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Effect of substitution of sorghum stover with sugarcane top silage on ruminal dry matter degradability of diets and growth performance of feedlot hair lambs

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ABSTRACT

The substitution of sorghum stover with sugarcane top silage [0 (T1), 5 (T2) and 10% (T3) DM] in high concentrate diets for feedlot hair lambs was evaluated in two experiments. In experiment one, ruminal dry matter degradability (RDMD) was evaluated in three ruminally cannulated 6-month-old Pelibuey sheep in a 3 × 3 Latin square design. The RDMD was determined by the nylon bag technique at incubation times of 4, 8, 12, 24, 48 and 72 h. There was no effect of diet ($P > 0.05$) for the rapidly degraded (a) or degradable fraction (b) of dry matter. The maximum degradability ($a + b$) was greater for T3 than T1 ($P < 0.05$); T2 was similar to T1 and T3 ($P > 0.05$). Effective degradability at 6% h^{-1} of ruminal turnover (k) was lower for T2 ($P < 0.05$) than for T1 and T3; ruminal turnover was higher ($P > 0.05$) for T1 than for T3. Growth performance of feedlot hair lambs was evaluated in a second experiment using the same diets as in experiment one. Twenty-seven 5-month-old intact crossbred male hair lambs (19.04 ± 1.56 kg) were assigned at random to 9 pens (3 lambs per pen). The feeding trial lasted for 63 days. Feed intake decreased ($P < 0.05$) with increasing level of sugarcane tops silage in diet. Nevertheless daily weight gain was not affected by diet. There was no treatment effect ($P > 0.05$) on feed efficiency (gain/feed intake). It is concluded that ensiled sugarcane tops is a practical alternative to substitute for sorghum stover in diets for growing finishing feedlot lambs. Partial replacement of sorghum stover with ensiled sugar tops does not negatively affect daily weight gain.

1. Introduction

Sugarcane is one of the most productive crops in the tropics, and can be used in intensive animal production systems (Landell et al., 2002). This forage can be offered as the entire plant without sugar extraction, or as forage using the tops after harvesting, which constitutes about 15% dry matter of the total plant (López et al., 2003). Despite the high availability of this forage during the sugarcane harvest, it is usually burned or wasted in the field. Sugarcane tops have greater protein content than stalks (López et al., 2003; Juárez et al., 2009), representing a more nutrient dense alternative forage for ruminants in subtropical areas. Although this forage is abundant during the sugarcane harvest, its preservation is complicated by climatic conditions of the tropics. Ensiling the tops is a logical alternative. In a previous study Alcántara et al. (1989), evaluating

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the feeding value of whole plant sugarcane, found that ensiling reduced dry matter digestibility and feed intake in lambs, probably because of excessive production of ethanol during the process (Bernardes et al., 2002).

With high forage diets, Ferreiro and Preston (1976) observed increased dry matter intake and body weight gain when fresh tops replaced stalks of sugarcane in feedlot cattle diets. In agreement, Galina et al. (2007) reported greater body weight gain by lambs fed fresh sugarcane tops supplemented with urea of slow ruminal degradation or chopped corn than by lambs fed sugarcane tops alone. Ruminal fermentation of fresh sugarcane tops is improved when supplemented with nitrogen and nonstructural carbohydrates (Gendley et al., 2009; Ortiz-Rubio et al., 2007).

Sugarcane tops have shown good conservation characteristics when ensiled with 45% of broiler litter (Mthiyane et al., 2001) or 5% ammonium sulfate plus 1% molasses (Deville et al., 1979). However, little is known about ruminal digestion and growth performance of sheep fed high concentrate diets with the sugarcane top silage. Therefore, the purpose of this study was to evaluate the feeding value of sugarcane tops silage, a plant residue available to sheep producers in the tropical zones of Mexico, and to test the hypothesis that this forage can replace sorghum stover in high concentrate diets for growing hair lambs. Sorghum stover is commonly used in feedlot lambs because of its availability throughout Mexico.

2. Materials and methods

2.1. Location

The present study was carried out in a subtropical area of northeastern Mexico (23°44′06″ N; 97°09′50″ W) during the summer of 2010. The area is located at an altitude of 340 m, the annual mean rainfall is 900 mm and the annual average temperature is 25 °C (INEGI, 2006).

2.2. Silage preparation and diets

The silage was made with sugarcane tops obtained from the field directly following harvest of the cane. Silage was prepared using eight 200-l drums lined with plastic bags (the wall has about 100 μm of thickness; Cici-Plastic, Cd. Victoria, Tamaulipas, Mexico). The forage was placed in the drum with the bag after being chopped with a hammer-mill to pass through a 1.5 cm screen. A urea solution (1:2 urea:water) was then sprayed on chopped forage at the rate of 0.5% urea (dry matter basis). Chopped forage was layered into drums, 3 layers per drum. Each layer was compacted by stamping the surface repeatedly for about 10 min per layer. Drums were then sealed by folding over the outer lip of the plastic drum liner, hand pressing to further compact the outer portion, binding the folded lip of the drum liner with adhesive tape, and then covering the sealed surface with about 15 cm of soil. Chopped forage was allowed to ensile for 30 days before being fed. Silage was analyzed according to the procedures of AOAC (1990) for DM (105 °C in a forced air oven for 24 h), organic matter (ash; weight retained upon ashing at 550 °C for 8 h; #942.05), N (#976.06) and ether extract (EE; Soxhlet procedure, #920.29). Also, silage was analyzed for neutral detergent fiber (aNDF; with a heat stable amylase and sodium sulfite in the ND) and acid detergent fiber (ADF; ANKOM 2000 fiber analyzer, ANKOM Technology Corporation, Macedon, NY, USA) according to procedures of Van Soest et al. (1991).

