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Blood testosterone level and growth of castrated, uncastrated, and cryptorchid lambs

Nível sanguíneo de testosterona e crescimento de cordeiros castrados, não castrados e criptorquidas

Pablo Tavares Costa[1*]; Gilson de Mendonça[2]; Rômulo Tavares Costa[3]; Fernanda Dornelles Feijó[4]; Antonio Wrubleski Bogacki Neto[5]; Mateus San Martins[5]

Abstract

The objective of this study was to evaluate the effects of sexual status on blood testosterone levels and its influence on lamb growth. A total of 49 Texel x Corriedale males, originating of single births, were divided into three groups: uncastrated (n = 16), castrated (n = 17) and cryptorchid (n = 16), in the State of Rio Grande do Sul, in extensive natural pasture, with feed supplementation after weaning. The effect of the sexual status was examined by analysis of variance. Uncastrated and castrated lambs showed higher body weight, thoracic perimeter, and body compactness between the 35th and 203th day of age. Uncastrated lambs had mean weight higher than cryptorchid lambs over the whole period. Cryptorchid lambs had an average weight gain greater than castrated lambs between the 203rd and 259th days. Castrated lambs had a higher body condition score on the 147th day than the cryptorchid lambs, and on the 175th and 203rd days than uncastrated and cryptorchid lambs. Blood testosterone concentrations were higher in the uncastrated and cryptorchid lambs on the 203rd and 231st days and in the overall mean. The findings of this study showed that, with advancing age, the sexual status affects the testosterone production, not showing differences regarding growth at young ages.
Key words: Castration. Cryptorchidism. Male hormone. *Ovis aries*.

Resumo

O estudo foi realizado com objetivo de avaliar os efeitos da condição sexual nos níveis sanguíneos de testosterona e sua influência no crescimento de cordeiros. Foram utilizados 49 machos cruza Texel x Corriedale, oriundos de partos simples, divididos em três grupos: não castrados (n=16), castrados (n=17) e induzidos ao criptorquidismo (n=16), criados na região do Bioma Pampa, no Estado do Rio Grande do Sul, em condições extensivas de pastagem natural, com suplementação alimentar após o desmame. Foi utilizada a análise de variância para avaliar o efeito da condição sexual. Cordeiros não castrados e castrados apresentaram valores superiores de peso corporal entre o 35º e o 203º dia de idade, assim como no perímetro torácico e compacidade corporal. Cordeiros não castrados foram superiores aos criptorquidas na média de peso no período total. Criptorquidas apresentaram ganho

[1] Zootecnista, M.e, Discente, Curso de Doutorado, Programa de Pós-Graduação em Zootecnia, Universidade Federal de Pelotas, UFPel, Capão do Leão, RS, Brasil. E-mail: pablocostta@hotmail.com
[2] Prof. Dr., Departamento de Fisiologia, UFPel, Capão do Leão, RS, Brasil. E-mail: gilsondemendonca@gmail.com
[3] Zootecnista, Autônomo, Pinheiro Machado, RS, Brasil. E-mail: romulo.tcosta@hotmail.com
[4] Zootecnista, M.e, Discente do Curso de Doutorado em Zootecnia, Programa de Pós-Graduação em Zootecnia, Universidade Federal do Rio Grande do Sul, UFRGS, Porto Alegre, RS, Brasil. E-mail: feijo.fernanda@gmail.com
[5] Discentes, Curso de Graduação em Zootecnia, UFPel, Capão do Leão, RS, Brasil. E-mail: awbneto@hotmail.com; mateussanmartins@hotmail.com
[*] Author for correspondence

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médio de peso superior aos castrados entre o 203º e 259º dias. Castrados apresentaram escore de condição corporal superior, no 147º dia em relação aos criptorquidas, e no 175º e 203º dias em relação a não castrados e criptorquidas. As concentrações de testosterona sanguínea foram superiores nos não castrados e criptorquidas no 203º e 231º dias e na média geral. Conclui-se que, com o avanço da idade, a condição sexual afeta a produção hormonal de testosterona não se observando diferenças em termos de crescimento em idades jovens.

Palavras-chave: Castração. Criptorquidismo. Hormônio masculino. *Ovis aries*.

Introduction

The Brazilian national sheep flock is around 16.8 million head, with 24.4% concentrated in the State of Rio Grande do Sul (IBGE, 2013). The sheep flock in RS is formed mostly by wool and/or dual-purpose breeds, among which Corriedale sheep are predominant.

With the valuation of the sheep meat, farmers have introduced breeds with greater aptitude for meat production, and Texel is one of the most common breeds used for crossings. According to Osório et al. (2002), the mating of sheep adapted to a region, as is the case of Corriedale to Rio Grande do Sul, with paternal breeds specialized for meat production is an alternative for increasing the efficiency of productive systems.

