INCLUSION OF *PROSOPIS JULIFLORA* PODS PRESERVED IN SUGAR CANE MOLASSES AND *LEUCAENA* LEAVES IN RABBITS DIETS

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ABSTRACT

The aim of this work was to study the inclusion of a mixture of *Prosopis juliflora* pods preserved in sugar cane molasses (PPM) and *Leucaena leucocephala* leaves flour (LFF) combined with a commercial rabbit feed (CRF) (representing 73.88 and 25% of the diet, respectively) on the feeding of rabbits during 63 days, from the weaning (48 d) to the slaughter (111 d). A total of 30 rabbits were assigned at random to five experimental treatments (three replicates per diet with two animals per replicate): T_1: 52.5% PPM, 21.4% LFF and 25% CRF; T_2: 43.1% PPM, 30.7% LFF and 25% CRF; T_3: 33.7% PPM, 40.1% LFF and 25% CRF; T_4: 24.4% PPM, 49.5% LFF and 25% CRF; T_5: 100% CRF. The variables measured during the study were feed intake (dry matter, organic matter, ash, crude protein, ADF and NDF), initial and final body weight, live weight gain, carcass weight, feed conversion, and feed cost per kg of live weight gain. Significant differences were found on all analysed variables ($P<0.005$). The best treatments ($P=0.015$) on cost of rations (opportunity cost of foods) were T_5 and T_1 (2.0 and 2.44 USD/kg of live weight gain) and the worst was T_4 (4.69 USD/kg of live weight gain), with intermediate values obtained for T_2 and T_3 (2.92 and 2.49 USD/kg of live weight gain, respectively).

Key Words: Concentrate substitution, Leucaena, *Prosopis juliflora* pods, Rabbits

INTRODUCTION

It is widely known that the main cost of the rabbit production corresponds to the feeding and every day there are fewer grain crop surpluses of cereals and legumes available to produce feed for livestock (Lebas *et al.*, 1997). So, it is crucial to find alternatives to depend, as little as possible, on these sources and thus, make sustainable rabbit meat production. The pods of *Prosopis sp*. can be a source of energy and protein, as has already been observed with the *Prosopis chiliensis*, which has been safely included in rations for rabbits up to 29% of inclusion (Lebas *et al.*, 1997). The objective of this study was to evaluate the growth of rabbits from weaning to slaughter, using diets which includes Cují pod (*Prosopis juliflora*) leaves preserved in molasses and Leucaena (*Leucaena leucacephala*) and its effect on feed intake and productive traits.

MATERIALS AND METHODS

Animals and experimental design

The study was conducted as a completely randomized design, consisting in five diets (Table 1) and three replicates per treatment with two crossbred weaned rabbits/replicate (45-50 days old), with an average weight of 1187.6 ± 29.9 g. Growth traits were recorded during 63 days. The animals were housed in cages of 16-gauge galvanized steel, with dimensions of 48 x 35 cm long x 56 cm deep, forming three batteries of six cages each. Two rabbits were placed per cage, which remained equipped with hopper type feeders of galvanized steel, with a capacity of 1.5 kg of feed and with dropper type drinker. The different diets were offered daily at 08:00 h, after removing the rejects.

Cují harvest (*Prosopis juliflora*) was performed at the Experimental Station San Francisco semiarid, the Dean of Agriculture at UCLA. Pods were collected from wild plants, using fruits that reached the maturity field located in the ground and trying to take the same material and as little as possible undesirable (sticks, stone, earth clods). The pods are dried in the sun for 48-72 hours, then they were ground with a sieve of 12 mm. Then, a mixture of 50% molasses and 50% ground pods (on DM basis) was done and transferred to plastic containers (70 litres capacity), and the mixture was compressed with a metal ram 25 cm of diameter and weighing about 6 kg, to remove air in the internal spaces (to facilitate silage), hermetically sealed with a plastic cap to prevent air entry. They were maintained closed at least for 14 days for further use, because it is only available from March to April and from September to October. Preserved pods in sugar cane molasses (PPM) showed the following composition: DM (dry matter 60 °C): 78.5%, pH: 3.96, ash: 7.24%, ADF (acid detergent fibre): 41.1%, NDF (neutral detergent fibre): 56.9%, OM (organic matter): 72.9% and CP (crude protein): 11.1%.

