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Article

Inclusion of guanacaste (*Enterolobium cyclocarpum*) pods in the diet of lambs on productive, carcass, and meat traits

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Abstract:

This study aimed to evaluate the effect of the partial substitution of soybean meal with guanacaste (*Enterolobium cyclocarpum*) pods on the productive performance and carcass and meat traits of finishing lambs. The evaluation was carried out with 16 lambs (East Friesian x Blackbelly) randomly distributed to two experimental diets with 0 and 19 % guanacaste pods, which were previously vaccinated, dewormed, and adapted for 15 d to the individual cages. The feeding trial lasted 60 d, during which time live weight and feed intake were recorded. At the end of the trial, the lambs were slaughtered, and hot and cold carcass weight, yield, and classification were evaluated. In the meat (*Longissimus dorsi*), acidity, texture, and color were determined. Lamb weight, feed intake, and carcass and meat traits were similar in lambs fed with and without guanacaste. It is concluded that adding 19 % of guanacaste pods to the diet for finishing lambs does not affect the productive performance or modify traits of meat and carcass quality, so it can be considered a viable alternative for feeding sheep in dry seasons.

Keywords: Food intake, Carcass conformation, Meat texture.

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Introduction

Feed for sheep in tropical regions with a warm climate, such as the state of Veracruz, is based on the grazing of established or introduced grasses, which will produce an amount of biomass and nutrients depending on rainfall(1). During the dry season, sheep farmers have food with lower amounts of nutrients, especially protein and energy, since the forage biomass decreases and the concentration of cell wall increases, which reduces digestibility and reduces weight gain and reproductive activity of the animals(2). Offering concentrated feed during this time increases the feeding cost due to the increase in the price of conventional ingredients and concentrated feed, decreasing profitability(3,4). That is why the sheep farmer must have alternatives of ingredients, mainly energy and protein ingredients, that are highly available in the region and affordable during this period(5). One option is the use of unconventional ingredients such as byproducts, fruits, and pods, which can have an acceptable nutritional value and allow animals to maintain their weight. The fruits (pod) of the tropical legume *Enterolobium cyclocarpum* (guanacaste) can be an alternative for feeding sheep; the whole pod contains up to 26.3 % crude protein (CP) and 2.5 megacalories of metabolizable energy (Mcal ME)(6); the concentration of essential and non-essential amino acids is similar or is even higher in some amino acids, such as methionine or aspartic acid, than those contained in soybean meal(7); it also contains triterpene saponins(6), which have a defauning effect on the rumen, which could imply a benefit in feed efficiency(8). In previous studies, the range of inclusion of pods in sheep diets is very wide, from 10 % to 50 % in substitution of energy ingredients, such as corn or sorghum; however, inclusions greater than 40 % have shown negative effects such as reduced intake and digestibility(6,7). This study aimed to assess the effect of the substitution of 19 % of soybean meal with guanacaste pods on productive parameters and traits and classification of the carcass, color, and texture of the meat of finishing lambs.

Material and methods

The study was carried out at the Torreón del Molino Ranch, Faculty of Veterinary Medicine and Zootechnics of the Veracruzana University, located in Tejería, municipality of Veracruz de Ignacio de la Llave, state of Veracruz (19°10´11" N, 96°12´46" W at 20 masl). The climate is “Aw” tropical humid and dry savannah, with average annual rainfall of 1,200 mm, rainfall in summer and winter, average temperature of 27 °C, and andosol soil(9). Ripe guanacaste pods were collected in April 2023, dried at room temperature, ground (Antarix THCF2000S2, 10 mm sieve), and stored for later use.

