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The Effect of Environmental Factors on Testicular and Body Measurements of Norduz Lambs

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ABSTRACT

The objective of this study is to determine the effects of certain environmental factors on the testicular size and body size of male Norduz lambs. In the study, testicular diameter, testicular length, scrotal length, and scrotal circumference were determined to be 2.98±0.10, 5.56±0.14, 9.76±0.16, and 14.08±0.20 cm in male Norduz lambs, respectively. Body length, chest width, chest depth, withers height, rump height, and chest girth were 50.25±0.55, 14.65±0.15, 23.64±0.25, 58.49±0.55, 59.14±0.55, and 71.39±0.73 cm, respectively. According to the results of the GLM analysis that birth type had no significant influence on testicular traits or on any of the body measurements except body length. Live weight gain had significant impact ($p<0.001$) on all traits. Age also had significant impact on lambs' body length, chest width, and chest depth ($p<0.001$), a significant effect on rump height and chest girth ($p<0.01$), and a significant effect on withers height ($p<0.05$).

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INTRODUCTION

Norduz sheep and goats, which have been bred in Van and the surrounding area for many years, take their name from the Norduz region, which is part of the Gürpınar district in the Van province. Norduz sheep are a domestic animal genotype that is well adapted to environmental conditions and disease-resistant; this genotype is very productive compared to other domestic animal genotypes (Bingöl, 1998; Kum, 2006). Norduz sheep are a very important genetic resource for the future and are closely related to a culture's history, society, and economy. It is well known that our domestic sheep breeds have low and vary considerably in fertility. Therefore, reproductive traits should be defined as specific to each breed, and the relationships between these traits and other yields should be determined (Kaşıkçı, 2007).

Reproduction is the foundation of other yields in animal production (Kaşıkçı, 2007). Animal products of economic importance, including meat, milk, and fleece, can only be produced through reproduction. Fertility is also very important for protecting generation and ensuring effective animal breeding (Özdemir and Altın, 2002).

Testicular characteristics, including testicular diameter and length and scrotal length and circumference, can easily be measured at an early age. These characteristics have high heritability and a strong hereditary relationship with the number of ovulations, which play an important role in genetically improving offspring (Yılmaz and Aygün, 2002; Koyuncu *et al*., 2005; Sarı *et al*., 2013; Kaymakçı, 2016). Therefore, parameters such as testicular characteristics are used as indirect selection criteria. Many studies have reported significant relationships between testicular traits and semen production and quality (Salhab *et al*., 2001; Söderquist and Hultén, 2006; Perumal, 2014).

Body measurements of farm animals are related to growth and developmental traits (Hajiyev and Akdağ, 2020). Environmental factors that may affect the growth and developmental traits of lambs include gender, birth type, dam age, dam weight at birth, weaning weight, and birth weight (Bingöl and Bingöl, 2015; Hajiyev and Akdağ, 2020). The growth and developmental characteristics of livestock can be defined as a function of various environmental factors; growth curves can be constructed and various models developed for tracking these characteristics.

Growth, defined as increase in weight and body measurements over time, is a heritable trait, and the differences among species, breeds, and individuals with respect to this trait can be explained by mathematics

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(Çelikeloğlu and Tekerli, 2014). Body measurements in livestock can be used for breed identification; these qualitative growth indicators are also used to evaluate the effectiveness of some breeding programs (Aytekin, 2011; Akdağ, 2019; Hajiyev and Akdağ, 2020).

For regional sheep production, many scientists recommend the development of a qualified breed of sheep with fat and semi-fat tails that can satisfy regional producers' demands for meat and milk and that is very well adapted to the region. Norduz sheep represent an important potential resource for the identification of new types that can be used to improve the genetic characteristics of local livestock in this region (Bingöl *et al*., 2007).

This study aimed to compare the testicular traits and body sizes of male Norduz lambs with those of other indigenous breeds and to determine the fertility, conformation, and morphological structure of male Norduz lambs.

