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Productive performance, composition and carcass yield of lambs treated with zeranol

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ABSTRACT - Twenty weaned male hair lambs with average body live weight of 19.20 kg±2.18 kg (SD) were used to evaluate the effect of zeranol on growth, composition and carcass yield. The animals were distributed into a completely randomized design with two treatments: no anabolics (control); and treatment with zeranol, using a subcutaneous dose of 10 mg/50 kg body live weight. Lambs received a diet with 15 g/100 g of crude protein and 2.8 Mcal of metabolizable energy/kg dry matter for 84 days. At the end of experiment all animals were harvested and entire carcass and its parts (neck, shoulder, loin-rib, loin-skirt and leg) were weighed to determine the composition of muscle and bone. Control animals had higher dry matter intake (1.01 vs 0.88 kg/d), average daily gain (198 vs 172 g/animal) and total weight gain (12.9 vs 10.9 kg) compared with those treated with zeranol. Zeranol group had higher muscle weight (1.76 vs 1.98 kg) and less bone (0.86 vs 0.61 kg) in leg section. The leg area represented about 16 kg/100 kg of the carcass weight for both treatments. No differences for other carcass traits were observed. Lambs treated with zeranol have better leg conformation because they develop more muscle mass, though their average feed intake and daily gain decrease.

Key Words: carcass composition, growth, sheep

Introduction

Lamb meat production in Mexico has increased significantly: from 30,274 tons in 1994 to 54,966 tons in 2010, representing a growth rate of 81% (SIAP, 2010). This increase is caused mainly by the growing demand of this type of meat and low supply of the national market, which is insufficient to satisfy the needs of consumers.

Sheep production in Mexico is rapidly developing among both commercial and small farmers, who are seeking greater profitability, better price, shorter production cycles and lower initial investment. Currently, flocks are composed of animals of the Pelibuey and Blackbelly breeds, which are perfectly adapted to tropical regions. It is possible, using these breeds, to initiate intensive systems for fattening lambs in places with good availability of crop residues and grains.

Balanced rations with high proportions of grains for fattening lambs are used by farmers, so it is necessary to find new alternatives to increase efficiency of these systems. Substances like anabolics, which promote fast growth rate and improve feed conversion are also used to improve production. These substances have hormonal properties and act on the animal metabolic processes, improving nitrogen balance in the body and increasing the protein production in the animal. The most commonly used substances are non steroidal, like zeranol; however, the obtained results are inconsistent, because there are differences in animal response. Several authors report an increase in daily gain of lambs treated with zeranol (Bachman et al., 1993; Prado, 2002), while others (Field et al., 1993; Nasahlai et al., 2002; Canul et al., 2009) did not observe a positive effect on lamb performance. For these reasons, it is essential to generate additional information that explains the response of sheep to the use of non-steroidal anabolics. This study was carried out to evaluate average daily gain, feed efficiency, carcass characteristics and muscle development of hair lambs treated with zeranol.

Material and Methods

The study was carried out at Mococha Experimental Station of the Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. The climate in the area is hot and humid (AWO classification), according to the Köppen classification, with an average annual temperature of 24 ºC and precipitation of 750 to 1,000 mL per year, mainly during the spring and winter (Duch, 2002).

Twenty weaned male lambs produced by different crosses of Pelibuey rams and Blackbelly ewes were used.

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Lambs had a body live weight (BLW) and age ± standard deviation of 19.2±2.2 kg and 60±4 d, respectively, and were distributed into a complete randomized design with two treatments (Montgomery, 2004): control (no anabolics), and sole application of zeranol, using a subcutaneous dose of 1 mL of Zeramec (Virbac)/50 kg of BLW, equivalent to 10 mg of zeranol and 10 mg of ivermectin/50 kg of BLW. Each treatment had ten replicates and each of these consisted of an animal housed in individual stall of cement floor with roof, drinker and feeder. Before the experiment started, all lambs were dewormed and vaccinated against pneumonic pasteurellosis.

