c)} \]

Where “p” is degradation loss after “t” hours, “a” is the zero time intercept at the fitted curve, “b” is the asymptote of the curve, and “c” is the fractional degradation rate constant of the exponential.

Statistical Studies: Results were analysed with the SAS programme (SAS, 1996). Live weight and DMI data were evaluated by ANOVA procedure for randomized complete design. Results of ruminal parameters were analysed under a Latin Square 5 x 5 design and using Tukey test \((P<0.05)\) for the determination of differences between treatments according to the model: 

\[ \eta_{ijkl} = \mu + \rho_i + \gamma_j + T_k + \varepsilon_{ijkl} \]

Where \(\eta_{ijkl}\) is the degradability, pH, VFA or NH3 concentration, \(\mu\) the general mean effect; \(\rho_i\) the \(i^{th}\) effect of the row (animal); \(\gamma_j\) the \(j^{th}\) effect of the column (period); \(T_k\) the treatment effect that appears in the \(j^{th}\) row/column; \(\varepsilon_{ijkl}\) the random error with experimental unit row/column.

Results

The results of feed intake and live weight gain are showed in Table 2. These results showed higher \((P<0.05)\) total DMI in T5 (5.97 kg/d) followed by T4 (5.13 kg/d), T3 (4.75 kg/d), T2 (4.32 kg/d), and T1 (3.96 kg/d). The highest SCT intake however was observed in T4, T4 had no significant differences when it was compared with the intake in T5 and T3 \((P>0.05)\). The bulls in T5 had the higher OMI in comparison with the others treatments \((P<0.05)\). The highest response in daily LWG was in T5 (0.850 kg/d). The bulls in T1 and T2 showed the lowest LWG (0.050 and 0.130 kg/d). There were no differences \((P>0.05)\) between T3 and T4 in LGW. Table 2 are shows the results of SCT degradability and rumen parameters from the present study. Fractional degradation rate of SCT in rumen increased \((P<0.05)\) with the addition of supplements. The highest fractional degradation rate was recorded with SIS (0.0576 h⁻¹) and there were no differences \((P>0.05)\) among T2, T3 and T4. Figure 1 shows in situ DMD with a higher disappearance from 16h in SIS followed by T4 and T3.
Table 2. Sugarcane tops (SCT) intake, supplement intake, total dry matter intake (DMI), initial and final live weight (LW), and daily weight gain (DWG) of young bulls fed SCT as basal diet plus different supplements.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SCT (%)</th>
<th>20% TG</th>
<th>10% PL</th>
<th>0.8% Urea</th>
<th>1.5 kg SIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC intake (kg DM/d)</td>
<td>3.94</td>
<td>2.88</td>
<td>4.41</td>
<td>5.00</td>
<td>4.68</td>
</tr>
<tr>
<td>Supplement intake (kg DM/d)</td>
<td>0.00</td>
<td>1.44</td>
<td>0.34</td>
<td>0.13</td>
<td>1.29</td>
</tr>
<tr>
<td>Total DMI (kg/d)</td>
<td>3.94</td>
<td>4.32</td>
<td>4.73</td>
<td>5.16</td>
<td>5.87</td>
</tr>
<tr>
<td>Total DMI (g/kg LW)</td>
<td>5.37</td>
<td>5.84</td>
<td>6.14</td>
<td>6.37</td>
<td>7.11</td>
</tr>
<tr>
<td>CMR (g/kg LW)</td>
<td>3.33</td>
<td>3.92</td>
<td>5.39</td>
<td>6.78</td>
<td>7.34</td>
</tr>
<tr>
<td>Consumption index</td>
<td>1.35</td>
<td>1.44</td>
<td>1.85</td>
<td>1.99</td>
<td>2.28</td>
</tr>
<tr>
<td>N (g)</td>
<td>3.29</td>
<td>4.93</td>
<td>5.54</td>
<td>10.78</td>
<td>82.56</td>
</tr>
<tr>
<td>Initial LW (kg)</td>
<td>211</td>
<td>210</td>
<td>240</td>
<td>238</td>
<td>242</td>
</tr>
<tr>
<td>Final LW (kg)</td>
<td>267</td>
<td>274</td>
<td>299</td>
<td>305</td>
<td>344</td>
</tr>
<tr>
<td>DWG (g/d)</td>
<td>0.056</td>
<td>0.130</td>
<td>0.330</td>
<td>0.380</td>
<td>0.850</td>
</tr>
</tbody>
</table>

* kg DM/100 kg LW
s.e.d. = Standard error of the difference
† = Estimated value
a, b, c, d, e Values in the same row with different superscripts differ P < 0.05.

