

Changes in the Apparent Digestibility of the *Lupinus rotundiflorus* Forage in the Pelibuey Sheep

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Abstract: The shrubs in the range systems contributes with forage which potentially could be use in ruminant feeding, however they must be evaluated in the animal that will consume it as a previous condition to the its normal usage as ingredient. Two trials were carried out to assess; the *in rumen* disappearance kinetics and *in vivo* apparent digestibility of *Lupinus rotundiflorus* (Lr) forage for its further employment in sheep feeding. The results showed that the Dry Matter (DM) consumption of a mixture of corn silage and Lr forage was increased as its amount was augmented. The intake of Organic Matter (OM) was of 358.05 g day⁻¹, presenting an upward behavior in relation to the level of Lr forage inclusion. The apparent digestibility of the OM in the sheep presented the same behavior, but in the case of the DM, it tended to diminish slightly as the Lr forage was added to the mixture. From the results it is concluded that the mixture of corn silage and forage of *Lupinus rotundiflorus* harvested at 180 days could be added up to 40% of the total mixture to feed sheep.

Key words: *Lupinus* forage, digestibility, pelibuey sheep

INTRODUCTION

The availability of corn harvesting by-product for the ruminant feeding in the agroforestry systems depends on the season and rainfall amount, which could be variable and the periodicity of production unpredictable resulting in the scarcity of feedstuffs, increasing its cost for the animal production^[1-3].

Whereas the quantity of forage is the most limiting nutritional factor, quality of forage (notably protein and digestibility values) is usually the factor limiting livestock production^[4]. The small and medium scale sheep production in the agroforestry systems look for alternative ingredients that provides protein to reduce the cost of feeding^[4-6]. The literature review highlighted that little information exists regarding the nutritive value of lupins produced in the whole American continent^[2,7-11] as an alternative protein source. Nevertheless, the research has been focused on the seed^[12] and there is a limited information on the nutritional value of narrow-leaf lupins as a high-protein forage source for ruminants^[8,10,13-15].

On the other hand, the sustainable production of animal protein tends to provide the producer with locally

grown leguminous plant^[2,4,16,17]. The forage of the genus *Lupinus* can be used as protein source as showed by different authors^[5-7,10,15], but their work was done with the domesticated white lupino. One alternative of this specie is the *Lupinus rotundiflorus* (Lr) which is actually assess for its seed potential value^[19]. Carrasco-García^[8] evaluated different stages of growth and mass yield of the Lr reported that the forage cut at 180 day produces the highest amount of dry matter and contained the best amount of protein and other nutrients. But, in the published literature on the nutritional value of the Lr forage for the sheep feeding has not been assessed.

MATERIALS AND METHODS

The Lr seed were scalded (60°C, 3 min) prior seeding in a 12×30 m plot to obtain forage. The lupin forages were harvested at 180 days of age by manually cutting the lupin stems 8-10 cm above ground level and sun dried on a cement floor. The particle size of the dried forage was reduced to 25 mm using a stationary mill for the *in vivo* trial. Samples of Lr dried material were further reduced to 1 mm in a Willey mill for the *in situ* assessment.

In situ study: Two Pelibuey lambs (average body weight 25 kg) were surgically operated to install hypoallergenic canulas in the dorsal sac of the rumen, such procedure was done by the licenced veterinary professional following the animal protection mexican act NOM-062-ZOO-1999^[20]. Animals had a 15 days resting period under daily veterinary evaluation and supervision. The canulated lambs received a progressive addition of Lr in the feed until the 25% (dry matter basis) was reached.

Samples of the one mm ground Lr material were introduced (50±10 mg mm⁻²) in dacron plastic bags (pore size 43 µm; Ankorm Industries, NY, USA) in triplicate for each withdrawal time. The sacs were heat sealed and then introduced in the rumen using a 20×10 cm laundry bag with a weight for each withdrawal time. The laundry bags were withdrawn at 0, 4, 8, 16, 32, 74 and 96 hours. After the elapsed period of time the undegraded incubation residue was thoroughly hand-washed with tap water to clean attached ruminal residues.