The main product in a sheep meat production system is the lamb, young animal with pinkish-red meat, good amount of fat, and a high carcass yield (CEZAR; SOUZA, 2007; ROCHA et al., 2007). Currently, the consumer eating habits and the scientific knowledge about the suitability of certain diets have changed, with preference for lean meats, and according to Azzarini et al. (2001) this was already a trend since the early 2000s. Many aspects of animal production are involved in the attempt to produce lean meat with good quality, including breeding, feeding, management, sex, animal age and genetics, as well as the interaction between these factors (TEIXEIRA et al., 2010).

Among the factors that influence the growth and development of lambs is sex and, within this fatctor, the difference between castrated and uncastrated animals (AZEREDO, 2003). Sexual status affects the rate of growth and deposition of the different tissues, which is higher in uncastrated males than in castrated males (AZZARINI, 1979; BEERMANN et al., 1995), the former having less fat in carcasses of similar weights (BEERMANN et al., 1995; ROCHA et al., 2010). Castration has routinely been used in ruminant breeding, aiming to facilitate male management, since they become more docile, allowing mixing of sexes and eliminating disturbances of sexual conduct (TEIXEIRA et al., 2010). Another advantage is that castration favors fat deposition in the carcass (AZEREDO, 2003).

Differential growth among uncastrated and castrated males and females is due to the hormonal effect of testosterone, which stimulates muscle and skeletal growth and is present at higher levels in uncastrated males (JACOBS et al., 1972).

Sheep reach puberty at young ages, thus the use of uncastrated lambs in a meat production system may be responsible for difficulties in handling and finishing these animals. Therefore, induction of cryptorchidism may bring advantages to sheep farmers because it allows the animals to maintain hormonal production close to the levels of those uncastrated, besides facilitating flock management and reducing stress in castrated lambs, enabling the production of heavier and leaner carcasses. Dobbie et al. (1993) argued that cryptorchid lambs still provide easier shearing and improved hygiene due to the removal of the scrotum.

Considering that, currently, sheep producers have resorted to crossing their flocks with breeds specialized in meat production to meet the growing demand for sheep meat, and that castration directly affects the hormonal metabolism and growth, it is important to understand the effect of this practice on animal development. Thus, the present study aimed to evaluate the effects of different types of castration, or its non-realization, on blood testosterone levels and its influence on growth of Texel x Corriedale lambs.

Material and Methods

The experiment was carried out in a private farm in the municipality of Pinheiro Machado, in the region of Encosta do Sudeste, southern Rio Grande do Sul, between 31°31’30”S and 53°29’45” W, in natural pastures of the Pampa Biome. The climate of the region is temperate, the annual averages of temperature is 16ºC, rainfall is 1380mm, and altitude of 365 m (IBGE, 2012).

A total of 49 male crossbred Texel x Corriedale lambs were divided into three groups: uncastrated (n = 16), castrated (n = 17) and induced to cryptorchidism (n = 16). The lambs were born between August 25 and September 10, 2012, delivered naturally, weighed at birth, individually identified by numbered earrings specific to the species, raised on extensive management system, and kept with their mothers in native grass pickets, with natural sources of water and shade. The predominant forage species in the area were the grasses *Andropogon lateralis* Nees, *Paspalum notatum* Flüegge, and *Axonopus affinis* Chase, and the legume *Desmodium incanum* SW. The lambs were castrated and induced to cryptorchidism with average age of 35 days. Castration was performed by bilateral orchiectomy. Induction to cryptorchidism was performed by using specific rubber rings placed at the base of the testicular pouch with an applicator, after manual reintroduction of the testicles into the abdominal cavity.

At each 28-day interval, after 12-hour of feed and water fasting, the body condition score (BCS) was estimated and the individual morphometric measurements of the animals were taken. Evaluations were carried out up to the average age of 259 days.

The evaluation of body condition was based on the method of Osório and Osório (2005). The lambs were examined individually by palpation of the transverse and spinal processes of the lumbar vertebrae to identify their presence as well as the muscle and adipose tissue associated with them. The assigned scores varied from 1 to 5, with subdivisions of 0.5, on a subjective scale, where 1 corresponded to a very lean lamb and 5 an overly fat lamb.

Individual body weights were measured with a digital scale in kg. The morphometric measurements were determined using a measuring tape: body length (distance between the cervico-thoracic joint and the first coccygeal vertebra); anterior height (distance between withers and distal forelimb region); posterior height (distance between sacral tuberosity and distal hind limb); and the thoracic perimeter (perimeter taking the sternum and withers as base, passing the tape behind the palette), all measurements expressed as cm. The body compactness (body weight divided by the body length of the animal) was calculated and expressed as kg cm^{-1}.

The lambs were sheared and weaned with the average age of 150 days, kept together on native pasture pickets and, from that time, receiving daily supplemention of milled corn, which corresponded to 1% of the live weight. For this, lambs were weighed weekly and the amount of supplement was adjusted to the average weight of the lot at the last weighing. Feed was manually served in wooden troughs, supplied at 2 pm.