MATERIALS AND METHODS

The animal material of the study consisted of 28 male lambs born in 2020 from Norduz sheep bred in Van Yüzüncü Yıl University Agricultural Application and Research Farm. Measurements of testicular diameter, testicular length, scrotum length and scrotum circumference of male lambs were started 45 days after birth and continued monthly until 165 days of age. During each inspection period when testes were measured, male lambs were weighed and measurements of body length, chest width, chest depth, withers height, breech height, and chest girth were taken and recorded. Male lambs were separated from their mothers the evening before the study day and all measurements were taken the next day on an empty stomach. Male lambs are weaned at 90 days of age. Testicular diameter, testicular length, scrotal circumference and scrotal length were measured in male lambs according to the definition of Kaymakçı (2016). In the study, body measurements, body length, distance from the top of the shoulder (*articulus humeri*) to the seat node (*tuber ischii*); chest width, distance between the pits behind the rudders; chest depth, vertical distance between the withers and *sternum*; withers height, vertical distance from the highest point of the withers to the ground were measured.

The height of the rump and the vertical distance from the rump region to the ground were measured with a measuring stick. Chest girth is the measurement that completely encloses the chest and passes through the withers and *sternum* and was measured with a tape measure (Mavule *et al*., 2013; Alarslan and Aygün, 2019; Hajiyev and Akdağ, 2020).

The following model for testicular and body measurements was used in the analysis of the obtained data.

$$Y_{ij} = \mu + a_i + b_j + b1(X_{ij} - \bar{X}) + e_{ij}$$

In the model; Y_{ij} = Anybody measurements or testicular characteristics of an i. old and j. birth type lamb; μ = expected value of the population; a_i = the effect of the i. age (i=1,2,3,4,5); b_j = the effect of the j. birth type (j=1,2; single, twin); $b1$ = regression coefficient of live weights of lambs at the time of inspection; $\bar{X}$ = average body weight of lambs at the time of inspection; X_{ij} = body weight of i. old, j. birth type lamb at the time of inspection; e_{ij} = Indicates independent and random error.

Statistical analyzes of the data were performed using the SAS statistical software program (SAS, 2020). The analyzes were performed using the general model procedure and the least squares method in SAS. Pearson's correlation analysis was used to determine the relationships between the characteristics.

RESULTS AND DISCUSSION

Characteristics of the testis

The least squares means and standard errors of testicular traits in male Norduz lambs are shown in Table I. Testicular diameter, testicular length, scrotal length and scrotal circumference are the characteristics of testes; they were determined to be 2.98±0.10, 5.56±0.14, 9.76±0.16 and 14.08±0.20 cm, respectively. While the influence of live weight and age of lambs on testicular traits was significant ($p<0.001$), the influence of birth type was found to be insignificant. The testicular diameter values obtained in this study were similar to those obtained in the study of Yılmaz and Aygün (2002) in male Norduz lambs (2.54 at day 90, 2.80 at day 110, 3.15 at day 130, 3.40 cm at day 170). It was found that the values obtained in the study of Yılmaz and Cengiz (2006) in male Norduz lambs (3.28 cm on day 90, 3.59 on day 120, 4.21 on day 150 and 4.74 cm on day 180).

For testicular length, the values in the study of Yılmaz and Aygün (2002) are similar in male Norduz lambs (5.52 cm at day 90, 5.88 at day 110, 6.23 at day 130, 6.45 cm at day 170). In the study of Yılmaz and Cengiz (2006), it was found that the values were higher in male Norduz lambs (7.03 cm on day 90, 7.37 cm on day 120, 8.32 cm on day 150 and 9.63 cm on day 180).

The values of scrotum length obtained in this study were lower than those obtained in the study of Yılmaz and Aygün (2002) in male Norduz lambs (10.92 cm at day 90, 11.18 at day 110. day, 11.70 cm on day 150 and 11.74 cm on day 170) and the values in the study of Yılmaz and Cengiz (2006) in male Norduz lambs (day 90 12.202, day 120 13.76, day 150 14.09 and day 180 15.40 cm).

Table I. Testicular characteristics of male Norduz lambs in different periods (cm) (Values are in Mean±SEM).

