Inclusion of Cactus Pear Cladodes in Diets for Finishing Lambs in Mexico♦

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ABSTRACT

The objective of this study was to evaluate the effect of forage cactus pear (nopal) cladodes in diets for growing-finishing lambs on dry-matter intake (DMI), total and daily live-weight gain (LWG and DLG), feed conversion (FC), and profitability (P). Fifty-four male lambs (Corriedale x Criollo) with an average live weight of 20.2 ±3.2 kg were used. Triads of lambs were formed with similar live weights and housed in a pen (experimental unit), which were randomly allotted to the following treatments: T0% no nopal (Control), lambs were fed with a regular growing-finishing diet; T15% Nopal, cactus pear cladodes at 15% (DM basis) of the ration; T30% nopal, cactus pear cladodes at 30% (DM basis) of the ration arranged as a completely randomized design with three treatments and six replicates. The diets were formulated in order to fulfill the nutritional requirements for growing-finishing lambs according to NRC (1985). The cladodes were chopped (approximately 2.5 cm^2 and mixed by hand with the diet in the feedbunker at each feeding. Lambs were fed twice a day, at 08:00 h and 16:00 h. The experiment lasted 71 days (adaptation: 14 days; experimental period: 56 days). Inclusion of cactus pear represented 55% and 75% of as-fed basis for T15% and T30%, respectively. Results showed that initial live weights were similar (P>0.01) among treatments, as well as the LWG between T0% (34.54 kg) and T15% (33.95 kg), but T30% (30.71 kg) was lower (P<0.01). DMI was consistently similar (P>0.01) between T0% (0.928 kg) and T15% (0.993 kg) and higher (P<0.01) than T30% (0.615 kg). Average feed conversion was similar (P>0.01) between T0% (5.14) and T15% (5.09), but higher (P<0.01) than T30% (3.44). Lambs fed with a high ratio of cactus pear (T30%) were more efficient in converting feed to LWG. The inclusion of cactus pear reduced feed cost approximately 48% and 65% for T15% and T30%, respectively, relative to T0%. Thus, LWG cost was reduced about 29.1% and 64.3% in T15% and T30%, respectively, relative to T0%. The inclusion of cactus pear between 15% and 30% may represent an important alternative to feeding growing-finishing lambs without affecting animal performance while reducing production costs.

Keywords: fodder, Opuntia, live-weight gain, feed intake, feed conversion, profitability.

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INTRODUCTION

Cactus pear is a natural plant component of the landscape of arid and semiarid regions of Mexico. Traditionally, nopal is used in Mexico as a vegetable (nopalitos), as fruit, and as colorant (cochineal). In addition, ranging animals consume cactus pear mainly during the dry season of the year and, in severe droughts, cactus pear cladodes are an important feed for the survival of cattle, sheep, goats, and other animals (Flores and Aguirre, 1992). Some farmers in Northern Mexico feed native cactus pear to lactating dairy cows during the whole year (Fuentes, 2004). When used as forage, usually the cactus pear plants are cut off and carried to the farms, where they are burnt and chopped or just chopped to eliminate thorns and reduce the risk of injuries (Lopez and Elizondo, 2004).

Experiments using wild cactus pear as a supplement for ranging cattle in Northern Mexico have been reported (Gutierrez and Bernal, 2004), but there is no information regarding cultivated forage cactus pear (spineless) to growing-finishing lambs in Central Mexico. Therefore, the objective of this study was to evaluate the effect of forage cactus pear in diets for growing-finishing lambs in relation to dry matter intake (DMI), total and daily live-weight gain (LWG and DLG), feed conversion (FC), and profitability (P).