Table 1: Ingredients and chemical composition of treatments

	T_1	T_2	T_3	T_4	T_5
Ingredients, %					
Prosopis juliflora	52.5	43.3	33.7	24.4	0
Leucaena leaf flour	21.4	30.7	40.1	49.5	0
Commercial Rabbit Feed[1]	25.0	25.0	25.0	25.0	100
Mineral and vitamin premix[2]	1.12	1.12	1.12	1.12	1.12
Chemical Composition, %					
Dry Matter	93.9	94.3	94.5	95.3	89.4
Organic Matter	85.8	86.0	86.2	86.7	80.8
Ash	8.07	8.34	8.30	8.58	8.57
Crude Protein	14.0	14.2	14.7	16.1	14.6
Neutral Detergent Fibre	40.3	45.6	42.4	47.2	77.8
Acid Detergent Fibre	18.7	19.5	19.0	21.3	19.7
Cost USD/kg DM	0.173	0.171	0.169	0.166	0.3(

[1]Ingredients CRF (%): corn, corn bran, soy cake, mineral, vitamins, vegetal oil, sorghum, rice, rice bran, alfalfa hay, cotton cake. [2]Premix provided per kg: Thiamine, 1000 mg; Riboflavin, 300 mg; Pyridoxine, 200 mg; Cyanocobalamin, 700 µg; Niacinamide, 4000 mg; Folic acid, 3.5 mg; Choline, 3000 mg; Fe, 10 mg; Mg, 500.

Leucaena (*Leucaena leucocephala)* were collected in the forage field of Agronomy Dean of UCLA, Tarabana, Lara. Then they were brought to a place where the roof was cool, and they were gradually shedding the leaves by themselves. Definitive drying material was performed in an oven at 60 °C for 24 h and then prepared the flour using a hammer mill with sieve 2 mm in diameter and packed in polyethylene bags sealed well and placed in a cool place protected from water and the sun to maintain its quality.
The feed was performed in a traditional way by using a manually corona mill, which allowed to obtain a food disintegrated shapeless form (flat corrugated varies) depending on the proportions of raw feed used.
A premix was firstly done with around 50% water, fodder, minerals and vitamins forming a paste. This was ground, mixed, dried (60ºC for 24 h) and stored in polyethylene bags.

The steps for the preparation of each treatment were: i) grinding the Cují pods preserved in cane molasses; ii) weigh each of the ingredients of the treatment (to make 10 kg); iii) weigh 4.5 kg of water for every 10 kg of dry matter; iv) vitamins and minerals are diluted or mixed in the water; v) to the dilution add the premix of pods and the rest of the ingredients, mixing them uniformly; vi) the resulting paste is stopped by a compression mill and the resulting granules were dehydrated in a forced air oven at 60 C for 24 h; vii) the dehydrated food was stored in polyethylene bags for later use.

Weight gain (WG) and feed conversion ratio (FCR) were evaluated by weighting weekly the animals on an electronic balance (capacity 6 kg ± 1g), during the weeks 1, 5 and 9. The feed intake was determined by the difference between the feed offered and rejected (rejection in the feeder was daily weighed) during the same periods. Samples of feed offered and refused were collected weekly and stored in sealed plastic bags, being refrigerated to make the corresponding chemical analysis. Animals were slaughtered at 111 days of age. They were sacrificed for stunning and bleeding in the jugular, proceeding to the removal of the head, legs, tail, skin and complete evisceration, cleaning and weighing. Carcass weight and final live weight were recorded to calculate carcass yield (CY). The opportunity costs of the raw materials used in the feeding of rabbits allowed determine the cost of each ration intake depending on them. The unit prices of raw materials were bagged pods Cují: 6.5 kg to 0.625 USD/bag; molasses: 0.059 USD/kg; Leucaena leaf processed: 0,052 USD/kg (estimated collection and processing 175-180 kg DM/wages, sun dried processing) soluble and water soluble vitamins: 0.781 USD/litre of product; minerals: 0.2 USD/kg, and commercial rabbit feed (CRF): 0.306 USD/kg. The daily wage rate was estimated in 0.914 USD by 8 hours.

Chemical Analyses

Procedures of AOAC (1984) were used to determine DM (60 °C and 110 °C) and ash. Crude protein was analysed according to Bilbao *et al.* (1999), and ADF and NDF to Van Soest *et al.* (1991).

Statistical Analysis

An analysis of variance for each variable including the treatment as sole source of variation was performed, and when significant means were compared by using the Tukey test. Statistical processing of the data was done with the program Statistix 7.0 (2000).

RESULTS AND DISCUSSION

Although the number or replicates was low, dry matter intake was suitable in all cases (Table 2) because in rabbits of this age (4-11 weeks) DM intake expected is around 110-130 g/d (Lebas *et al.*, 1997). All treatments evaluated showed a high fibre content (>40% NDF; Table 1) which proved to be much higher than the optimal 33-35 % dietary NDF for rabbits (De Blas and Mateos, 2010), and resulted in a high NDF intake (> 46 g/animal/d; Table 2), although the range of ADF was within normal expected for such animals reported by the same authors (18-20l% ADF).