Factors	n	Testis		Scrotum	
		Diameter	Length	Length	Circum
Overall mean	140	2.98±0.10	5.56±0.14	9.72±0.16	14.08±0.20
Birth type		NS	NS	NS	NS
Single	120	2.97±0.05	5.57±0.07	9.67±0.11	14.09±0.14
Twin	20	3.03±0.11	5.48±0.17	9.96±0.27	14.03±0.35
Lamb age		***	***	***	***
45 days	28	2.64±0.16^{a}	4.74±0.23^{a}	10.54±0.38^{ae}	14.10±0.48^{a}
75 days	28	2.50±0.12^{b}	5.25±0.17^{b}	9.28±0.28^{bcd}	13.12±0.36^{b}
105 days	28	2.56±0.11^{b}	5.53±0.16^{b}	8.57±0.26^{c}	13.88±0.34^{ab}
135 days	28	3.63±0.11^{cd}	5.72±0.17^{b}	9.74±0.28^{ad}	14.20±0.36^{ac}
165 days	28	3.68±0.12^{d}	6.41±0.17^{c}	10.96±0.28^{e}	14.08±0.36^{ab}
Regression (Lin.)		***	***	***	***
Live weight (kg)		0.08±0.01	0.11±0.01	0.15±0.02	0.19±0.03

($p<0.05$): *, ($p<0.01$):**, ($p<0.001$):***, $\bar{X}$ = Means, $S_{\bar{x}}$ = Standard error, NS: Not Significant. $^{a, b, c,}$ means bearing different superscript along a row are significantly different.

The values in this study for scrotal circumference were compared with those in the study of Yılmaz and Aygün (2002) in male Norduz lambs (16.02 at day 90, 16.98 at day 110, 16.56 at day 130, 17.74 cm at day 150 and 17.98 cm at day 170). It was found that the values in the study of Yılmaz and Cengiz (2006) in male Norduz lambs (90th day 18.16, 120th day 19.37, 150th day 21.13 and 180th day 23.96 cm).

In this study, the effect of age of lambs on testicular diameter, testicular length, scrotal length and scrotal circumference was significant ($p<0.001$), while the differences between age groups of lambs were significant for each trait (Table I). Özdemir and Altın (2002) and Koyuncu *et al*. (2005) reported that in their study on male Kıvırcık lambs, they found the age period significant ($p<0.05$-$p<0.01$) and the difference between the age groups of the lambs significant, respectively. In the study conducted by Yılmaz and Cengiz (2006) and Yılmaz and Aygün (2002) on male Norduz lambs, it was reported that the effect of age periods on testicular characteristics was significant ($p<0.05$-$p<0.01$). In the present study, the differences between age periods were statistically significant only for scrotal length. It was reported that the difference between age periods was significant or significant only for scrotal length. In the present study, the difference between age groups was found to be significant for each of the testicular characteristics (Table I).

Body measurements

The least squares means and standard error of body measurements of male Norduz lambs are presented in Table III. For body measurements, it was found that the general mean of body length was 50.25±0.55 cm, chest width was 14.65±0.15, chest depth was 23.64±0.25, withers height was 58.49±0.55, rump height was 59.14±0.55 and chest girth was 71.39±0.73. It was found that the influence of live weight on body measurements was significant ($p<0.001$). The influence of age of lambs on body length, chest width and chest depth was significant ($p<0.001$), influence on rump height and chest girth was significant ($p<0.01$) and influence on withers height was significant ($p<0.05$). It was found that the influence of birth type on all body measurements except body length was insignificant.

Table II shows some of the studies on body measurements. Table III shows the least squares means and standard errors of the values obtained in this study. When the values in this study (Table III) are compared with Table II, they are lower than the values in the study of Bingöl *et al*. (2007) on sheep of different ages and similar to the values in the study of Kum (2006) on male lambs of different ages. The study by Akdağ (2019) on 5-7 months old male and female lambs revealed that the values for depth of chest, height at withers and width of chest were similar but lower than the values for body length and chest girth.

It was found that the values in the study were lower than those of Bingöl and Bingöl (2015) (Hamdani sheep of different ages), Gökdal *et al*. (2000) (Karakaş sheep of different ages), Koncagül *et al*. (2012) (Zom rams), Çimen *et al*. (2003) (Gıcık rams), in Table II.