The dietary treatments are shown in Table 1. Treatments were: 0 (T1), 5 (T2) and 10% (T3) sugarcane tops silage (DM basis). Sugarcane tops silage replaced sorghum stover on a dry matter basis. Diets were formulated according to NRC (2007) for maximum growth rate of lambs; diets were calculated to contain 14% CP and 2.7 Mcal/kg ME (DM). Water was continuously available.

Table 1
Ingredient composition of experimental diets fed to lambs (DM basis).

Item	Sugarcane tops silage (%)		
	0	5	10
Ingredient composition (%)			
Sorghum, grain	59.2	59.2	59.2
Soybean meal	19.5	19.5	19.5
Molasses, sugarcane	4.0	4.0	4.0
Mineral premix[a]	0.8	0.8	0.8
Alfalfa, hay	2.0	2.0	2.0
Sorghum stover	10.0	5.0	0.0
Sugarcane tops silage[b]	0.0	5.0	10.0
Tallow[c]	4.0	4.0	4.0
Urea	0.3	0.3	0.3
Common salt	0.2	0.2	0.2
Nutrient composition			
DM (%)	89.7	83.2	77.55
ADF (%)	11.5	10.9	10.2
NDF (%)	20.9	20.6	20.2
CP (%)	14.3	14.3	14.3
Ether extract (%)	6.33	6.34	6.35
Estimated ME (Mcal/kg)	2.68	2.70	2.72

[a] Mineral premix of macro and microminerals for feedlot lambs (Ovitec 302 F ®Tenusa; Monterrey, NL, Mexico).
[b] Silage composition (% DM basis): ash, 6.8; CP, 4.2; EE, 2.0; CF, 32.4; NFE, 54.7; NDF, 67.4; NDF, 36.5. The metabolizable energy of silage was estimated according to NRC (1984).
[c] The metabolizable energy value of tallow was that reported in NRC (1984).

2.3. Experiment one

Three 6-month-old intact Pelibuey ram lambs (25 ± 1.8 kg body weight), fitted with permanent ruminal cannulas (40 mm in diameter) were used in a 3 × 3 Latin square design to evaluate DM degradability of highconcentrate diets containing three levels of sugarcane tops silage. Before the trial, lambs were treated for internal and external parasites (ivermectin; Iverfin®, Salud y Bienestar Animal, Ciudad de Mexico, Distrito Federal, Mexico), and were administered an intramuscular injection of vitamins A, D, and E (E-AD 300; AgriLabs, St. Joseph, MO; each ml contains: 100,000 I. U. vitamin A, 10,000 I.U. vitamin D_3, and 300 I.U. vitamin E as d-alpha-tocopherol, a natural source of vitamin E). Lambs were housed in individual well-ventilated draft-free pens and allowed ad libitum access to their respective dietary treatments. Fresh feed was provided at 09:00 and 16:00 h. The level of daily feeding was 110% of feed consumption on the previous day.

Each experimental period consisted of 10 days for adaptation prior to the incubation of bags in the rumen. Characteristics of in situ ruminal digestion were evaluated using 53-μm mesh nitrogen-free polyester bags (5 cm × 10 cm; ANKOM Technology, Macedon, NY, USA). Previously dried (55 °C, 72 h) samples of each dietary treatment were ground in a No. 4 Wiley mill equipped with a 2.0-mm retaining screen. Six grams of diets samples was added to each bag. Bags were then sealed and individually tied to a 20-cm nylon cord, which was attached at the end to metal weight to ensure that samples were immersed in the ruminal ventral sac. Bags were placed in the rumen with duplicates for each ruminal incubation time. Bags were incubated in the rumen for 4, 8, 12, 24,48 and 72 h. After each incubation time, bags were washed with tap water at low pressure until clear water came out of the bag. Washed bags were dried in an air-forced oven (60 °C for 48 h) to constant weight.

The in situ dry matter degradability for samples at each incubation time was calculated by the weight loss of samples in bags before and after ruminal incubation, in accordance with the Ørskov and McDonald (1979) model, modified by McDonald (1981):

$$P = a + b(1 - e^{-c(t-lag)})$$

where *P* is the ruminal disappearance of DM at time *t*. *a* is the rapidly soluble fraction or washing loss *b* is the degradable fraction *c* is the fractional degradation rate (h^{-1}). $a + b$ is the potential degradability (%; representing the quantity of feed that can be solubilized or degraded in the rumen if time is not a limiting factor). *t* is the time (h).