Preventive sanitary management was carried out by vaccination against *ecthyma* and *clostridiosis* (symptomatic carbuncle, malignant edema, kidney disease, hemorrhagic enterotoxemia, bacillary hemoglobinuria, tetanus, sudden death, and botulism). Parasite infestation was monitored by biweekly Famacha exams of each animal, and drugs were only applied to animals scored 4 and 5, according to Molento et al. (2013). In addition to this periodic monitoring, a strategic dosage of the active ingredient closantel 10% was administered to all experimental animals, at 150 days of age. Apart from this, the animals were constantly monitored throughout the experimental period, and sanitary measures were adopted whenever a disease was diagnosed.

From the mean age of 119 days and at 28-day average intervals, blood samples were collected individually from 25% of the animals of each experimental group to measure total blood testosterone concentration. The collections extended until 231 days of average age, totaling five collections. Blood was collected via direct venipuncture of the jugular vein, using disposable needles and syringes with clot activator, with the lambs restrained manually. Five ml of blood were collected from each animal, these samples remained in rest for 20 minutes and were centrifuged (TDL80-2B Centribio®centrifuge) at 2700 rpm for 10 minutes to obtain blood serum. The serum was pipetted out into sterile Eppendorf tubes, and two sub-samples (per animal) were stored, identified, and frozen at -20ºC. Hormone analyses were performed in a commercial laboratory, using the radioimmunoassay method.

The effect of the sexual status was examined by analysis of variance and means were compared by the F test. DMS Fisher test was used to compare means when statistical significance ($p < 0.05$) was detected by analysis of variance. BCS data, which are distributed in scales, were compared by the Kruskal-Wallis non-parametric test. Blood testosterone concentration data, non-normally distributed, were analyzed by Kruskal-Wallis test and, when statistical significance was found ($p < 0.05$), their means were compared using the Student-Newman-Keuls test. The analyses using parametric tests were performed with the Statistical Analisys System (SAS INSTITUTE INC., 2008) and the non-parametric tests by the BioEstat 5.3 program (AYRES et al., 2007), at a significance level of 5 %.

Results and Discussion

Birth weight did not differ between among ($p > 0.05$). However, castrated and uncastrated lambs had higher body weights than cryptorchid lambs ($p < 0.05$), in the seven weighings carried out between 35 and 203 days of average age and in the mean weight of the whole experimental period (Table 1). From 203 days to the last measurement (259 days) the differences disappeared ($p > 0.05$).

These results disagree with those obtained by Azeredo et al. (2005a) and Rocha et al. (2010), who found no differences in weight between groups until the slaughter of castrated, uncastrated and cryptorchid males of Corriedale and cross-breeds of Suffolk, Ile de France, Santa Inês and Texel.

According to Fernandes et al. (2009), ewe milk production has a great influence on lamb performance, especially in the first weeks of life. In this study, since the distribution of the animals in the different groups was totally randomized, the difference found in the weight of lambs at 35 days of age was possibly influenced by differences in milk production by the matrices. This is because, although no statistical differences were found, the lambs induced to cryptorchidism showed lower absolute values of average daily weight gain (ADG) from birth until treatment application. Thus, the observed differences in weight at 63, 91, 119, 147, 175, and 203 days of age, with uncastrated and castrated lambs having higher weight than cryptorchid lambs ($p < 0.05$), may be associated with the difference found at the 35th day of age, since the average daily weight gain in this period showed no differences among the groups ($p > 0.05$). It should be noted that castration and cryptorchidism induction were performed at 35 days of age, therefore, the weight differences observed at this age were not due to the treatments, to which the animals were totally randomized.

Table 1. Mean and standard error for body weight per age (kg) and average daily weight gain (kg day^{-1}) in cryptorchid, uncastrated, and castrated sheep.

