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Growth Characteristics and Some Body Measurements of Tuj Lambs*

Mehmet SARI[1], Serpil ADIGÜZEL IŞIK[1], Kadir ÖNK[2], Ali Rıza AKSOY[1], Muammer TİLKİ[1]
[1]Kafkas University, Faculty of Veterinary Medicine, Department of Animal Science, Kars-TURKEY
[2] Kafkas University, Kars Vocational College, Department of Crop and Animal Production, Kars-TURKEY

Summary: The study was conducted to investigate the effects of birth year, sex, birth type and age of dam on the growth characteristics and some body measurements of Tuj lambs. These traits were measured on 163 Tuj lambs with 30 day intervals from birth to 180 days of age in 2010 and 2011. The effect of birth year on live weight was significant (P<0.05-P<0.001) in all age groups except for the 120th, 150th and 180th days of live weights. Sex was not found to be significant (P<0.05) in all age groups except for the 30th day live weight. The effect of the birth type on the live weight on day 30th and 60th were significant (P<0.05-P<0.001). The effect of age of dam on the birth weight, the 30th, 60th, 90th and 120th day weight were also found significant (P<0.05-P<0.001). The lambs born from 4 year-old ewes had heavier birth weight than those of lambs born from 2, 3 and 5 years old ewes. The effect of birth year on body measurements was significant (P<0.05-P<0.001). Generally, the effects of sex and birth type on body measurements were not significant (P>0.05). The effect of dam age on body measurements was found to be significant (P<0.05-P<0.001) in all age groups except for the150th and 180th days. The results of the study showed that the influence of age of dam on growth is very important and ought to be taken into account in lamb production breeding.

Key Words: Body measurements, growth characteristics, tuj lamb

Tuj Kuzularında Büyüme Özellikleri ve Bazı Vücut Ölçüleri

Özet: Bu araştırma Tuj kuzularının büyüme özellikleri ve bazı vücut ölçülerine ana yaşı, cinsiyet, doğum tipi ve doğum yılının etkisini belirlemek için yapılmıştır. Kuzuların canlı ağırlıkları ve vücut ölçüleri 2010 ve 2011 yıllarında doğan 163 Tuj kuzusundan canlı ağırlıkları ve vücut ölçüleri doğumdan 180. güne kadar 30 gün aralıklarla alınmıştır. Doğum yılının 120, 150 ve 180. gün canlı ağırlıkları hariç diğer günlerdeki canlı ağırlıklara etkisi önemli belirlenmiştir (P<0.05-P<0.001). Cinsiyetin, 30. gün canlı ağırlığı hariç diğer günlerde etkisi önemsiz bulunmuştur (P>0.05). Doğum tipinin yalnız 30 ve 60. gün canlı ağırlıkları üzerine etkisinin önemli olduğu belirlenmiştir (P<0.05-P<0.001). Ana yaşının, doğum, 30, 60, 90 ve 120. gün canlı ağırlıklarına etkisinin önemli olduğu tespit edilmiştir (P<0.05-P<0.001). Dört yaşlı analardan doğan kuzuların doğum, 30, 60 ve 90. gün canlı ağırlıkları 2, 3 ve 5 yaşlı analardan doğan kuzuların doğum, 30, 60 ve 90. gün canlı ağırlıklarından yüksek olduğu belirlenmiştir. Genel olarak, cinsiyet ve doğum tipinin vücut ölçülerine etkisi önemsiz bulunmuştur (P>0.05). Ana yaşının 150 ve 180. gün vücut ölçüleri hariç, diğer tüm günlerde etkisinin önemli olduğu belirlenmiştir (P<0.05-P<0.001). Sonuç olarak özellikle ana yaşının büyüme özellikleri üzerine çok etkili olduğu ve kuzu üretiminde ve ıslahında dikkate alınması gerektiğinin önemi ortaya çıkmıştır.

Anahtar Kelimeler: Büyüme özellikleri, tuj kuzusu, vücut ölçüleri

Introduction

Sheep breeding plays an important role in the Turkish agricultural economics and in nourishing people. The indigenous sheep breeds are adapted to the natural environment of different regions of the country and play a unique role in the utilization of vast areas of natural grazing throughout Turkey (2). "Tuj sheep, a well adopted breed for the geography and climate of the highlands, and is also very common breed throughout the north-east of Turkey". As a general practice, Tuj lambs are reared for meat and some are sold at the end of the grazing season (16).Despite the presence of a large population of sheep in Turkey, the yield of sheep breeds are inadequate. In recent years, incomes obtained from sheep production have increased significantly owing to the production of lambs with high meat quality and quantity Despite the presence of a large population of sheep in (11). Approximately 95.29% of Turkey's sheep population (23.089.691 head) consists of fat-tailed breeds. Sheep meat (135.687 t) is an important component of red meat production corresponding to 17.37% of the total meat production (780.718 t) in Turkey. There are 195.992 heads of sheep in Kars, 1/7 of which is Tuj breed (5, 17).

Lamb production is highly influenced by non-genetic factors such as birth year, sex, birth type and age of dam. Dixit et al. (7), Keasev and Tsaliev (12), Lacin

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and Aksoy (14), Macit et al. (15) reported that birth year, sex, birth type and age of dam have a significant influence on body weight and body measurements of lambs.

The aim of this study was to determine the characteristics of body weight and body measurements of Tuj lambs. In order to describe the variation within the traits of interest of Tuj lambs, birth year, sex, birth type and age of dam, measurements taken from this study were compared with other studies. Furthermore, the effects of birth year, sex, birth type and age of dam on growth characteristics and some body measurements were investigated.

