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The Effect of Chemical and Surgical Castration on the Live Weight Gain and some Hormones of Male Norduz Sheep

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Authors' Contribution
KK, AT and TS conceived and designed the survey. KK collected and statistically analyzed the data. BC, AC and DSA analyzed seminal plasma samples obtained from males. TS, HK and KK evaluated characteristics. KK and MMT significantly contributed to the interpretation of data, drafting and carefully revising the manuscript for intellectual content.

Key words
Castration, Hormone, Body weight, Norduz.

ABSTRACT

The aim of this study was to investigate the effects of surgical and chemical castration on body weight and some hormones. In the present study, 2.5-3-month-old weaned male Norduz sheep were used. The sheep were obtained in the year 2015 from Livestock Application and Research Directorate of Yuzuncu Yil University. The sheep were randomly allocated into three groups each of which contained 10 sheep. The groups were formed as; Group 1 The Control Group (No castration), Group 2 (Surgical castration group) and Group 3 (Chemical castration group), respectively. Blood sample was taken from vena jugularis of the animals before the application and every two months for a total of 4 times for 6 months and hormone analyses were performed. The order of statistical significance for TSH (thyroid stimulating hormone) were found as Surgical > Control > Formol ($P < 0.05$). The order of statistical significance for growth hormone was Formol = Surgery > Control ($P<0.05$). In August month, the application factor was found to be significant only in testosterone ($P < 0.05$). No significant difference between the control and surgical groups in testosterone was noted. In this study, although the application of different castration methods in 4-month-old male Norduz sheep resulted in changes in the blood hormone levels, it was determined that these changes did not affect body weight. In conclusion, the evaluation of the process in castrated six-month-old sheep revealed an increase in the body weight which was similar to that in the control group.

INTRODUCTION

In farm animals, growth has always been one of the most important characteristics that attract both livestock breeders and the researchers. The castration of male animals that will be taken to fattening is a priority in practice for breeders and researchers. Castration is a significant application that can be made for small ruminants in different ways depending on its purpose (Bakır *et al*., 2006). In the castration applications in sheep, there are many studies with the aim of investigating its interactions with age, growth-development, behavior, body weight, hormonal changes, nutrition and meat quality (Molony *et al*., 1993; Popkin *et al*., 2012; Calık, 2014). It was reported that castration increases the growth rate, provides more efficient and economical feeding opportunities and has positive effects on the intended product (Sales, 2014).

Castration is made in sheep, goat and cattle in Turkey. Castration is applied to make these animals easier to manage, avoid haphazard mating, obtain better quality cubs and prevent the smell caused by androgens in male animals (Türkoğlu, 1985).

Castration is an application that aims to eliminate reproductive ability in male animals and it prevents sexual behavior. Although the testosterone release is inhibited by castration in adult animals, sexual behavior characteristics continue for a while with the desire to mate. However, pre-sexual maturation applications can prevent the desire to mate (Ataç *et al*., 2004). Castration can be made both surgically and chemically. The relevant studies

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on the effects of castration on growth and development are still scarce. More detailed studies on the changes in the hormones that affect growth and development after castration are required.

In sheep, castration is applied in two ways; namely, surgical and chemical castrations. In bloodless method, burdizzo, castrator and elastrator are used. For anesthesia, local infiltration of the funiculus spermaticus is performed. In the surgical method, the testis is removed by cutting with the help of an emasculator. In the bloodless method, testes are atrophied by applying pressure on the funiculus spermaticus (Aslanbey and Candaş, 1987). Bakir *et al.* (2006) reported that early reproductive functions were inhibited when 0.2 mL of 5% formol solution was injected into scrotum for chemical castration.

It is accepted that the endocrine system plays an important role in the physical and chemical composition of blood. In particular, it has been accepted that corticosteroids and gonadal steroids may have significant effects on the composition of blood (Guyton, 1971). To best of our knowledge, there is lack of information about examining the effect of different methods on body weight and hormones in Turkey. Hence, the aim of this study was to investigate the effects of surgical and chemical castration on body weight and some hormones.