Parameter [(1)]	Sexual Status			F test
	Cryptorchid	Uncastrated	Castrated	
Weight at birth	$4.83^a \pm 0.19$	$4.86^a \pm 0.19$	$4.97^a \pm 0.18$	0.8421
Weight at 35 days old	$10.99^b \pm 0.61$	$13.55^a \pm 0.61$	$13.41^a \pm 0.59$	0.0061
Weight at 63 days	$15.20^b \pm 0.79$	$18.49^a \pm 0.79$	$18.18^a \pm 0.76$	0.0080
Weight at 91 days	$19.62^b \pm 0.91$	$23.26^a \pm 0.91$	$22.71^a \pm 0.88$	0.0146
Weight at 119 days	$22.83^b \pm 0.99$	$26.41^a \pm 0.99$	$25.96^a \pm 0.95$	0.0264
Weight at 147 days	$26.29^b \pm 1.07$	$30.24^a \pm 1.07$	$29.72^a \pm 1.04$	0.0240
Weight at 175 days	$24.90^b \pm 1.20$	$28.59^a \pm 1.16$	$28.71^a \pm 1.12$	0.0426
Weight at 203 days	$28.62^b \pm 1.09$	$32.95^a \pm 1.05$	$32.34^a \pm 0.99$	0.0132
Weight at 231 days	$31.19^a \pm 1.22$	$34.12^a \pm 1.22$	$30.92^a \pm 1.59$	0.1670
Weight at 259 days	$33.53^a \pm 1.59$	$35.34^a \pm 1.71$	$30.59^a \pm 2.97$	0.3961
Average weight in the period	$21.17^b \pm 0.84$	$24.23^a \pm 0.84$	22.63 ± 0.51^{ab}	0.0213
ADG birth - 35 days	$0.212^a \pm 0.01$	$0.239^a \pm 0.01$	$0.249^a \pm 0.01$	0.1936
ADG 35 - 63 days	$0.151^a \pm 0.01$	$0.176^a \pm 0.01$	$0.170^a \pm 0.01$	0.0822
ADG 63 - 91 days	$0.158^a \pm 0.01$	$0.170^a \pm 0.01$	$0.162^a \pm 0.01$	0.5548
ADG 91 - 119 days	$0.115^a \pm 0.01$	$0.113^a \pm 0.01$	$0.117^a \pm 0.01$	0.9208
ADG 119 - 147 days	$0.123^a \pm 0.01$	$0.136^a \pm 0.01$	$0.133^a \pm 0.01$	0.2482
ADG 147 - 175 days	$-0.050^a \pm 0.01$	$-0.059^a \pm 0.01$	$-0.035^a \pm 0.01$	0.4041
ADG 175 - 203 days	$0.130^a \pm 0.02$	$0.133^a \pm 0.02$	$0.129^a \pm 0.01$	0.9834
ADG 203 - 231 days	$0.127^a \pm 0.02$	$0.083^{ab} \pm 0.02$	$0.050^b \pm 0.02$	0.0191
ADG 231 - 259 days	$0.160^a \pm 0.02$	$0.112^{ab} \pm 0.02$	$0.043^b \pm 0.03$	0.0240
Total ADG	$0.130^a \pm 0.01$	$0.137^a \pm 0.01$	$0.132^a \pm 0.01$	0.5122

* Means followed by different letters in the row are significantly different by the Fisher's DMS test ($p < 0.05$).
(1) ADG, average daily gain.

At 175 days of age, the animals were found to have lost weight, as the lambs were sheared and weaned a few days before the measurement, due to wool removal and stress by the separation from their mothers, the reduction in body weight can be considered normal.

In the period between 203 and 259 days of age, lambs induced to cryptorchidism showed higher ADG than castrated lambs ($p < 0.05$), possibly due to the effect of testosterone, since from the 175th day, differences in the blood concentrations of this hormone were found between these two groups.

Jacobs et al. (1972) argued that the production of testosterone increases weight gain in lambs, and this effect increases with advancing age of the animal. Testosterone has no action on the initial life phase of the animals, which occurred after weaning.

The study of Carvalho et al. (2005) corroborates our results. The authors, working with uncastrated and castrated Suffolk lambs, finished in confinement and slaughtered with a mean age of 128.5 days (uncastrated males) and 134.2 (castrated males), found no significant effect on the total weight gain of uncastrated lambs in relation to castrated ones. However, especially after weaning, these authors verified the same trend of increased weight gain of uncastrated lambs in relation to castrated lambs.

It is noteworthy, though, that in the present study, differences in ADG were only found for lambs that were weaned, adapted, and fed supplementation with milled corn proportional to 1% of their daily live weight, which can be corroborated by the results obtained by Crouse et al. (1981), Azzarini et al. (2001), Azeredo et al. (2005a), Azeredo et al. (2006), Rocha et al. (2010), and Osório et al. (2012), meaning that it is necessary to provide a good food supply so that uncastrated animals can express their greatest growth potential.

No differences were observed in the weighing at 231 and 259 days of average age ($p > 0.05$), since the greater weight gain of the cryptorchid lambs in this period allowed them to reach similar weights to the other groups.

There were no differences in total ADG ($p > 0.05$) in any of the groups studied. Crouse et al. (1981) stated that a better performance of uncastrated than castrated males is to be expected, but especially when a high level of feeding is provided to lambs. This was not done in most of the present study, as the lambs were kept in an extensive rearing system on native pasture fields with a normal low availability of quality food, which may account for the non-observable differences in total ADG.

Azzarini et al. (2001) studied castrated and cryptorchid Corriedale lambs reared on cultivated pasture and slaughtered at 350 days and found that cryptorchid lambs had 36% growth higher than castrated ones, with weight gains of 112 and 82 g day^{-1}, respectively.