Productive trial

The protocol was reviewed and endorsed by the bioethics committee of the Faculty of Veterinary Medicine and Zootechnics of the Veracruzana University. Sixteen (16) East Friesian x Blackbelly lambs (23 ± 0.8 kg live weight) were used, which were vaccinated (clostrigen 2 ml), dewormed (10 % closantel 1 ml per 20 kg body weight), and vitaminized (selenium and vitamin E) 15 d before the cage adaptation period. They were randomly distributed to two diets with 0 and 19 % (dry basis) of guanacaste pods (Table 1), which were formulated to meet the nutritional requirements for finishing sheep 4 to 7 mo old with 30 kg of live weight(10). Lambs were housed in individual metabolic cages (1.2 m x 0.8 m) equipped with individual feeders and drinkers. The animals had 14 d of adaptation to the cages, handling, and experimental diets, which were offered free access at 0800 and 1600 h. The experimentation period lasted 60 d. The contents of dry matter, crude protein, ethereal extract, ash(11), neutral detergent fiber, and acid detergent fiber (12) were determined in the diets.

Table 1: Ingredients and chemical composition of experimental diets

	Guanacaste pod, % dry basis	
Ingredient, % dry basis	**0**	**19**
Ground corn	30.0	30.5
Soybean meal, 45 % CP	21.0	10.4
Enterolobium cyclocarpum		19.0
Molasses	1.3	1.3
Plant oil	1.3	1.3
Sea salt	0.6	0.6
Ammonium sulfate	0.0	0.6
Vitamin and mineral premix	0.6	0.6
Mycotoxin sequestrant	0.2	0.2
Pangola grass (*Digitaria decumbens)*	45.0	35.0
Chemical composition, dry basis		
Dry matter, %	26.5	26.1
Crude protein, %	15.7	15.6
Metabolizable energy, Mcal/kg	2.3	2.3
Ethereal extract, %	3.7	3.5
Ashes, %	7.6	8.7
Neutral detergent fiber, %	33.1	30.5
Acid detergent fiber, %	22.0	19.5

Body weights were recorded at the beginning of the experiment, then every 7 d before the first feeding, and at the end of the experimental period using a hanging scale (WeiHeng C 500). Feed intake was measured daily by weighing the feed offered and the feed rejected. Food samples were collected, and the amount of dry matter was determined (Velab VE-50-1 moisture analyzer). Daily weight gain was calculated using changes in live weight, whereas total weight gain was determined by the difference between the initial weight and the final weight. Feed conversion was calculated by dividing intake and daily gain.

Slaughter and assessment of meat and carcass

At the end of the experimental period, the lambs were slaughtered according to NOM-033-SAG/ZOO-2014[13] after 14 h of fasting. The carcass weight was recorded hot and cold (carcasses refrigerated at 4 °C for 48 h), and the yield of each was calculated using the live weight of the animal and the final carcass weight. Carcass traits were evaluated following the Official Mexican Standard for the Classification of Sheep Meat in Carcass[14]. Back fat was measured using a vernier at the level of ribs 12 and 13; the length and width of the carcasses were also measured, and their quality was classified according to the standard. A sample of the left *Longissimus dorsi* (LD) was obtained at the level of the 13th rib for analysis. Twenty (20) milliliters of deionized water were added to 3 g of meat, and it was homogenized with a Waring 51BL32 700 blender (Torrington, CT, USA) and filtered, and acidity was measured with a potentiometer (Thermo-Orion 410Aplus, Torrington, CT, USA). Color and texture analyses were performed on muscle sectioned from the LD sample. The compression test was conducted at 25 ± 2 °C using an Instron 3365 Universal Texture meter (Instron Engineering Corp., High Wycombe, UK). Lightness (Hunter L*), redness (Hunter a*), and yellowness (Hunter b*) were determined using a colorimeter (Konica Minolta On Color CM-2500d Online, Osaka, Japan). The assessments in meat were carried out in triplicate.

The experimental design was completely randomized, with two treatments of eight lambs each. The MIXED procedure of SAS was used[15]; the lamb was the random component, and the amount of pod in the diet was the fixed component. A t-test was performed to detect differences between the means with a significance level of 0.5. The classification of the carcasses was analyzed by the Kruskal-Wallis test using the SAS program[15].