Lambs were fed *ad libitum* and had a period of adaptation to diets and stalls of 14 days and were weighed after 16 hours of feed deprivation, at the onset, and every 14 days, until the end of the experiment, which lasted 84 days. Animals received a diet with 15 g/100 g crude protein and 2.8 Mcal metabolizable energy (ME)/kg dry matter (DM) (Table 1). The diet was offered freely twice a day (7.00 and 13.00 h) and daily feed intake was recorded, weighing the amount offered and rejected. Feed:gain ratio (FG) was determined and the average daily gain (ADG) in each weighing period was calculated.

At the end of the experiment, lambs were weighted and harvested after 16 hours of feed deprivation, according to the Mexican official standard established for slaughter animals (NOM-194-SSA1-2004). Lamb heads were removed at the occipito-atloid joint, and skin, limbs, organs, and gastrointestinal and pelvic contents were removed from the carcass. Hot carcass weight (HCW) and pericardial, kidney-pelvic and mesenteric fat weight were recorded to estimate dressing percentage (kg/100 kg of BLW) and carcass composition. The neck, shoulder, loin-rib, loin-skirt and leg were separated according to the procedures reported by Partida and Martinez (2010). Total weight of each region was recorded and muscle and bone were separated and weighted.

The results for ADG were analyzed using a repeated measures model, whereas the other variables were analyzed using a linear model for fixed effects, through the procedures PROC MIXED and PROC GLM of SAS (Statistical Analysis System, version 6).

Table 1 - Ingredients and chemical composition of diet

Ingredients	g/kg of DM
Ground sorghum	710.0
Soybean meal	70.0
Dried citrus pulp	100.0
Ground corn stover	62.0
Molasses	27.0
Salt	10.0
Urea	10.0
Gustor ruminants	6.0
Calcium carbonate ($CaCO_3$)	4.0
Minerals and vitamins	1.0
	1,000.0
Nutritional content	
Dry matter (g/kg of DM)	843.2
Metabolizable energy (Mcal/kg of DM)[1]	2.8
Crude protein (g/kg of DM)	150.0
Calcium (g/kg of DM)	8.0
Phosphorus (g/kg of DM)	4.0

[1] Based on NRC (1985).

Results and Discussion

Lambs of control group had higher DM intake, ADG and final weight compared with those treated with zeranol (P<0.05). No differences were found for FG (P>0.05) (Table 2). It is known that feed intake has a positive relationship with live weight, in which animals change their consumption to fill their nutritional requirements (Cañeque et al., 2001; Allen and Bradford, 2005). This probably happened with control group, since they had highest weight gain. Similar results were reported by Lopez et al. (2012), who found a reduction in DM intake for lambs receiving constant dose of ractopamine hydrochloride (RH) or zilpaterol hydrochloride (ZH); however, ADG and FG were improved compared with control animals.

Other authors (Chanetsa et al., 2000; Nasahlai et al., 2002; Canul et al., 2009) have also observed similar results to those found in this study. However, Prado (2002) and Talley et al. (2003) reported a positive response on ADG and FG of lambs implanted with zeranol. The results of this experiment also agree with those reported by Eckerman et al. (2013), who found no differences in feed intake, FG, final BLW and ADG in Rambouillet × Suffolk lambs treated with 0, 12, 24, or 36 mg/lamb of zeranol implant.

Previous research indicates that FG can be improved by implanting lambs twice with 12 mg of zeranol (Nold et al., 1992), and both FG and ADG can be improved by implanting lambs with 12 mg of zeranol 3 or more times (Hufstedler et al., 1996). Domínguez et al. (2010) reported

Table 2 - Mean effect of zeranol on productive performance of lambs

Variables	Treatment		P-value	SEM
	Control	Zeranol		
Initial weight (kg)	21.2	20.2	0.416	0.56
Final weight (kg)	35.1a	31.5b	0.023	0.73
Dry matter intake (kg/d)	1.01a	0.88b	0.001	0.02
Average daily gain (g)	198a	172b	0.032	6.33
Total weight gain (kg)	12.9a	10.9b	0.002	0.38
Feed:gain ratio	5.3	5.8	0.174	0.17

Different letters in the same row are statistically different (P<0.05).
SEM - standard error of the mean.

that lambs implanted with 24 mg zeranol had increased FG compared with lambs implanted with 12 mg zeranol or with no implantation.