Rocha et al. (2010) reported ADGs of 152.4, 167.5 and 160.0 g day^{-1}, for cryptorchid, uncastrated and castrated lambs, respectively, derived from crosses between Suffolk, Ile de France, Santa Inês, and Texel breeds and slaughtered at 148 days of age. The authors explained the lack of differences in the growth of the groups by the low age of the animals at slaughter. Azeredo et al. (2005a) studied uncastrated, castrated, and cryptorchid male lambs of the Corriedale breed raised on native pasture and found no differences in weight gain up to 360 days of age. They reported gains of 75 g day^{-1} for uncastrated and cryptorchid lambs and 81 g day^{-1} for castrated lambs, at 270 days of age.

Lambs uncastrated, castrated and induced to cryptorchidism, had similar means for anterior height, posterior height and body length ($p > 0.05$; Table 2), corroborating with the findings of Ribeiro et al. (2012), in which these measurements are influenced mainly by the genotype of the animals.

Table 2. Mean and standard error for morphometric measurements and body compactness of cryptorchid, uncastrated, and castrated sheep in the period between 35 and 259 days of age.

Parameter	Sexual Status			
	Cryptorchid	Uncastrated	Castrated	F test
Body length (cm)	$50.95^a \pm 0.79$	$52.53^a \pm 0.71$	$52.15^a \pm 0.43$	0.2193
Posterior height (cm)	$56.19^a \pm 0.80$	$57.71^a \pm 0.65$	$58.22^a \pm 0.53$	0.0890
Anterior height (cm)	$55.6\ 1^a \pm 0.76$	$57.02^a \pm 0.56$	$57.75^a \pm 0.59$	0.0534
Thoracic perimeter (cm)	$65.69^b \pm 0.86$	$69.50^a \pm 1.11$	$68.09^a \pm 0.61$	0.0082
Body compactness (kg cm^{-1})	$0.43^b \pm 0.01$	$0.48^a \pm 0.01$	$0.47^a \pm 0.01$	0.0041

* Means followed by different letters in the row are significantly different by the Fisher's DMS test ($p < 0.05$).

Castrated lambs had higher BCS than those induced to cryptorchidism at 147 days of age ($p < 0.05$ - Table 3). At 175 days of age, the animals showed a reduction of about 0.5 points in BCS due to weaning.

In the evaluations performed on the 175th and 203rd days, castrated lambs had BCS higher than uncastrated and cryptorchid lambs ($p < 0.05$). This can be considered normal, since according to Azeredo et al. (2005a) and Teixeira et al. (2010), castrated animals have a greater ability to deposit adipose tissue. Azeredo et al. (2006), reported lower BCS values than this study for uncastrated, castrated and cryptorchid Corriedale lambs, probably because lambs were reared only in native pasture system without access to supplementation.

Table 3. Mean and standard error for body condition score (BCS) of cryptorchid, uncastrated, and castrated sheep from 91 to 259 days of age.

Parameter [(1)]	Sexual Status			(p) Kruskal-Wallis
	Cryptorchid	Uncastrated	Castrated	
BCS 91days (1 to 5)	$2.34^{a} \pm 0.12$	$2.47^{a} \pm 0.12$	$2.71^{a} \pm 0.12$	0.1513
BCS 119 days (1 to 5)	$2.19^{a} \pm 0.15$	$2.41^{a} \pm 0.15$	$2.68^{a} \pm 0.14$	0.1392
BCS 147 days (1 to 5)	$2.19^{b} \pm 0.13$	$2.44^{ab} \pm 0.13$	$2.71^{a} \pm 0.13$	0.0439
BCS 175 days (1 to 5)	$1.63^{a} \pm 0.11$	$1.78^{a} \pm 0.11$	$2.26^{b} \pm 0.10$	0.0004
BCS 203 days (1 to 5)	$2.11^{b} \pm 0.14$	$2.33^{b} \pm 0.13$	$2.88^{a} \pm 0.12$	0.0006
BCS 231 days (1 to 5)	$2.42^{a} \pm 0.15$	$2.54^{a} \pm 0.15$	$2.57^{a} \pm 0.20$	0.9759
BCS 259 days (1 to 5)	$2.64^{a} \pm 0.10$	$2.33^{a} \pm 0.11$	$2.25^{a} \pm 0.18$	0.0932

* Means followed by different letters in the row are significantly different by the Kruskal-Wallis test ($p < 0.05$).
(1) Subjective evaluation.

Lambs induced to cryptorchidism had lower mean thoracic perimeter and body compactness than the others during the experimental time ($p < 0.05$). Different results were reported by Azeredo et al. (2006) and Rocha et al. (2010), who found no differences for the thoracic perimeter, when analyzing uncastrated, castrated, and cryptorchid lambs of different genetic groups and slaughtered at different ages.