MATERIALS AND METHODS

The experiment was installed in the Experimental Cactus Pear Field "Dr. Facundo Barrientos" of the University of Chapingo, Chapingo, Mexico (19° 29′ N, 96° 53′ W), which has a temperate climate, at an altitude of 2,450 m.a.s.l. (Garcia, 1981). Fifty-four male lambs (Corriedale x Criollo) with an average live weight of 20.2 ±3.2 kg) were used. Before the trial, lambs were weighed, marked, and treated with internal and external deparasitation (Ivermectina), vitamination (B_{12} + ADE), vaccination (7 vias *Clostridium*, Ultrabac 7), and antibiotic injection (Tetracyclin). Triads of lambs (experimental unit) of similar live weight were randomly distributed into three groups (A, B, or C). Each group (feeding treatment) consisted of six subgroups (replications). Groups A, B, and C had an initial average live weight of 20.2 ±3.3, 20.2 ±3.2, and 20.2 ±3.3), respectively (Figure 1). Each replication was housed in a wooden 2 x 2 m^2 pen with soil floor, feed bunker, and water bunker (18 L). The lambs were submitted to the following feeding treatments: T0% Nopal (control), lambs were fed with a regular growing-finishing diet for this region. T15% Nopal, cactus pear was included at 15% (DM basis) of the ration. T30% Nopal, cactus pear was included at 30% (DM basis) of the ration. These diets were formulated to fulfill the nutritional requirements for growing-finishing lambs (NRC, 1985) (Table 1). The experiment lasted 71 days (14 days as an adaptation period followed by 56 days of an experimental feeding period).

Diets were supplied twice a day, in the morning (08:00 h) and in the afternoon (16:00 h). Nonconsumed feed was collected and weighed before the morning feeding during the experiment. Lambs were received with oats straw for three days and then adapted in a stepwise fashion (14 days) to their respective ration. The cladodes of cactus pear (forage type) were only chopped (approximately 2.5 cm^2) and mixed with the diet in the feed bunker by hand at each feeding. Dry-matter intake (DMI) was analyzed in four intake periods: DMI1 (d15-d21), DMI2 (d22-d28), DMI3 (d29-d42), and DMI4 (d43-d56). Similarly, feed conversion (FC) was calculated according to the DMI periods. Data were analyzed using the GLM procedure of SAS (SAS, 1989) as a completely randomized design with three treatments and six replicates.

RESULTS AND DISCUSSION

LWG changes are presented in Figure 1. The initial and second live weights (LW1 and LW2) were similar ($P>0.01$) among treatments. However, from d22 to d71, T0% and T15% showed a similar ($P<0.01$) and higher ($P<0.01$) LWG than T30%. As a consequence, the final LWG (d71) was higher ($P<0.01$) for T0% (34.54 kg) and T15% (33.95 kg) than T30% (30.71 kg). This trend was followed by the DLG throughout the experiment, except for d15 to d22, where the DLG was different ($P<0.01$) among all treatments (0.333, 0.210, and 0.036 kg for T0%, T15%, and T30%, respectively) (Table 2).

DMI from d15 to d56 is presented in Table 2 as four intake periods: DMI1 (d15-d21), DMI2 (d22-d28), DMI3 (d29-d42) and DMI4 (d43-d56). T0% and T15% consistently showed a higher ($P<0.01$) DMI than T30%, maybe due to higher succulence (DM=31.68%) of the ration, and limited by the rumen capacity (diet 3 + cactus pear). A higher water proportion produced less consistent faeces, a phenomenon already observed by Lopez and Elizondo (2004). The lambs for T30% decreased water intake in comparison to control lambs, which is important considering that drinking water is a limited resource in arid and semiarid regions and has a significant impact in animal production systems (Gutierrez y Bernal 2004).

Feed conversion (FC) was calculated and analyzed according to the DMI periods, that is, FC1 (d15-d22), FC2 (d22 –d28), FC3 (d29-d42), and FC4 (d43-d56). At the beginning of the experiment (FC1) there was a large variation among treatments, which resulted in nonsignificant ($P>0.01$) differences among them. However, T0% and T15% presented similar and higher ($P<0.01$) FC values than T30% during the rest of the experiment. Inclusion of 30% (DM basis) of cactus pear reduced FC; therefore less amount of feed was needed to convert one unit of lambs' LWG (Table 2).