The majority of studies indicates that implanting feedlot lambs with 12 mg/lamb of zeranol increases ADG (Stultz et al., 2001; Salisbury et al., 2007) and FG (Field et al., 1993; Stultz et al., 2001).

Higher doses maintain a constant concentration of the active substance for a long time. This was evidenced by Pelcastre et al. (2005) in Pelibuey lambs, because no difference in ADG was observed when a dose of 12 mg/lamb of zeranol was used. However, greater weight gain was found when the dose was increased to 24 mg/lamb, so the response would depend on dose, size and weight of animals.

No differences were found between control and zeranol group for carcass composition and dressing percentage (P>0.05) (Table 3). The few variations observed for most variables are probably because carcass composition is affected by the feeding level and harvest weight: heavier and better-fed animals present higher values for carcass conformation (Díaz et al., 2002; Freking and Leymaster, 2004; Salgueiro et al., 2009). It is noteworthy that the diets in this study were balanced to have equal amounts of protein and energy. Similar results were reported by Field et al. (1993) and Nasahlai et al. (2002), who found minimal effects on carcass composition between lambs implanted with zeranol and a control group. Eckerman et al. (2013) also reported no differences for carcass characteristics in lambs implanted with increasing dosages of zeranol. However, Stultz et al. (2001) reported that lambs implanted with zeranol had decreased rib-eye area and carcass weight compared with non-implanted lambs. Reimplanting animals has been shown to change carcass characteristics, so the effects of zeranol on lamb appear to be inconsistent. Hufstedler et al. (1996) and Salisbury et al., 2007) found a greater dressing percentage in lambs implanted twice (d 0 and 56) or at 30 d intervals. Lopez et al. (2012) also reported that carcass weight is increased by using a continuous dose program of RH or ZH in lambs. Conversely, Salisburry et al. (2007) did not observe differences among double and single implanting with zeranol for hot carcass weight and yield grade in Rambouillet lambs. Felix et al. (2005) reported that cold carcass weight, dressing percentage, *longissimus dorsi* muscle area and fat thickness of Pelibuey lambs were unaffected by ZH supplementation at doses of 4.5 or 6.7 mg/kg of DM during 56 d, whereas Aguilera et al. (2008) administered ZH to Rambouillet lambs and observed increase in cooling loss, but not in other carcass traits. Other studies have reported that zilpaterol supplementation decreased intramuscular fat content by 30 g/100 g compared with control group (Davila et al., 2013). This reduction is due to the anabolic and lipolytic effects of the β-adrenergic agonists (β-AA). In the adipocyte, the β-AA increase the catabolism of lipids through the activation of hormone-sensitive lipase through Protein Kinase A, which degrades triglycerides into glycerol and fatty acids (Mersmann, 2002).

Lambs treated with zeranol had higher muscle (13 g/100 g) and lower bone weight (29 g/100 g) in the leg (P<0.05) (Table 4). However, no differences in leg yield relative to HCW were observed (P>0.05). Although less muscle mass was deposited, control animals had higher bone growth, which caused the muscle-bone relationship to be comparable between groups of lambs and resulted in similar leg yield (16 kg/100 kg of HCW). These results are in agreement with those reported by McClure et al. (2000), who found a greater leg lean accretion in whethers implanted with trenbolone acetate:estradiol benzoate than non-implanted wheters; the implant did not affect fat or bone accretion.

