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Effects of two intake levels of *Leucaena leucocephala* on rumen function of sheep

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Introduction

Ruminant production systems based on grass pastures often produce only poor animal performance as expressed by growth or reproductive rates. The nutrient imbalance affecting rumen function is due to low energy and protein intake.

The incorporation of leguminous forages such as *Leucaena leucocephala*, in the diet of ruminants, can stimulate rumen function by providing protein-rich forage (Barros-Rodríguez et al. 2012). This increases the availability of compounds such as ammonia, amino acids and peptides as well as branched short-chain fatty acids, which are produced as a result of degradation of proteins. These substances promote fiber breakdown by acting as ruminal growth activators for rumen bacteria, especially cellulolytic bacteria (Hoover and Stokes 1991). This study aimed to evaluate the effects of 2 intake levels of *L. leucocephala* (leucaena) on rumen function of sheep fed *Pennisetum purpureum*.

Materials and Methods

The experiment was conducted over 60 days at the Faculty of Veterinary Medicine, University of Yucatán, Mérida, using 18 Pelibuey sheep, cannulated in the rumen and with an average weight of 33.3 ± 6.13 kg. A completely randomized design was usedwith 3 replicates of the following 3 treatments: T1− 100% grass, T2− 20% leucaena + 80% grass, T3− 40% leucaena + 60% grass.

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Dry matter (DM) degradation was determined using the technique described by Ørskov et al. (1980), incubating at 4, 8, 12, 24, 36, 48, 72, 48 and 96 hours. Rumen constants of DM were analyzed by Graph Pad Prism (GraphPad 2003) that fits the data of the exponential equation $Y = a + b\ (1 - e^{-ct})$ (Ørskov and McDonald 1979). Concentration of NH_3 and pH were determined on rumen liquid samples, collected 6 hours after feeding. The samples were filtered through cotton gauze and 10 mL of rumen liquor from each sample was stored in 0.5% HCl (1:1) for later analysis of NH_3. The pH was measured immediately after collection with a portable potentiometer (Hanna pHep family). Apparent digestibility of DM and voluntary intake were estimated directly in metabolic cages. Data were analyzed by ANOVA and means were compared by the Tukey test using SAS statistical software (SAS 2002).

Results and Discussion

Degradation rate of forage was higher on Treatments T2 and T3 than on the pure grass diet (Table 1).

Voluntary intake and apparent digestibility of DM of the diets containing legume were higher than those of the pure grass diet. Ammonia concentration in rumen liquor was also higher on the diets containing leucaena and rumen pH level declined as proportion of legume in the diet increased.

For all parameters evaluated, there were no differences between T2 and T3 ($P>0.05$). The lack of a major response in T3 can probably be attributed to a crude protein vs digestible energy imbalance caused by higher leucaena intake in T3 (data not shown), leading to low efficiency of synthesis of microbial protein in the rumen (Calsamiglia et al. 2010). These results are consistent with those reported by Barros-Rodríguez et al. (2012).

Table 1. In situ degradation of DM, apparent digestibility of DM, voluntary intake, ruminal pH and ammonia concentration.

	Treatments			Significance level
	T1	T2	T3	
DM degradation (%)				
Pennisetum purpureum				
t0	17.68	17.68	17.68	
a[1]	19.02±1.52[a2]	19.27±1.27[a]	17.88±1.36[a]	>0.05
b	47.49±1.47[a]	46.59±1.16[a]	47.58±1.24[a]	>0.05
c	0.038±0.003[b]	0.050±0.003[a]	0.052±0.003[a]	>0.05
a+b	66.51[a]	65.86[a]	65.46[a]	>0.05
r^2	0.95	0.97	0.97	
Leucaena leucocephala				
t0	34.27	34.27	34.27	
a	32.53±1.42[a]	31.99±1.54[a]	32.33±1.63[a]	>0.05
b	52.81±1.70[a]	49.17±1.41[a]	49.02±1.49[a]	>0.05
c	0.029±0.003[b]	0.061±0.004[a]	0.059±0.004[a]	>0.05
a+b	85.34[a]	81.16[a]	81.35[a]	>0.05
r^2	0.96	0.97	0.97	
Apparent DM digestibility (%)	52.52±2.17[b]	56.5±2.28[a]	57.6±2[a]	0.002
VI (g/kg $LW^{0.75}$)	67.58±0.053[b]	86.94±6.09[a]	83.72±2.31[a]	0.0001
pH	6.86±0.03[a]	6.62±0.02[b]	6.56±0.03[c]	0.0001
NH_3 (mg/L)	25.33±3.78[b]	36.06±6.31[a]	33.38 ±4.56[a]	0.005

[1]a: soluble fraction (in percentage); b: insoluble but potentially degradable fraction (in percentage); c: degradation rate (in percentage per hour); a+b: potential degradation; VI: voluntary intake; LW: live weight; t0: time zero.
[2]Means within rows with different superscripts differ significantly (P< 0.05).

Crude protein concentration of grass was apparently a limiting factor for ruminal digestion, restricting microbial function and limiting energy intake, as indicated by the low rumen ammonia levels on the pure grass diet. The additional protein provided by the leucaena would have increased availability of ammonia for rumen microflora, stimulating microbial growth and increasing rate of breakdown of the forage, which increased rate of passage of the diet and consequently voluntary intake. Kakengi et al. (2001) obtained similar trends with leucaena supplementation in the diet of cattle. The reduction in pH with increasing level of leucaena in the diet indicates increased production of volatile fatty acids from the increased intake and breakdown of the forage. These findings support the results reported by Osakwe and Steingass (2006) that, as leucaena proportion in the diet increases, rumen function improves.

Conclusions

Providing supplements of leucaena in the diet of sheep can improve rumen function by increasing the rate of degradation of forages and stimulating voluntary intake. This increases availability of nutrients for metabolic processes resulting in improved growth rates, wool growth and reproductive performance. Our results indicate that providing leucaena at more than 20% of the diet would not produce additional benefits. It would seem preferable to supplement twice as many sheep with this lower level. Further studies may be warranted to determine how effective lower levels of supplementation might be.

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