MATERIALS AND METHODS

In this study, 2.5-3-month-old weaned male Norduz sheep were used. The sheep were obtained in 2015 from Yüzüncü Yıl University Livestock Application and Research Directorate. The required permissions for the study were first obtained from the Ministry of Agriculture, Food and Livestock and later from the Yüzüncü Yıl University Experimental Animals Local Ethics Committee. In the study, Vilcain (5-10 cc) was used as a local anesthetic agent, Rompun (0.25 mg / kg, Xylasine hydrochloride) for sedation, Reptopen enj (1cc / 10kg / day) as post operative antibiotic and 5% formol solution for chemical castration.

The sheep were randomly allocated into three groups each of which contained 10 sheep and each sheep was given an ear number. The experiment groups were formed as; Group 1 The Control Group (No castration), Group 2 (Surgical castration group) and Group 3 (Chemical castration group). Weaning weights were measured using a 100-g sensitive scale. Daily feeds were given under the same conditions applied for the other animals in the flock. Every two months, the sheep were recorded for 6 months by weighing their body weights in the early morning.

In chemical castration, 0.2 cc of 5% formol solution was injected into the scrutums of sheep under sedation. For surgical castration, the sheep were sedated using Rompun. This was followed by local infiltration anesthesia of finaculus spermaticus. After shaving and disinfecting the region, the scrotum tip was cut with scissors in a size that the testes could be removed from the tip of the scrotum. The testes were taken out and then withdrawn to place the emulsion in the funiculus spermaticus. The testicles were removed appropriately by placing the emasculator. This procedure was performed separately for each testicle. Postoperative parenteral antibiotic administration was continued at least for one week.

Blood was taken from vena jugularis of animals before the application and every two months for a total of 4 times for 6 months. Blood samples were taken to non-anticoagulant tubes. The tubes were centrifuged at 3000 RPM for 10 min. The resultant serums were taken into Eppendorf tubes. The serums were stored at -20°C in deep freeze until the analysis. Leptin, ghrelin, testosterone, TSH, growth hormone analyses in the serum were performed using ELISA kits (YH Biosearch Laboratory) by following the manufacturer's instructions.

Statistical analysis

To analyze the biochemical parameters obtained during each measurement period, a randomized plot trial plan (one way ANOVA) was applied. Duncan multiple comparison test was used to determine significant differences between the measurement periods (Yeşilova and Denizhan, 2016). All statistical computations were performed using SAS 9.1.4 statistical software program.

RESULTS

June (Baseline), August, October and December values of the traits examined for each group are given in Table I. In August, testosterone in the formol group was significantly lower compared with those in the other groups ($P<0.001$) (Table I).

In June month, the application factor was found to be significant on testosterone and growth hormone parameters. The order of statistical significance for TSH was found as Surgical > Control > Formol ($P <0.05$). The order of statistical significance for growth hormone was determined as Formol = Surgery > Control.

In the month of August, the application factor was found to be only significant for testosterone ($P <0.05$). For testosterone, no significant differences between the control and surgical groups were found. However, the value of testosterone-treated group was found lower statistically than those of the other groups ($P <0.05$). There was no statistical difference between the application averages in terms of other parameters (Table I).

Table I.- Average value of live weight, leptin, ghrelin, testosterone, TSH and growth hormone in June (beginning), August, October and December.