The costs per kg as-fed basis for T0%, T15%, and T30% were US$1.98 (US$1.00=$11.20 Mexican pesos), US$1.03, and US$0.70 (considering cactus pear cost to be US$0.10 kg^{-1}), respectively. Inclusion of cactus pear at 15% or 30% reduced feed cost approximately 48% and 65%, respectively, compared to the control. If we consider the average FC values from d22 to d56, FC for T0%, T15%, and T30% were 5.14, 5.09, and 3.44, respectively. Converting these values to an as-fed basis, we have FC values for T0%, T15%, and T30% of 5.73, 7.81, and 5.79, respectively. Multiplying these by the feed cost, the live-weight cost per kg was US$11.34, US$8.04, and US$4.05 for T0%, T15%, and T30%, respectively. Therefore, inclusion of cactus pear in diets for growing-finishing lambs reduced live-weight cost approximately 29.1% and 64.3% for T15% and T30%, respectively.

CONCLUSIONS

Inclusion of 15% to 30% (DM basis) of cladodes of spineless cactus pear in diets of growing-finishing lambs represented 55% or 75% of the diets on an as-fed basis.

Inclusion of 15% of cactus pear did not affect animal performance as measured by total and daily live-weight gain, DM intake, or feed conversion. When increased to 30%, there were some differences in animal performance, reducing DM intake and total live-weight gain, but enhanced feed conversion, which resulted in a more efficient feeding strategy.

The inclusion of 15% or 30% of cactus pear (dry-matter basis) reduced feed cost approximately 48% and 65%. The cost of live-weight gain was lowered to 29.1% and 64.3%, for T15% and T30%, respectively.

Supplementing cactus cladodes in the diet reduces the cost of feed, representing an additional income for cactus pear growers and improving this production system in Central Mexico.

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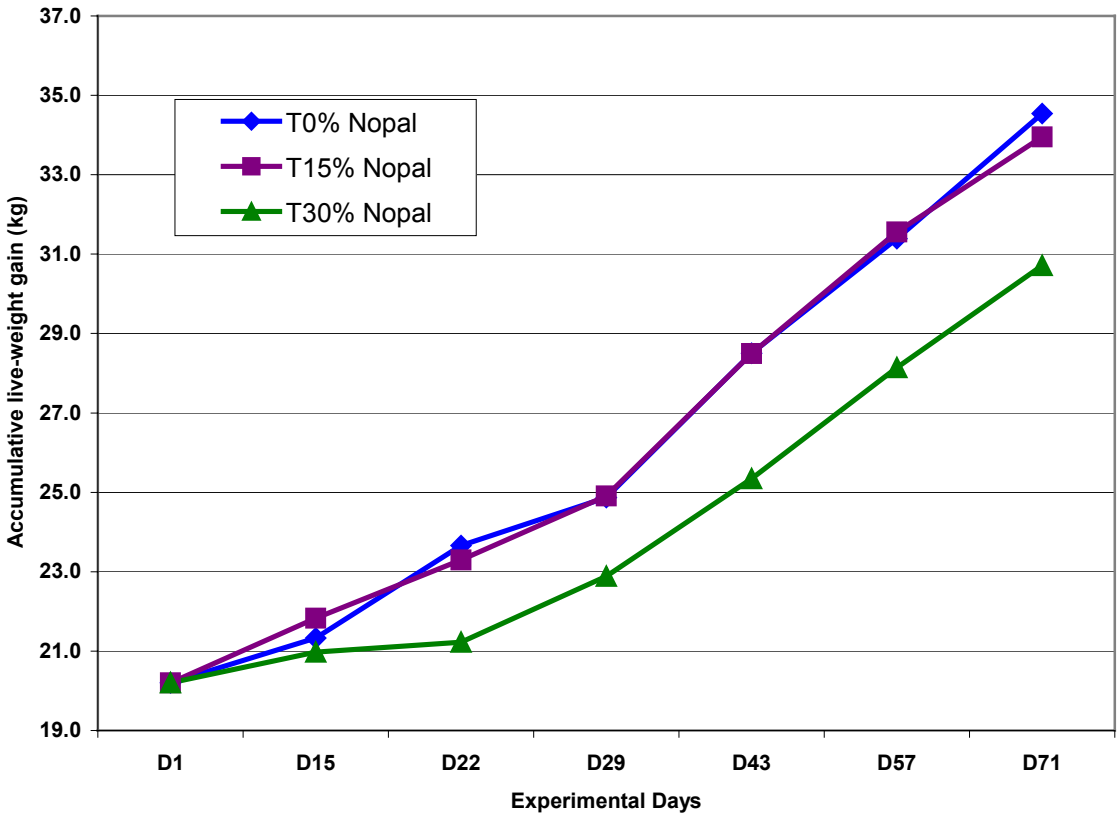