Results and discussion

Productive trial

The inclusion of guanacaste pods in the diet to partially replace soybean meal did not affect (P>0.05) the productive performance of finishing lambs or carcass traits (Table 2), nor the texture and color of the meat (Table 3). Similar results, without affecting feed intake, were reported in Pelibuey sheep when the pod was included in the diet at 20 % to replace corn and soybean meal; nevertheless, when the inclusion percentage was increased to 30 %, there was a decrease in intake and productive performance[16]. On the other hand, in another study, also with Pelibuey sheep, it was reported that 20, 30, 40, and 50 % of guanacaste pods in the diet linearly increased feed intake but reduced the digestibility of the diet when it exceeded 40 %[17,18]. The undesirable effects of including high percentages of guanacaste in the diet can be attributed to the fact that the content of secondary metabolites, such as tannins and saponins, can affect rumen microorganisms and therefore decrease fiber digestibility[19,20]. Evidence suggests that the guanacaste pod is an unconventional food with high potential to be used as an alternative, especially when ruminants are fed with forages, as long as the pod does not represent more than 25 % of the protein supplemented by the amount of secondary metabolites[21]. Nonetheless, there is also evidence that these secondary metabolites of pods can contribute to improving microbial protein synthesis at the rumen level[22].

Meat and carcass traits

Regarding the texture and color of the meat and carcass traits, although there is limited evidence in the literature, the existing one indicates that, in Katahdin and Blackbelly lambs and their crosses, the guanacaste pod replaced 0, 12, 24, and 36 % of a diet based on forage, sorghum, and cottonseed meal, and it was found that weight gain and carcass weight and yield were not affected by the level of pods in the diet[23].

Table 2: Productive variables and carcass traits of lambs fed with guanacaste pod

	Guanacaste pod (% dry basis)			
	0	**19**	**SEM**	***P***
Productive performance				
Initial weight, kg	39.3	38.6	1.84	0.87
Final weight, kg	50.3	49.4	1.88	0.99
Total weight gain, kg	11.0	10.8	0.67	0.83
Weight gain, g/day	183	180	2.34	0.49
DM intake, g/day	880	871	4.08	0.47
Feed conversion	4.8	4.8	0.15	0.51
Carcass traits				
Hot carcass, kg	24.2	23.4	1.66	0.73
Cold carcass, kg	23.1	21.9	1.60	0.61
Hot carcass yield, %	48.1	47.4	1.93	0.79
Cold carcass yield, %	45.9	44.3	1.19	0.83
Hot carcass pH	6.57	6.32	0.16	0.06
Cold carcass pH	6.05	5.91	0.16	0.33
Back fat (mm)	8.0	6.0	0.95	0.08
Classification	Mex 2	Mex 1	-	-

SEM= standard error of the mean.

Table 3: Characteristics of meat from sheep fed with experimental diets

	Guanacaste pod (% dry basis)			
	0	**19**	**SEM**	***P***
Texture, kg/cm^3	0.32	0.37	0.02	0.23
L*	42.71	40.55	0.58	0.08
a*	12.62	13.41	0.21	0.06
b*	12.24	12.21	0.16	0.95
Hue angle	0.79	0.83	0.01	0.16
Chroma	17.60	18.17	0.17	0.14

L*= lightness; a*= redness; b*= yellowness.
SEM= standard error of the mean.

There is evidence that deer supplemented with guanacaste leaves had better meat sensory characteristics (aroma, juiciness, and texture) in their meat as a result of the secondary metabolites contained in the plant[24]; however, the effects of pods on these attributes in ruminants have not been assessed. According to the reports in the literature, in guanacaste pods, the concentration of saponins is 27 to 28 mg/g DM and 41.3 mg/kg of condensed tannins[19,25]. With these values and the 19 % level of pod used in the present study, in the diet, the concentration (dry basis) of saponins was 5.3 g/kg and condensed tannins 7.8 g/kg, which are low values compared to 33 g/kg of tannins[26] and 40 g/kg of saponins[27], which may or may not positively or negatively modify feed intake, the energy balance, and the composition of the carcasses in sheep.

Conclusions and implications

It is concluded that the substitution of 19 % of soybean meal with guanacaste pods in sheep feeding does not affect productive behavior or modify meat and carcass quality parameters, so it can be considered a viable alternative for feeding sheep during the dry season.

Conflict of interest

The authors declare that they have no conflict of interest.

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