	Control	Surgical	Chemical(Formol)	Sig.
June				
Live weight	33.60±2.96	36.78±3.92	31.37±4.26	
Leptin	54.77±7.34^{a}	70.45±3.35^{a}	76.85±9.75^{a}	0.1464
Ghrelin	19.55±3.03^{b}	36.07±4.72^{a}	26.50±2.77^{ab}	0.0493
Testosterone	55.32±13.47^{c}	193.47±23.08^{a}	131.68±8.33^{b}	0.0003
TSH	34.53±8.84^{b}	76.68±15.47^{a}	79.62±14.29^{a}	0.0425
Growth hormone	244.93±27.81^{b}	471.87±83.15^{a}	511.12±67.88^{a}	0.0213
August				
Live weight	35.53± 2.96^{a}	37.00±5.35^{a}	32.60±5.54^{a}	0.3583
Leptin	73.79±9.43^{a}	78.78±17.14^{a}	40.26±8.87^{a}	0.0890
Ghrelin	34.35±4.35^{a}	34.33±6.51^{a}	21.57± 4.07^{a}	0.1577
Testosteron e	153.03±20.97^{a}	145.48±14.75^{a}	57.93±11.19^{b}	0.0013
TSH	65.25±9.09^{a}	55.98±6.50^{a}	47.92±9.46^{a}	0.3734
Growth hormone	356.68±48.59^{a}	325.47±59.48^{a}	295.42±31.06^{a}	0.6707
October				
Live weight	36.00± 5.53^{a}	35.76± 5.54^{a}	33.80±4.58^{a}	0.8034
Leptin	49.65±6.12^{a}	65.24±6.73^{a}	80.25±18.95^{a}	0.1914
Ghrelin	30.40±4.23^{a}	27.70±4.03^{a}	36.88±3.99^{a}	0.3336
Testosterone	39.52±14.63^{a}	165.64±56.48^{b}	90.70±36.26^{b}	0.1162
TSH	44.02±7.01^{a}	79.66±15.13^{a}	91.60±53.17^{a}	0.4760
Growth hormone	296.74±32.14^{a}	355.40±25.42^{a}	286.85±45.11^{a}	0.3289
December				
Live weight	41.84± 6.76^{a}	41.24±5.86^{a}	36.10±9.40^{a}	0.4725
Leptin	67.53±10.29^{a}	76.93±7.77^{a}	61.27±4.79^{a}	0.3962
Ghrelin	22.00±4.46^{a}	21.63±1.69^{a}	17.08±2.43^{a}	0.4743
Testosterone	124.35±26.01^{a}	143.95±16.02^{a}	99.13±22.33^{a}	0.3718
TSH	46.23±9.68	83.30±16.68	69.38±11.26	0.1560
Growth hormone	268.48±34.02^{ab}	383.20±51.87^{a}	207.62±52.00^{b}	0.0449

The difference between the different letters was statistically significant (P <0.05).

In the control group, positive correlations were determined between the body weight and leptin, leptin and ghrelin, leptin and TSH, TSH and leptin, TSH and ghrelin, TSH and testosterone, and the growth hormone and ghrelin (P<0.05, P<0.01) (Supplementary Table SI).

A negative correlation was found insignificantly between the body weight and ghrelin in surgical group. In addition, several positive correlations were recorded for the body weight- testosterone, leptin-ghrelin, testosterone- TSH, ghrelin-testosterone, ghrelin- growth hormone, testosterone- body weight, testosterone-leptin, testosterone- ghrelin, testosterone-TSH, TSH-testosterone, testosterone-growth hormone, and growth hormone-ghrelin (Supplementary Table SII).

There was a significant negative correlation between body weight and growth hormone in the Formol Group. The correlations of leptin with ghrelin, testosterone and growth hormone were moderately positive, whereas the correlation between leptin and TSH was strongly positive. There was a negative and insignificant correlation between ghrelin and leptin, testosterone and TSH, testosterone and body weight. The correlations of testosterone with leptin, ghrelin and growth hormones, and the correlation between TSH and leptin were very strongly positive (P<0.01). Also, there was a positive correlation between TSH and ghrelin, testosterone and growth hormone. There was a negative correlation between growth hormone and body weight (P <0.05), and a positive correlation between leptin, and growth hormone and testosterone (Supplementary Table SIV).

DISCUSSION

In this method, the infection risk and pain is very high. Bloodless methods are the Elastrator method, Burdizzo emasculator method and the elastic tape method (Kent *et*

al., 1993; Lester *et al*., 1996; Molony *et al*., 1993). There are also chemical and immunological castration methods (Bakır *et al*., 2006). The comparison of the chemical castration method and the surgical castration method was carried out in the present study.

Sibyll *et al*. (2006), in their study on 2-7-month-old sheep, adopted both the burdizzo castration method and the elastic tape method and used Lidocaine as local anesthetic. The researchers found that both stress and pain were minimum before and after the applications. In the present study, lidocaine was used in a similar manner to the abovementioned study in chemical and surgical methods and pain was observed at a minimum level. However, Xylasine Hydrochloride, which was used as a sedative in the reduction of pain, was thought to be effective.