Table 3. Constants from the equation of degradability trail in rumen of young bulls fed sugarcane tops (SCT) supplemented with different source of nitrogen (Taiwan grass, TG; Poultry litter, PL; Slow intake supplement, SIS).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>SCT (%)</th>
<th>20% TG</th>
<th>10% PL</th>
<th>0.8% Urea</th>
<th>1.5 kg SIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing loss (%)</td>
<td>17.4</td>
<td>17.4</td>
<td>17.4</td>
<td>17.4</td>
<td>17.4</td>
</tr>
<tr>
<td>b value</td>
<td>0.19</td>
<td>0.20</td>
<td>0.21</td>
<td>0.22</td>
<td>0.23</td>
</tr>
<tr>
<td>Pseudo degradability (%)</td>
<td>55.59</td>
<td>57.13</td>
<td>57.25</td>
<td>57.75</td>
<td>58.76</td>
</tr>
<tr>
<td>Degradability rate (g/kg DM)</td>
<td>0.0435</td>
<td>0.0459</td>
<td>0.0461</td>
<td>0.0503</td>
<td>0.0576</td>
</tr>
<tr>
<td>Log used (h)</td>
<td>5.1</td>
<td>5.2</td>
<td>5.3</td>
<td>5.4</td>
<td>5.5</td>
</tr>
<tr>
<td>Residual standard deviation</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>Pseudo pH</td>
<td>5.51</td>
<td>5.46</td>
<td>5.65</td>
<td>5.65</td>
<td>5.67</td>
</tr>
<tr>
<td>Pseudo oxide (mmol/L)</td>
<td>44.9</td>
<td>51.5</td>
<td>71.5</td>
<td>92.5</td>
<td>190.5</td>
</tr>
</tbody>
</table>

s.e.d. = Standard error of the difference
a, b, c Values in the same row with different superscripts differ at P < 0.05.
Figure 1. Sugarcane tops degradation in young bulls fed sugarcane tops (SCT) supplemented with different sources of nitrogen (Taiwan grass, TG; Poultry litter, PL; Slow intake supplement, SIS).

Means of ruminal pH values ranged from 6.48 to 6.71 and did not differ between treatments ($P>0.05$). Ruminal NH$_3$ concentration increased with the addition of supplements with significant differences between treatments ($P<0.05$). The highest NH$_3$ was in T5 (190.8 mg/l). Figure 2 shows the relationship between fractional degradation rate of SCT and NH$_3$ concentration in rumen. The highest fractional degradation rate and NH$_3$ concentration was in T5. The addition of nitrogen to SCT diets increased the total VFA concentration ($P<0.05$) from 79.0 mM/l in T1 to 101 mM/l in T5. The results did not show differences in VFA concentration among T2, T3 and T4 ($P>0.05$). The molar proportion of acetic acid decrease significantly with the supplementation without differences among supplemented treatments. Proportion of propionic acid increased from 21.4% (T1) up to 24.6% with SIS ($P<0.05$). The molar proportion of propionate did not differ between T2, T3 and T4. The ratio acetate: propionate decrease from 3.3 in T1 to 2.8 in T5. (Table 4).
Table 4. Concentration (mM/l) and molar proportions (%) of volatile fatty acids in rumen liquor from young bulls fed sugarcane tops (SCT) plus different source of nitrogen (Taiwan grass, TG; Poultry litter, PL; Slow intake supplement, SIS).