Silva et al. (2006) observed that the correlation coefficients between live weight and thoracic circumference of sheep are high, and it is possible to estimate the body weight of an animal through its thoracic perimeter. Thus, in the present study, the results of these variables may have been responsible for differences in body weight, and may be indicative of differences in conformation between cryptorchid animals and the others, with random occurrence.

According to Yáñez et al. (2004) and Pinheiro et al. (2007), body compactness is an index that objectively estimates the conformation of the animals, showing that the higher the kg cm^{-1} ratio, the greater the proportion of muscles and fat in the animal.

Azeredo et al. (2006), studying Corriedale lambs, castrated and induced to cryptorchidism, and slaughtered at 120, 210 and 360 days of age, found no differences for mean body compactness, reporting values of 0.46, 0.44 and 0.45 kg cm^{-1}, respectively, according to the castration method used.

Table 4 shows data on blood testosterone levels. No significant differences ($p > 0.05$) were found for testosterone concentration up to 147 days of average age. Castrated lambs had lower testosterone levels from 203 days of age, in relation to the others, even for the overall testosterone level ($p < 0.05$). The testosterone concentrations were lower than those reported by Rosa et al. (2000), which was 3950 pg ml^{-1} in adult and sexually experienced rams of the Texel and Suffolk breeds, after they were kept away from females for three months. This result was already expected, since the animals analyzed in the present study were younger, isolated from females from 150 days of age, and without any sexual experience.

Although the observed differences in blood testosterone concentration, the growth of the lambs seems to have been influenced from the time at which they were fed with supplementation, indicating that there may be an association between testosterone levels (anabolic hormone par excellence) and nutritional status. Supplementation started at 150 days of age (weaning), and from 203 days, the differences in weight, thoracic perimeter and body compactness, which were lower in the cryptorchid lambs, disappeared, and they showed greater average daily weight gain. At the same time, testosterone levels were higher in uncastrated and cryptorchid lambs.

Table 4. Mean and standard error for blood testosterone levels of cryptorchid, uncastrated, and castrated sheep (pg ml^{-1}) from 119 to 231 days of age.

Parameter (1)	Sexual Status			(p) Kruskal-Wallis
	Cryptorchid	Uncastrated	Castrated	
T 119 days	$256.8^a \pm 100.6$	$367.0^a \pm 159.2$	$123.3^a \pm 13.0$	0.1738
T 147 days	$492.5^a \pm 297.6$	$701.5^a \pm 317.3$	$146.5^a \pm 22.1$	0.3024
T 175 days	$1665.5^a \pm 617.6$	$243.3^b \pm 64.0$	$149.5^b \pm 18.8$	0.0183
T 203 days	$427.0^a \pm 181.3$	$1941.3^a \pm 1589.8$	$110.0^b \pm 5.1$	0.0210
T 231 days	$2108.3^a \pm 633.8$	$2341.8^a \pm 626.5$	$303.3^b \pm 172.6$	0.0388
OT	$990.0^a \pm 288.6$	$1118.9^a \pm 421.2$	$175.1^b \pm 38.6$	0.0249

* Means followed by different letters in the row are significantly different by the Kruskal-Wallis test ($p < 0.05$). (1) T, testosterone. OT, overall testosterone. pg ml^{-1}, picogram per milliliter.

Crouse et al. (1981), Azeredo et al. (2005a), Azeredo et al. (2005b), Rota et al. (2006), Jardim et al. (2007), and Osório et al. (2012) state that in young sheep, the hormone effect may not be manifest and, consequently, there is no effect of castration and/or sex when feeding is deficient, mainly due to the lack of supplementation.

Factors other than blood testosterone levels appear to influence lamb growth, especially at younger ages, which may account for the non-observation of future differences linked to the hormone.

Conclusions

The effect of castration on the production of testosterone can be observed from 175 days of average age, with hormone increase in blood levels in both uncastrated and induced to cryptorchidism lambs.

With advancing age, especially from 203 days of average age, both uncastrated and induced to cryptorchidism lambs, with feed supplementation, have greater potential for weight gain, with no differences until this age.

References

AYRES, M.; AYRES JUNIOR, M.; AYRES, D. L.; SANTOS, A. A. S. *BioEstat 5.3:* aplicações estatísticas nas áreas das Ciências Biomédicas. Belém: Sociedade Civil Mamirauá, 2007. 324 p.

AZEREDO, D. M. *Avaliação In Vivo, dos componentes corporais e da carcaça em cordeiros não castrados, castrados e criptorquidas da raça Corriedale.* 2003.

Dissertação (Mestrado em Zootecnia) - Curso de Pós-Graduação em Zootecnia, Universidade Federal de Pelotas, Pelotas.