Table II. Some studies of other researchers on body measurements.

Animal material	Lamb age	Rump height	Body length	Chest depth	Withers height	Chest girth	Chest width	References
Norduz		59.20±0.55	49.94±0.64	23.66±0.25	58.52±0.56	71.47±0.73	14.66±0.15	This study
Norduz			67.68±0.24	33.22±0.10	71.18±0.18	97.77±0.36	18.30±0.11	Bingöl *et al*. (2007)
Norduz	90th day		50.84±0.51	21.41±0.21	56.17±0.46	62.60±0.53	13.66±0.16	Kum (2006)
Norduz	150-210		56.29±0.50	23.47±0.26	60.32±0.51	75.81±0.83	14.73±0.24	Akdağ (2019)
Hamdani			66.20±0.80	32.25±0.92	68.47±1.21	99.62±0.94	22.34±0.66	Bingöl and Bingöl (2015)
Karakaş			64.68±0.40	33.37±0.21	67.32±0.39	95.06±0.92	19.88±0.25	Gökdal *et al*. (2000)
Karakaş	118th day		56.22±0.55	25.02±0.22	56.50±0.55	73.13±0.86	16.42±0.19	Gökdal *et al*. (1999)
Zom		75.50±0.83	66.10±0.91	34.40±0.59	76.20±1.57	99.80±1.73	21.10±0.49	Koncagül *et al*. (2012)
Gıcık		63.44±0.44	67.89±0.65	33.67±0.53	62.22±0.66	99.78±1.24	21.11±0.26	Çimen *et al*. (2003)
Kıvırcık	90th day	55.78±0.28	54.95±0.35	21.44±0.17	55.48±0.30	66.57±0.48	14.53±0.16	Alarslan and Aygün (2019)
Hemşin	90th day		8.70±0.47	22.49±0.93	56.58±0.78	67.81±1.06		Sarı *et al*. (2014)
Karadolak	90th day	52.51±0.28	51.88±0.37	23.35±0.34	53.00±0.30			Hajiyev and Akdağ (2020)

Table III. Body measurements in Norduz male lambs (cm) (Values are in Mean±SEM).

Factors	N	BL	CW	CD	WH	RH	CG
Overall mean	140	50.25±0.55	14.65±0.15	23.64±0.25	58.49±0.55	59.14±0.55	71.39±0.73
Birth type		*	NS	NS	NS	NS	NS
Single	120	50.46±0.26	14.71±0.09	23.67±0.08	58.44±0.25	59.10±0.23	71.29±0.20
Twin	20	48.99±0.64	14.27±0.22	23.47±0.21	58.79±0.62	59.42±0.57	72.00±0.49
Daily age of lamb		***	***	***	*	**	**
45 days	28	45.67 ± 0.88^{a}	15.10 ± 0.30^{a}	22.86 ± 0.28^{a}	56.75 ± 0.85^{ab}	59.17 ± 0.78^{ab}	69.91 ± 0.67^{a}
75 days	28	47.72 ± 0.65^{b}	16.61 ± 0.22^{a}	23.11 ± 0.21^{b}	58.20 ± 0.63^{bd}	58.60 ± 0.58^{a}	72.08 ± 0.49^{bcd}
105 days	28	51.61 ± 0.62^{c}	14.21 ± 0.21^{bc}	22.92 ± 0.20^{b}	58.55 ± 0.60^{bd}	58.52 ± 0.55^{a}	71.19 ± 0.47^{ab}
135 days	28	52.52 ± 0.65^{c}	14.26 ± 0.22^{c}	24.48 ± 0.21^{cd}	59.13 ± 0.63^{cd}	59.07 ± 0.58^{a}	72.37 ± 0.49^{ce}
165 days	28	51.10 ± 0.66^{c}	13.27 ± 0.22^{d}	24.48 ± 0.21^{d}	60.45 ± 0.64^{c}	60.92 ± 0.59^{b}	72.66 ± 0.50^{de}
Regression (Lin.)		***	***	***	***	***	***
Live weight (kg)		0.38±0.05	0.20±0.02	0.25±0.02	0.54±0.05	0.62±0.04	0.83±0.04

BL, Body Length; CW, Chest width; CD, Chest depth; WH, Withers height; RH, Rump height; CC, Chest girth; NS, Not Significant. [a, b, c.] means bearing different superscript along a row are significantly different, ($p<0.05$):*, ($p<0.01$):**, ($p<0.001$):***, $\bar{X}$ = Means, $S_{\bar{x}}$ = Standard error.