<table>
<thead>
<tr>
<th></th>
<th>SCT</th>
<th>20% TG</th>
<th>10% PL</th>
<th>0.8% Urea</th>
<th>1.5 kg SIS</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid (A)</td>
<td>355</td>
<td>378**</td>
<td>61.0*</td>
<td>59.7**</td>
<td>69.1*</td>
<td>0.25</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>169</td>
<td>184*</td>
<td>197*</td>
<td>192*</td>
<td>24.8*</td>
<td>0.13</td>
</tr>
<tr>
<td>Total</td>
<td>82.7*</td>
<td>87.1*</td>
<td>85.0*</td>
<td>101.0*</td>
<td>28.8*</td>
<td>0.27</td>
</tr>
<tr>
<td>Ratio of A/P</td>
<td>33*</td>
<td>31*</td>
<td>31*</td>
<td>31*</td>
<td>23*</td>
<td>0.12</td>
</tr>
</tbody>
</table>

Molar proportion (%)

<table>
<thead>
<tr>
<th></th>
<th>SCT</th>
<th>20% TG</th>
<th>10% PL</th>
<th>0.8% Urea</th>
<th>1.5 kg SIS</th>
<th>s.e.d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic acid</td>
<td>70.8*</td>
<td>69.9**</td>
<td>70.0**</td>
<td>70.2**</td>
<td>68.4*</td>
<td>0.18</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>21.4*</td>
<td>22.3*</td>
<td>22.4*</td>
<td>22.3*</td>
<td>24.4*</td>
<td>0.21</td>
</tr>
</tbody>
</table>

s.e.d. = Standard error of the difference

a, b, c, d Values in the same row with different superscripts differ at P < 0.05.

Figure 2. Relationship between fractional degradation rate of sugarcane tops (SCT) and rumen ammonia concentration in cattle fed SCT supplemented with different sources of nitrogen (Taiwan grass, TG; Poultry litter, PL; Slow intake supplement, SIS).
Discussion

The increase in SCT intake observed in response to the inclusion of supplements in Experiment one was due to combined results of an alleviation of rumen nitrogen and energy deficiency associated with effects on DMD as shown in Experiment two.

Non-conventional feeds, such as crops residues are often deficient in nitrogen and other primary nutrients. Hence, when such feeds are given as the sole source, potential benefits of feeding such non-conventional feeds may be masked. In such cases, it is necessary to analyze the nutritional characteristics of the forage in order to offer sufficient nutrients required for the rumen microorganisms and animal per se [Coleman and Moore, 2003].

The low TDMI in the young bulls fed SCT alone, observed in the present study could be due to the effect of rumen fill as was demonstrated by Brosh et al. [1993]. However, the lowest intake of SCT with TG supplementation could be due to a substitution effect by the TG; similar effect was reported by Ortiz-Rubio [2005] in SCT tops diets.

The consumption index in T3 was lower (1.89) than that reported by Nouel and Combellas [1999] who observed a consumption index of 2.17 in young bull grazing low quality forage plus a supplement with 79% of PL. The addition urea increase 29% the SCT intake, in comparison with un-supplemented animals. This value was higher than that (26%) reported by Siebert et al. [1976] in cattle fed sugarcane when a solution of urea plus sodium sulphate was sprayed on the forage. In the present study the increase of SCT intake was lower when the bulls were supplemented with SIS (18%) than with urea (29%). Therefore, the higher TDMI in the young bulls supplied with SIS was due to the quantity of SIS intake (1.29kg) per se rather than an increase in the forage intake.

Daily LWG of 0.850 kg/d, when SCT were supplemented with SIS, could be compared to previous information with sugarcane and SCT supplemented with nitrogen supplements where the LWG was near to 0.900 kg/d [Ferreiro and Preston 1976; Ortiz, et al. 2001]. The LWG with urea treatment in the present study (0.330 kg/d) was higher than those (0.125 kg/d) reported by Ho Quang Do et al. (1999) in Yellow cattle fed rice straw plus 0.8% of urea. The difference could be related to the energy content of the forage used. In our trials the energy in SCT was 2.15 Mcal/kg DM, in contrast, rice straw having an energy content of 1.20 Mcal/kg.