The dacron bags were dehydrated at 70°C for 72 h until the constant weight was obtained (Dry Matter; DM) and de proportional loss calculated. The Organic Matter (OM) was evaluated by burning a representative dried sample in a muffle furnace at 500°C for 4 h and the Neutral Detergent Fiber (NDF) content was obtained by the van Soest method^[21] and the crude protein (N×6.25) by the Kjeldahl procedure^[22]. The obtained data were used to determine the *in situ* disappearance kinetic (soluble, degradable, undegradable portion and rate) using the non linear procedure of SAS package^[23].

The *in vivo* apparent digestibility: For this study, nine (25 kg average body weight) Pelibuey lambs were sheltered in individual 1.2×1×1.2 m crates with plastic floor, provided with feeder and constant clean water supply. The crates were located in a building with curtain system to control the wind and the cleaning of the installation was performed every day at noon.

Three lambs were randomly assigned to each of the addition Lr forage levels (0, 20, 40%, dry matter basis) of a corn silage-based complete ration and a commercial vitamin-mineral mix. The trial consisted in a cross-over design with 15 days for adaptation and 6 days of measurement of intake and fecal production. Daily samples from individual animals were bulked across the measurement period and a sub-sample retained for analysis. With the obtained values of DM, MO and NDF the total tract apparent digestibility was calculated. The data were statistically evaluated as a random design establishing an alpha of 0.05 to declare difference among treatments and when they exist the Duncan method was used to separate the means^[23].

RESULTS AND DISCUSSION

In situ disappearance kinetics. For the dry matter the degradable portion (fd) of Lr forage aged of 180 days was 29.69%, the undegradable portion (fnod) was 35.95%, the soluble part (fs) in ruminal liquor was 34.35% and the rate of disappearance was 6.44 (% h⁻¹). On the other hand, the organic matter of the Lr had values for fd, fnod, fs and rate of disappearance of 30.25, 38.80, 30.95 and 9.95% h⁻¹, respectively. This rate could represent a potential for microbial protein yield according to the literature (20 g 1000 g⁻¹ of degraded OM) for each kilogram of Lr 10 g of microbial protein may be produced.

Furthermore, the values for crude protein were; 68.45, 22.56, 8.99 and 10.68% h⁻¹ for fd, fnod, fs and rate of *in situ* disappearance. The corresponding values for fd, fnod, fs rate of disappearance for NDF of the Lr were 28.93, 54.28, 16.8 and 9.8% h⁻¹, respectively. The present results shows the high utilization of the protein in the rumen to provide nitrogen for microbial growth which may contribute to fill the protein that the host animal requires every day. Even though the forage mass production at the 180 day of age at cut, most of the NDF could pass to hind gut and potentially stimulate the peristalsis.

Feed intake and *in vivo* digestibility. The daily consumption of dry matter of the Pelibuey lambs averaged 447.5 g, but was increased as the Lr forage augmented in the diet (p<0.05; Table 1). However, the apparent digestibility tended to be reduced as the Lr forage was increased in the diet (p>0.05) with an overall average of 58.36%. This could be a reflection of the slow disappearance rate previously observed for the Lr forage and probably to the highly soluble nitrogen fraction in the rumen of the lamb.

The OM consumption had a mean of 358.04 g per day, but showed slight increment in each of the Lr forage addition to the diet. Such an increase reached statistical significance (p<0.05). Nevertheless, the whole tract digestibility was similar among the addition levels of Lr forage (p>0.05) with an average of 54.33%. On the other

Table 1: Intake and digestibility of nutrients of *Lupinus rotundiflorus* (Lr) forage

Parameter	Level of Lr in diet (% of dry matter)			SE*
	0	20	40	
Dry matter				
Intake, g day ⁻¹	405.98	446.46	490.22	4.36
Digestibility, %	60.24	59.30	58.55	1.41
Organic matter				
Intake, g day ⁻¹	324.79	357.27	392.18	3.49
Digestibility, %	54.83	54.43	53.74	1.58
Neutral detergent fiber				
Intake, g day ⁻¹	215.17	236.62	259.82	2.31
Digestibility, %	53.31	54.06	53.07	1.69

*SE = standard error of the mean

hand, the NDF intake showed a general average of 237.20 g and was affected by the Lr level in the diet ($p < 0.05$). But the apparent digestibility was similar among the different levels of Lr in the feed of the Pelibuey lambs ($p > 0.05$; Table 1).

Based on the results of the present experiment we conclude that the Lr could represent an alternative source of nutrients for the sheep producer in the agroforestry systems.

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