Castration greatly reduces the testosterone hormone, the androgenic hormones, and the levels of the estrogenic hormones secreted in very small quantities from the testes. They continue to be secreted in very small quantities only from the adrenal glands. There are significant changes in metabolism and growth rate resulting from the inadequacy of these hormones in the castrated animals. Castrated animals are calmer and docile and more likely to work compared to others. It was aimed in an earlier study to increase the meat yield and quality in fattening animals (Aslanbey and Candaş, 1987). Testosterone, the male sex hormone, is used to increase muscle mass due to its anabolic activity in cases including anemia, hypogonadism, and growth retardation (Kayaalp, 2000). It was determined that there was a positive correlation between serum testosterone level and body weight gains of animals in the present study, and a similar result was reported by Sales (2014). Yılmaz and Cengiz (2006) focused on the changes in the testicular characteristics and serum testosterone concentration according to age in male Norduz sheep and observed that environmental factors examined for their effects on testicular properties and serum testosterone concentration changed depending on the reproductive characteristics as well as age periods and body weight. It was also reported that the effect of body weight on serum testosterone concentration was very important.

Leptin is a protein hormone that plays an important role in the control of food intake and the regulation of energy homeostasis in mammals (Houseknecht and Portocarrero, 1998). It suppresses the secretion of neuropeptide Y, a potent appetizing peptide in the arcuate nucleus, known as the appetite center, located in the hypothalamus (Garcia *et al*., 2004). Thus, leptin, which also plays a role in the adaptation of animals to malnutrition, increases energy expenditure and reduces appetite (Mantzoros and Moschos, 1998; Garcia *et al*., 2004). Leptin, which regulates the energy balance and controls body weight (Houseknecht and Portocarrero, 1998), provides information to the brain about body fat deposits (Delavaud *et al*., 2000). The examination of the leptin values revealed different and irregular changes depending on the months and methods. The changes were more pronounced in the formol group than those in the surgical group, which may be due to the nutritional regimen and other environmental factors.

Ghrelin hormone affects many different systems such as growth hormone (GH), nutrition, gastric acid secretion, gastric motility and cell proliferation. Ghrelin increases growth hormone secretion in both *in vitro* and *in vivo* conditions, depending on the dose (Kojima *et al*., 1999; Peino *et al*., 2000). A positive correlation between Ghrelin and growth hormones was determined in our study. Ghrelin hormone increases the release of the growth hormone releasing hormone (GHRH) while reducing somatostatin release (Kaiya *et al*., 2007). As it increases the release of ghrelin from stomachs and other tissues during meals, the concentration in saliva and blood also increases by 70-80% (Kojima and Kangawa, 2005; Aydin *et al*., 2006). In the present study, while the values of ghrelin hormone decreased regularly in both trial groups, it was observed that this value increased in the second two-month period in the formol group.

In the studies conducted on experimental animals, ghrelin application had no effect on adrenocorticotropic hormone (ACTH), prolactin, follicle stimulating hormone (FSH), luteinizing hormone (LH) or thyroid stimulating hormone (TSH) released from the pituitary, whereas it increased the growth hormone (GH) (Arvat *et al*., 2001). Examining the ghrelin and growth hormone values in the study, a similar pattern was observed in the control group, which was similar to those reported by Arvat *et al*. (2001).

In conclusion, it was determined that, when the six-month period in castrated sheep was examined, the body weight gain in the surgical group was similar to the control group, whereas the body weight gain in the formol group was lower than those in both groups.

Aiming to examine factors affecting growth in Norduz sheep, Karakuş *et al*. (2009), found the effects of gender and delivery method on the birth weight and body weights on the 30th, 60th, 90th, 120th, 150th and 180th day while the dam's age had no effect on the body weights in all the periods.

CONCLUSION

Breed and age factors should be taken into consideration to slow down the movements of the animals and to reduce their energy consumption for the castration process in months in which sexual maturity is observed in male sheep. In addition, the application of the castration

process can give better results by taking the influence and share of genetic and environmental factors into consideration. In this study, although the application of different castration methods in 4-month-old male Norduz sheep resulted in changes in the blood hormone levels, it was determined that these changes had no significant effect on body weight. Based on the results of this study, for the future studies on this subject, it is recommendable that factors affecting growth, species and breed identification along with continuous and discontinuous environmental factors affecting the research, gene factors including gene expression levels that can be induced by direct or indirect joint gene interactions of hormone genes such as ACTH, LH, FSH, TSH and GH directly affecting sexual activities and dominance and epistatic effects should be taken into consideration during planning, and appropriate methods should be adopted accordingly.

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Supplementary material

There is supplementary material associated with this article. Access the material online at: http://dx.doi.org/10.17582/journal.pjz/2017.49.5.1835.1840

Statement of conflict of interest

Authors have declared no conflict of interest.

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