The higher muscle development found in the leg of animals receiving zeranol can be explained by the fact that the main effect of zeranol is to promote retention of body protein, obtaining an increase in muscle protein (Song and Choi, 2001; Prado, 2002; Sumano, 2002). Muscle growth is determined by the balance between the amount of muscle protein synthesized and muscle protein degraded. Any

Table 3 - Mean effect of zeranol on carcass composition and dressing percentage of lambs

Variables	Treatment		P-value	SEM
	Control	Zeranol		
Hot carcass weight (kg)	17.0	16.3	0.736	1.01
Pericardial fat (g)	90	106	0.622	15.0
Kidney-pelvic fat (g)	487	393	0.440	54.0
Mesenteric fat (kg)	1.6	1.5	0.561	0.13
Total fat (kg)	2.2	2.0	0.446	0.14
Fat yield (kg/100 kg of BLW)	5.9	5.8	0.936	0.32
Muscles yield (kg/100 kg of HCW)	60.4	61.9	0.258	171
Bones yield (kg/100 kg of HCW)	34.2	32.7	0.266	0.98
Dressing percentage (kg/100 kg of BLW)	52.4	57.0	0.141	1.28

SEM - standard error of the mean; BLW - body live weight; HCW - hot carcass weight.

Table 4 - Mean effect of zeranol on weight and yield of different sections of lambs

Variables	Treatment		P-value	SEM
	Control	Zeranol		
Neck				
Total (kg)	1.69	1.47	0.553	0.17
Muscle (kg)	1.23	1.05	0.570	0.14
Bone (kg)	0.46	0.42	0.597	0.04
Yield (kg/100 kg of HCW)	9.8	8.9	0.556	0.67
Shoulder				
Total (kg)	1.93	1.61	0.162	0.09
Muscle (kg)	1.55	1.26	0.204	0.09
Bone (kg)	0.38	0.35	0.152	0.01
Yield (kg/100 kg of HCW)	11.6	9.9	0.307	0.69
Loin-rib				
Total (kg)	2.73	2.52	0.516	0.14
Muscle (kg)	1.24	0.94	0.107	0.07
Bone (kg)	1.48	1.57	0.696	0.10
Yield (kg/100 kg of HCW)	16.1	15.5	0.482	0.42
Loin-skirt				
Total (kg)	1.19	1.00	0.383	0.09
Muscle (kg)	0.84	0.78	0.677	0.07
Bone (kg)	0.34	0.22	0.273	0.04
Yield (kg/100 kg of HCW)	6.9	6.1	0.291	0.34
Leg				
Total (kg)	2.70	2.53	0.342	0.07
Muscle (kg)	1.76a	1.98b	0.043	0.04
Bone (kg)	0.86a	0.61b	0.019	0.03
Yield (kg/100 kg of HCW)	15.9	15.8	0.946	0.68

Different letters in the same row are statistically different ($P<0.05$).
SEM - standard error of the mean; HCW - hot carcass weight.

possible combination that results in a positive balance in this equation will result in muscle hypertrophy (Buttery et al., 2000). Similar results have been reported by Eckerman (2011), who suggests that zeranol estrogen has a major effect in stimulating muscle growth in the leg area. The effect of addition of other beta β-AA compounds to the diet with a consequent increase in muscularity and reduced fat content in sheep carcasses has been also reported for cimaterol (Rikhardsson et al., 1991) and metaproterenol (Nourozi et al., 2008).

The enhancement of carcass weight and dressing percentage is an expected response to β-AA supplementation, because these compounds have the potential to stimulate muscle hypertrophy through both an increase in protein synthesis and a decrease in protein degradation (Dikeman, 2007).

No differences were observed for the other carcass sections ($P>0.05$). Neck, shoulder, loin-rib and loin-skin represented, on average, 9, 11, 16 and 6 kg/100 kg of HCW for both treatments, respectively.

Conclusions

The main effect of zeranol in lambs fed concentrate rations is improvement in leg conformation, because greater muscle mass is developed, though feed intake and daily gain decrease. Zeranol does not improve other carcass characteristics.

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