Table 2: Feed intake of treatments (4-11 weeks)

Feed Intake, g/d	Diets					SEM[1]	P-value
	T_1	T_2	T_3	T_4	T_5		
Dry Matter, 60ºC	135^{a}	126^{ab}	108^{c}	114^{bc}	114^{bc}	7.09	0.0001
Ash	10.9^{a}	10.5^{ab}	9.00^{b}	9.80^{ab}	9.80^{ab}	0.92	0.0158
Organic Matter	124^{a}	115^{ab}	99.4^{c}	104^{bc}	104^{bc}	6.55	0.0001
Crude Protein	19.8^{a}	17.9^{ab}	17.4^{b}	15.9^{b}	16.6^{b}	1.20	0.0001
Neutral Detergent Fibre	54.3^{bc}	57.3^{b}	46.1^{c}	53.8^{bc}	88.6^{a}	5.43	0.0001
Acid Detergent Fibre	25.3^{a}	24.6^{a}	20.6^{d}	24.3^{a}	22.5^{ab}	2.16	0.0059

[1]SEM: standard error of means (n=3) [a,b,c] - means with different superscripts are significantly different (P<0.05)

The lowest carcass yield (CY) were observed in T_2, T_3 and T_4 (P = 0.003; Table 3), which were lower than expected in rabbits for meat (around 60%). Even CY of animals fed the commercial feed was also lower than expected, probably because this diet, with high fiber content, promotes an increase in the size of the cecum and colon of animal. The feed conversion of T_4 was 2.5 times higher than those achieved in T_5 and almost 1.33 times than T_1, which is very influenced by the high level of Leucaena meal present in this treatment that was almost the double of that recommended for rabbit's diets (Norton *et al.*, 1999). This food has high levels of mimosine that might negatively affect the use of the protein. Another factor that could negatively impact the utilization of nutrients is the processing applied during the food preparation, because as proposed Nouel *et al.* (2006), the process used to prepare the feed for rabbits may facilitate the formation of indigestible compounds, which could retain the indigestible nitrogen (Acid detergent insoluble nitrogen, ADIN). The process used in this experiment agrees with of those tested by these authors and showed the worst performance of the digestion of nutrients and high ADIN formation.

Table 3. Productive traits and economic variables

	Diets					SEM[1]	P-value
	T1	T2	T3	T4	T5		
Initial weight, g	1185	1186	1187	1192	1188	73.2	0.9999
Final weight, g	1813[b]	1684[bc]	1676[bc]	1552[c]	2365[a]	127	0.0001
DWG, g	9.80[b]	8.00[bc]	7.80[bc]	5.30[c]	17.8[a]	1.94	0.0001
CW, g	1012[b]	920[c]	905[c]	945[bc]	1404[a]	69.4	0.0001
CY, %	55.8[ab]	54.7[b]	53.4[b]	50.3[b]	59.1[a]	2.30	0.0029
FCR, g feed/g WG	12.8[b]	16.4[b]	15.9[c]	17.1[a]	6.80[b]	17.2	0.0575
Cost Feed[1] USD/kg WG	2.44[b]	2.92[ab]	2.49[ab]	4.69[a]	2.00[b]	1.34	0.0155

[1]SEM: standard error of means (n=3). DWG: daily weight gain; CW: Carcass weight, CY: Carcass yield, FCR: Feed conversion, [2]Opportunity cost of raw materials for diets. [a,b,c] - means with different superscripts are significantly different (P<0.05).

Parra (2003) using 49% levels Leucaena flour mixed with rice polishing (25 to 37.5%) and molasses (12.5 to 25%), achieved feed conversion slightly better than those found in this experiment (10.46 to 11.46), which are high compared to the commercial diet used in this work, and indicate that the high content of molasses could contribute to reduce the negative effect of the mimosine (Gupta *et al.,* 1991, Norton *et al.*, 1999). The best treatments (P = 0.015) on cost of rations (opportunity cost of foods) were T_5 and T_1 (2.0 and 2.44 USD/kg of live weight gain) and the worst was T_4 (4.69 USD/kg of live weight gain), with intermediate values obtained for T_2 and T_3 (2.92 and 2.49 USD/kg of live weight gain, respectively). So, the costs obtained by incorporating the highest level of pods can be economically sustainable, especially considering that the producer is the one who prepares the feed and get an income from such work, which is not purchased directly as CRF, which was obtained in the trade.

CONCLUSIONS

The incorporation of 52.5% of *Prosopis juliflora* pods preserved in sugar cane molasses (50:50%), 21.4% of Leucaena leaf meal and 25% of commercial rabbit diet may be an alternative for feeding rabbits and can reduce the dependence on diets from the feed industry. However, it should be improved the technique of preparing such food to increase the energy and protein availability to reach greater performance.

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