From the observations in Experiment two, the supplementation induced a rise in the ruminal NH3 concentration. Ruminal NH3 concentrations were consistent with an increase in the degradation rate of the forages observed in the present study. The addition of a source of nitrogen could lead to a more favorable rumen environment by providing NH3 continuously for efficient microbial growth, there by increasing the utilization of forage by the microorganisms [Rihani et al., 1993]. The lower ruminal NH3 concentrations observed with both un-supplemented steers and those supplemented with TG were due to the lower intake of supplementary nitrogen in comparison to the higher intake with
the PL, urea and SIS. Similar results in ruminal \( \text{NH}_3 \) concentration were reported by Mahouachi et al. [2003], who observed higher ruminal \( \text{NH}_3 \) concentrations in sheep supplemented with urea than those supplemented with PL.

Nouel and Combellas [1999] observed higher levels of \( \text{NH}_3 \), reaching 130 and 170 mg/l in the rumen of young bulls receiving a supplement with 79% of PL and low quality forages. The levels of \( \text{NH}_3 \) found in this study with PL were much lower (71.5 mg/l), and could be related to the lower PL offer. In our trials, the offer of PL was 10%. The concentrations of \( \text{NH}_3 \) observed in the present studies were higher than those reported by Galina et al. [2003] in steers fed SCT plus SIS (120 mg \( \text{NH}_3 \)/l). This difference should be ascribed partly at least to the fact that in the present study the SIS and SCT offered, had higher energy content than in the studies of Galina et al. [2003]. However, \( \text{NH}_3 \) concentration was lower than those reported by Krebs and Leng [1984]; Boniface et al. [1986] and Leng [1990] who reported 200 mg/l as the minimum ruminal \( \text{NH}_3 \) concentration for optimum degradation of low quality forage by cattle.

Total VFA concentration differed with the supplement provided in the present study. The increase in VFA concentrations was consistent with the increase of fractional degradation rate and intake of SCT. In the present study reduction of the ratio of acetic acid/propionic acid when SIS was added to the diet probably was due to its content of starch.

The different levels of nitrogen supplied to SCT in the present study did not have a large effect on pH values. The pH levels observed in the current studies were consistently within the range 6.2-7.0, mentioned by Leng [1990] for ruminants fed poor-quality forage. The pH levels were maintained in the range for optimal fiber degradability by the microorganisms in all treatments [Terry et al., 1969; Russell and Wilson, 1996].

The addition of supplements improved DMD, as a result of the greater availability of nitrogenous substrates in the rumen. The lowest fractional degradation rates were observed in the un-supplemented animals, and fractional degradation rates with the addition of TG, PL and urea were very similar in the present study. Mehrez et al. [1977] indicated that the majority of microbial communities in the rumen use \( \text{NH}_3 \) as a nitrogen source for growth. Therefore, increasing \( \text{NH}_3 \) availability to the microorganisms can enhance fiber digestion in the rumen when \( \text{NH}_3 \) concentration is the limiting factor [van Soest, 1994].

Sugarcane tops had a similar total DMD in steers supplemented with TG and PL. The results of Experiment two indicate that the availability of nitrogen in the rumen provided by TG was not sufficient to optimize the use of SCT by cattle in comparison with the other supplements. The fractional degradation rate of the forage in the rumen depends on the rate and extent of colonization of the fiber and the biomass of adherent microorganisms [Cheng et al., 1990]. The increase in the fractional degradation rate with
the addition of PL, urea or SIS was achieved by a higher availability of NH₃. However, the large differences of degradability of SCT in response of NH₃ concentration with PL, urea versus SIS show clearly a deficit of both nitrogen and energy content in SCT diet.

Conclusion

Sugarcane tops diets are deficient in both nitrogen and energy content. The use PL and urea increased the degradation of forage and LWG of young bulls fed SCT. Supplementation with both nitrogen and energy (SIS) had the highest response in degradation of SCT and LWG in bulls fed SCT. Supplementation with Taiwan grass exerted a substitution effect in SCT intake in the present study. The cost of supplementation in relation with the benefit should be evaluated in order to choose the best source of nitrogen in conformity with the needs of the farmer.

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Literature


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