Based on the 90-day values of male and female Kıvırcık, Hemşin and Karadolak lambs in Table II, it is clear that the values in this study are lower than the results of Alarslan and Aygün (2019) and Sarı *et al*. (2014) in terms of body length and similar to the results of Hajiyev and Akdağ (2020). It can be seen that the values of withers height and chest girth in this study are higher than the results of Alarslan and Aygün (2019) and Sarı *et al*. (2014). The depth of chest is higher than Alarslan and Aygün (2019) and similar to Hajiyev and Akdağ (2020) and Sarı *et al*. (2014).

In the study, the difference between the control age of lambs was significant ($p<0.05$). Accordingly, the effects on body length, chest width, chest depth, withers height, rump height and chest girth are shown in Table I.

The Pearson correlation coefficients explaining the relationship between body weight, height, and testicular characteristics are shown in Figure 1. If you look at the figure, you will find the distribution chart of the relevant values in the section below the intercept formed by the relevant trait itself. The bar graph of the relevant characteristic in the intercept cell and the Pearson correlation coefficients of the body weight, body measurements and testicular measurements with each other are given above the intercept. As can be seen from Figure 1, the relationship between all the traits was found

to be significant (p<0.001).

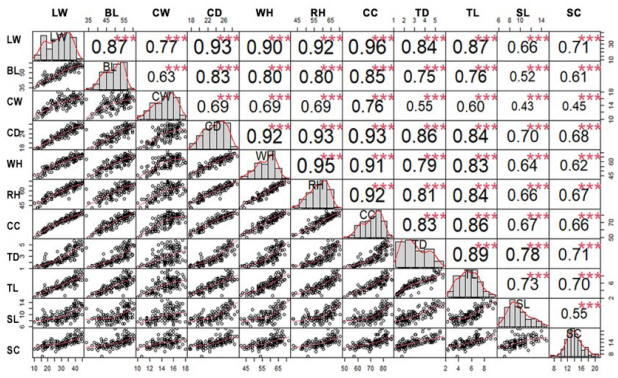

Fig. 1. Pearson correlation coefficients explaining the relationship between body weight, body size and testicular characteristics. BL, Body Length; CW, Chest width; CD, Chest depth; WH, Withers height; RH, Rump height; CC, Chest circumference; TD, Testis Diameter; TL, Testis Length; SL, Scrotum Length; SC, Scrotum Circumference. *** all correlations are statistically significant (p<0.001).

The correlation between body weight and body measurements and testicular characteristics was found to be positive and significant (p<0.001). Specifically, correlation with chest depth, withers height, rump height and chest girth was found to be 0.93, 0.90, 0.92 and 0.96 respectively. Chest depth also showed high correlation with other traits.

According to Figure 2, it can be seen that body length, height at withers, rump height and chest girth increase in parallel. The live weight of lambs increases rapidly from birth to 3 months of age, and after 3 months (post weaning) it shows a similar increase parallel to the body measurements as shown in the figure. Interpretation of the values given in Figure 2 shows that the correlations between individual body sizes and the influence of live weight on body traits are very large (p<0.001).

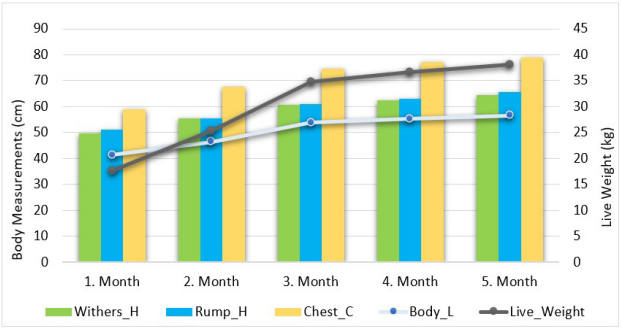

Fig. 2. Changes in live weights and body measurements in Norduz lambs between 1 and 5 months.