Figure 1. Effect of the inclusion of cladodes of spineless cactus pear on live-weight gain of growing-finishing lambs.

Table 1. Bromatological composition of the diets[1] for growing-finishing lambs on a dry-matter basis.

Ingredient	0% Nopal	15% Nopal	30% Nopal
Cactus pear (nopal)	0.0	15.01	30.02
Oat straw	29.84	15.20	0.0
Corn grain	21.88	22.05	21.98
Sorghum grain	21.88	22.05	21.98
Soybean meal	11.70	11.58	11.50
Corn gluten 60% cp	5.09	4.92	4.97
Molasses	5.09	5.95	5.94
Tallow	2.26	2.14	2.52
Calcium carbonate	1.13	0.00	0.0
Premix[2]	1.13	1.07	1.07
Total	100.0	100.0	100.0
Cost (US$ kg^{-1} DM)	2.24	2.21	2.20
Calculated composition			
Dry matter	88.46	46.61	31.68
Metabolizable energy (Mcal/kg)	2.697	2.689	2.677
NEM (Mcal/kg)	1.781	1.648	1.519
NEG (Mcal/kg)	1.152	1.035	0.921
Crude protein	14.50	14.51	14.53
Crude fiber	12.14	9.80	7.27
Ca	1.02	1.01	1.45
P	0.32	0.32	0.32

[1] The diets were formulated to fulfill the requirements for a growing-finishing lamb from 20 to 40 kg of live weight according NRC (1985).
[2] Commercial premix containing minerals, vitamins, and ionofore.

Table 2. Effect of the inclusion of cactus pear (0, 15, or 30%, dry matter basis) in diets for growing-finishing lambs on animal performance profitability.

	T0%	T15%	T30%	SE[1]
Daily live-weight gain (kg)				
DLG1 (d1-d14)	0.081	0.116	0.055	0.025
DLG2 (d15-d21)	0.333[a]	0.210[b]	0.036[c]	0.025
DLG3 (d22-d28)	0.172	0.230	0.238	0.027
DLG4 (d29-d42)	0.260[a]	0.256[a]	0.176[b]	0.026
DLG5 (d43-d56)	0.206	0.219	0.200	0.016
DLG6 (d57-d71)	0.225[a]	0.171[b]	0.184[ab]	0.017
Dry-matter intake (DMI, kg)[2]				
DMI1 (d15-d21)	0.714[a]	0.731[a]	0.453[b]	0.048
DMI2 (d22-d28)	0.955[a]	0.965[a]	0.601[b]	0.048
DMI3 (d29-d42)	1.069[a]	1.136[a]	0.688[b]	0.062
DMI4 (d43-d56)	0.973[a]	1.141[a]	0.717[b]	0.057
Feed conversion (FC)[2]				
FC1 (d15-d21)	2.182	3.689	11.153	3.349
FC2 (d22-d28)	6.398[a]	5.321[a]	2.532[b]	1.152
FC3 (d29-d42)	4.214	4.756	4.078	0.439
FC4 (d43-d56)	4.799[a]	5.200[a]	3.721[b]	0.273
Profitability[3]				
Feed cost (US$ ton^{-1})	1,982.75	1,030.60	698.78	
Cost of LWG (US$ kg^{-1})	9.73	7.50	6.32	

[1] Standard error of means on the same row.
[2] Day 1 to 14 corresponded to the adaptation period. Data from d58 to d71 not presented.
[3] US$1.00=$11.20 Mexican pesos.
[abc] Means within the same row with different superscripts were significantly different (P<0.05).