AZEREDO, D. M.; OSÓRIO, M. T. M.; OSÓRIO, J. C. S.; MENDONÇA, G.; BARBOSA, J.; ESTEVES, R. M. Crescimento e desenvolvimento de ovinos Corriedale não castrados, castrados e criptorquidas abatidos com diferentes pesos. *Revista Brasileira Agrociência*, Pelotas, v. 11, n. 3, p. 339-345, 2005a.

AZEREDO, D. M.; OSÓRIO, M. T. M.; OSÓRIO, J. C. S.; MENDONÇA, G.; ESTEVES, R. M.; JARDIM, R. D.; POUEY, J. L. O., BARBOZA, J. Componentes corporais em ovinos corriedale não castrados, castrados e criptorquidas abatidos em diferentes idades. *Revista Brasileira Agrociência*, Pelotas, v. 11, n. 3, p. 333-338, 2005b.

AZEREDO, D. M.; OSÓRIO, M. T. M.; OSÓRIO, J. C. S.; MENDONÇA, G.; ESTEVES, R. M.; ROTA, E. L.; JARDIM, R. D.; PRADIÉE, J. Morfologia in vivo e da carcaça e características produtivas e comerciais em ovinos Corriedale não castrados, castrados e criptorquidas abatidos em diferentes idades. *Revista Brasileira Agrociência*, Pelotas, v. 12, n. 2, p. 199-204, 2006.

AZZARINI, M. Produção de carne ovina. In: JORNADA TÉCNICA DE PRODUÇÃO OVINA NO RIO GRANDE DO SUL, 1., 1979, Bagé. *Anais...* Bagé: Embrapa, 1979. p. 49-63.

AZZARINI, M.; GAGGERO, C.; CASTELLS, D.; CARDELLINO, R. Efeito de la castración, de la criptorquidia inducida y de la dotación, sobre el crecimento y la producción de carne de corderos pesados Tipo Sul en pasturas sembradas. *Producción Ovina*, Montevideo, v. 14, n. 1, p. 25-34, 2001.

BEERMANN, D. H.; ROBINSON, T. F.; HOGUE, D. E. Impact of composition manipulation on lean lamb production in the United States. *Journal of Animal Science*, Champaign, v. 73, n. 8, p. 2493-2502, 1995.

CARVALHO, S.; PIVATO, J.; VERGUEIRO, A.; KIELING, R.; TEIXEIRA R. C. Desempenho e características quantitativas da carcaça de cordeiros da raça Suffolk, castrados e não castrados, terminados CEZAR em confinamento. *Revista Brasileira Agrociência*, Pelotas, v. 11, n. 1, p. 79-84, 2005.

CEZAR, M. F.; SOUZA, W. H. *Carcaças ovinas e caprinas:* obtenção, avaliação e classificação. Uberaba: Agropecuária Tropical, 2007. 147 p.

CROUSE, J. D.; BUSBOOM, J. R.; FIELD, R. A.; FERRELL, C. L. The effects of breed, diet, sex, location and slaughter weight on lamb growth, carcass composition and meat flavor. *Journal of Animal Science,* Champaign, v. 53, n. 2, p. 376-386, 1981.

DOBBIE, J. L.; KIRTON, A. H.; FRASER, M. D.; WISE, B. D. Criptorquidia induzida - mejor que la castración tradicional. *Selecion de Temas Agropecuarios*, Montevideo, v. 3, n. 15, p. 46-50, 1993.

FERNANDES, M. Â. M.; MONTEIRO, A. L. G.; BARROS, C. S.; FERNANDES, S. R.; SILVA, M. G. B.; FERREIRA, F. S. Métodos para avaliação de produção de leite ovino. *Revista Brasileira Agrociência*, Pelotas, v. 15, n. 1-4, p. 17-22, 2009.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. Banco de dados. Pinheiro Machado: IBGE, 2012. Disponível em: <http://www.ibge.com.br>. Acesso em: 3 fev. 2014.

_______________. Cenário pouco favorável para os rebanhos. Brasília: IBGE, 2013. Disponível em: <https://censo2010.ibge.gov.br/2013-agencia-de-noticias/releases/14488-asi-ppm-2012-cenario-pouco-favoravel-para-os-rebanhos.html>. Acesso em: 5 fev. 2014.

JACOBS, J. A.; FIELD, R. A.; BOTKIN, M. P. Effects of testosterone enanthate on lamb carcass composition and quality. *Journal of Animal Science*, Champaign, v. 34, n. 1, p. 30-36, 1972.

JARDIM, R. D.; OSÓRIO, J. C. S.; OSÓRIO, M. T. M.; MENDONÇA, G.; ESTEVES, R.; GONÇALVES, M. Efeito da idade de abate e castração sobre a composição tecidual e química da paleta e da perna de ovinos Corriedale. *Revista Brasileira de Agrociência*, Pelotas, v. 13, n. 2, p. 237-242, 2007.