According to Figure 3, testicular diameter, testicular length, scrotal length and scrotal circumference increased in parallel until 5 months of age, while live weight increased rapidly from birth to 3 months of age (weaning age) and there was a parallel increase in testicular characteristics after 3 months of age. Interpreting the values in Figure 3, it was found that the correlations between each testicular trait and the effect of live weight on body traits were very large (p<0.001).

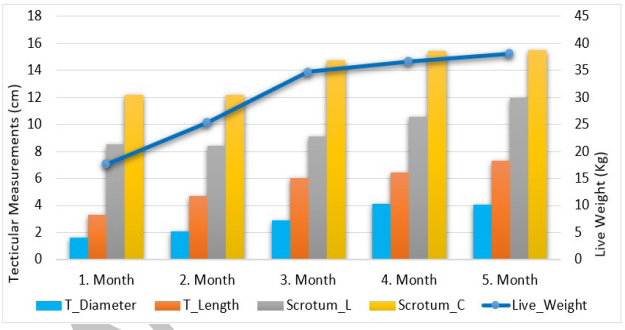

Fig. 3. Changes in live weights and testicular measurements in Norduz lambs between 1 and 5 months.

CONCLUSIONS AND RECOMMENDATIONS

Among the indirect selection criteria used in genetic improvement of progeny, some negative traits can be eliminated by selecting male breeding animals at an early age, taking into account testicular traits that have important advantages, such as being easy to measure at an early age. At the same time, it is desirable that male lambs or rams have good reproductive ability to achieve a high pregnancy rate in sheep. In fact, the inability of females to become pregnant or infertile may be caused by males.

Body measurements provide information on the morphological structure of animals. Considering that meat yield is closely related to body size, it is possible to increase meat production by using big size, elongated, wide and deep animals in sheep farming (Sarı *et al*., 2014). Rapid growth of lambs is a preferred way to increase the efficiency of sheep production. Measurements such as withers height, chest depth, chest girth, body length, rump height and tibia girth are emphasized in the growth and development process and morphological identification of animals.

Most of the sources reported that it is not sufficient or would not be sufficient to select animals on the basis of testicular traits only. Therefore, in this study, an attempt was made to determine body measurements and body weight gain in male Norduz lambs in addition to testicular traits. The effects of qualitative and quantitative

environmental factors on testicular traits and body measurements were also determined. It was found that the effects of age and live weight of lambs on testicular traits, which were among these environmental factors, were very important ($p<0.001$). In body measurements, age of lambs had a significant ($p<0.001$) effect on body length, chest width and chest depth. Age of lambs had significant ($p<0.01$) effect on rump height and chest girth and significant ($p<0.05$) effect on withers height. Qualitative environmental factors such as birth type had no significant effect on testicular traits and body measurements except body length ($p<0.05$).

It is important that animals have good conformation to increase productivity in sheep production. This is because any structural defect in breeding rams is passed on from generation to generation. Body size and testicular characteristics are important body traits to be considered.

In order to determine the morphological and physiological characteristics as well as various yield traits of the Norduz sheep, which is of great importance for regional sheep production and is threatened with extinction, studies should be conducted in larger populations. Norduz sheep are characterized as a high meat and milk productive breed. With this feature, it is important in terms of providing the livelihood of the people of the region. At the same time, Norduz sheep are a very important genetic resource for the future and represent a culture historically, socially and economically. This study aims to contribute to the studies on Norduz sheep, which have been poorly researched, and to provide a basis for future scientific studies. Taking into account the data of this and previous studies, it can be said that Norduz lambs are a breed of sheep that have important characteristics related to testicular traits, grow fast and reach yielding age early and can be successful in mutton production due to their morphological structures, body size, length and depth. In relation to these traits, it can be said that it is a local genotype that can be considered highly productive compared to indigenous breeds.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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