MOLENTO, M. B.; VERÍSSIMO, C. J.; AMARANTE, A. T.; VAN WYK, J. A.; CHAGAS, A. C. S.; ARAÚJO, J. V.; BORGES, F. A. Alternativas para o controle de nematoides gastrintestinais de pequenos ruminantes. *Arquivos do Instituto Biológico,* São Paulo, v. 80, n. 2, p. 253-263, 2013.

OSÓRIO, J. C. S.; OLIVEIRA, N. M.; OSÓRIO, M. T. M.; JARDIM, R. D.; PIMENTEL, M. A. Produção de carne em cordeiros cruza Border Leicester com ovelhas Corriedale e Ideal. *Revista Brasileira de Zootecnia*, Viçosa, v. 31, n. 3, p. 1469-1480, 2002.

OSÓRIO, J. C. S.; OSÓRIO, M. T. M. *Produção de carne ovina:* técnicas de avaliação in vivo e na carcaça. 2. ed. Pelotas: Universidade Federal de Pelotas, 2005. 82 p.

OSÓRIO, J. C. S.; OSÓRIO, M. T. M.; VARGAS JUNIOR, F. M.; FERNANDES, A. R. M.; SENO, L. O.; RICARDO, H. A.; ROSSINI, F. C.; ORRICO JUNIOR, M. A. P. Critérios para abate do animal e a qualidade da carne. *Revista Agrarian*, Dourados, v. 5, n. 18, p. 433-443, 2012.

PINHEIRO, R. S. B.; SILVA SOBRINHO, A. G.; MARQUES, C. A. T.; YAMAMOTO, S. M. Biometría *In Vivo* e da carcaça de cordeiros confinados. *Archivos de Zootecnia*, Córdoba, v. 56, n. 216, p. 955-958, 2007.

RIBEIRO, T. M. D.; COSTA, C.; MONTEIRO, A. L. G.; PIAZETTA, H. V. L.; FERNANDES, M. A. M.; PRADO, O. R. Carcaças e componentes não-carcaça de cordeiros terminados em pasto de azevém recebendo suplementação concentrada. *Ciência Rural*, Santa Maria, v. 42, n. 3, p. 526-531, 2012.

ROCHA, H. C.; DICKEL, E. L.; MESSINA, S. A. *Produção de cordeiro de corte em sistema de consorciação.* 2. ed. Passo Fundo: UPF, 2007. 76 p.

ROCHA, H. C.; VIEIRA, M. I. B.; FONSECA, R. S.; COSTA, L. O.; CECCHETTI, D.; NADAL, R. P.; ROCHA, F. S. Produção de carne e características da carcaça de cordeiros não castrados, castrados e induzidos ao criptorquidismo. *Semina: Ciências Agrárias*, Londrina, v. 31, n. 3, p. 783-792, 2010.

ROSA, H. J. D.; JUNIPER, D. T.; BRYANT, M. J. The effect of exposure to oestrous ewes on rams' sexual behaviour, plasma testosterone concentration and ability to stimulate ovulation in seasonally anoestrous ewes. *Applied Animal Behaviour Science*, Amsterdam, v. 67, n. 4, p. 293-300, 2000.

ROTA, E.; OSÓRIO, M. T. M.; OSÓRIO, J. C. S.; OLIVEIRA, M.; WIEGAND, M.; MENDONÇA, G.; ESTEVES, R.; GONÇALVES, M. Influência da castração e da idade de abate sobre as características subjetivas e instrumentais da carne de cordeiro Corriedale. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 35, n. 6, p. 2397-2405, 2006.

SILVA, D. C.; AZEVÊDO, D. M. M. R.; ALVES, A. A.; CAMPELO, J. E. G.; OLIVEIRA, M. E.; MALHADO, C. H. M. Estimativa do peso vivo através do perímetro torácico de ovinos Santa Inês. *Revista Científica Produção Animal*, Areia, v. 8, n. 2, p. 41-46, 2006.

STATISTICAL ANALYSIS SYSTEM INSTITUTE - SAS Institute Inc. SAS/STAT® 9.2 User's Guide. Cary: SAS Institute Inc, 2008. 16 p.

TEIXEIRA, P. P. M.; SILVA, A. S. L. da; VICENTE, W. R. R. Castração na produção de ovinos e caprinos. *Revista Científica Eletrônica de Medicina Veterinária*, Garça, v. 8, n. 14, p. 1-15, 2010.

YÁÑEZ, E. A.; RESENDE, K. T.; FERREIRA, A. C. D.; MEDEIROS, A. N.; SILVA SOBRINHO, A. G.; PEREIRA FILHO, J. M.; TEIXEIRA, I. A. M. A.; ARTONI, S. M. B. Utilização de medidas biométricas para predizer características da carcaça de cabritos Saanen. *Revista Brasileira de Zootecnia*, Viçosa, MG, v. 33, n. 6, p. 1564-1572, 2004.