Material and Methods

This experiment was conducted at the Application and Research Farm of the Faculty of Veterinary Medicine, Kafkas University in Kars, Turkey. The lambs were born in March and April during the lambing season in 2010 (n=74) and 2011 (n=89). Lambing occurred in a building with littered floor which had ambient temperature. Routine lamb management such as iodine treatment of the navel and ear tagging was practised. The lambs remained with their dams in individual boxes for three days after birth and were allowed to suckle their mothers continuously. The lambs were grazed separately under the semi-free range grazing management system. Any lamb with an incomplete record was eliminated from the data file.

Identities of newborn lambs and their dams, dates of birth, sex, birth type and birth weights (within 24 h of lambing), body weight and body measurements (body length, chest girth, wither height, chest depth, circumference of cannon bone forelimb and circumference of cannon bone hind limb) on the 30^{th}, 60^{th}, 90^{th}, 120^{th}, 150^{th} and 180^{th} days of age were recorded. Live weights of lambs were recorded during morning hours and on fasting animals. When taking the body measurements; length, height and depth measurements were taken, using a measuring whilst; chest girth and cannon bone circumference measurements were taken using a tape measure (1). The birth weights of the lambs were weighed a scale sensitive to 0.01 g.

The following parameters were recorded:

Live weight: Recorded by a weighing scale at the same time of the day;
Body length: Distance from the most cranial point of the sternum to the most caudal point of the pin bone;
Chest girth: Chest circumference just behind the forearms;
Withers height: It was measured vertically from the thoracic vertebrae to the ground;
Chest depth: was measured from the spianus process to the xyfoid process of the sternum;
Circumference of cannon bone forelimb: Smallest circumference of the cannon bone of the forelimb;
Circumference of cannon bone hind limb: Smallest circumference of the cannon bone of the hind limb.

Live weights of body and measurements at the 30^{th}, 60^{th}, 90^{th}, 120^{th}, 150^{th} and 180^{th} days were calculated by interpolation method. Data were analyzed, using least squares mixed model procedures of SPSS 12.0 software package. The traits measured on lambs were analyzed by fixed effects of year (2010, 2011), sex of lamb (male, female), age of dam at birth (2, 3, 4 and 5 years of age) and type of birth (single, twin). Duncan multiple comparison tests were used to evaluate the significance of the difference among the groups. The model used to analyze the growth characteristics and body measurements were:

$$Y_{ijkl} = \mu + a_i + b_j + c_k + d_l + e_{ijkl}$$

Where; for lamb growth characteristics and body measurements, Y is the characteristics, μ is the overall mean, ai is the effect of year of birth (2010 and 2011), bj is the effect of sex of lamb (male, female), ck is the effect of type of birth (single, twins), dl is the effect of dam age (2-5) and eijkl is the random residual.

Results

The least squares means for live weights of the lambs at the birth, 30^{th}, 60^{th}, 90^{th}, 120^{th}, 150^{th} and 180^{th} days of age are shown in Table 1. The overall mean birth, the 30^{th}, 60^{th}, 90^{th}, 120^{th}, 150^{th} and 180^{th} days weights of lambs were 4.19±0.13, 9.04±0.29, 12.94±0.47, 16.94±0.71, 21.38±0.84, 26.77±0.91 and 29.94±0.92 kg, respectively. The effect of birth year was found significant ($P<0.05$-$P<0.001$) in all age groups except for the 120^{th}, 150^{th} and 180^{th} days live weights. The lambs born in 2010 had heavier live weights in age groups than those born in 2011. Male lambs had heavier live weights in all age groups compared to the female lambs. Effect of the birth type on the live weight at birth, the 90^{th}, 120^{th}, 150^{th} and 180^{th} day weights was not significant ($P>0.05$), while the difference at 30^{th} and 60^{th} the day weights was significant ($P<0.05$-$P<0.001$). The effect of the age of dam on birth weight, the 30^{th}, 60^{th}, 90^{th} and 120^{th} day weights was found to be significant ($P<0.05$-$P<0.001$). Lambs born from 4 years old ewes had heavier birth weight than those born from 2, 3 and 5 years old ewes.

The least squares means for body measurements of the lambs at birth, the 30th, 60th, 90th, 120^{th}, 150^{th} and 180^{th} days of age are shown in Table 2, Table 3, and Table 4. The effect of the birth year on body measurements was significant ($P<0.05$-$P<0.001$). Lambs born in 2010 had longer body length, chest girth, withers height and chest depth than those born in 2011 in all age groups; while the lambs born in 2010 had lower circumference of cannon bone forelimb and

Table 1. Means (±SEM) for weights of lambs from birth to 180 days of age (kg)

Production trait	Live weights							
	n	Birth	30 day	60 day	90 day	120 day	150 day	180 day
2010	74	4.41±0.14	9.85±0.31	14.20±0.51	17.75±0.77	21.81±0.91	27.46±0.99	30.36±1.00
2011	89	3.97±0.15	8.22±0.32	11.68±0.52	16.13±0.79	20.94±0.94	26.09±1.02	29.52±1.03
Years	Sig.	P<0.001	P<0.001	P<0.001	P<0.05	P>0.05	P>0.05	P>0.05
Male	87	4.30±0.14	9.38±0.32	13.18±0.51	17.22±0.78	21.56±0.93	27.00±1.00	29.98±1.01
Female	76	4.08±0.14	8.69±0.32	12.70±0.51	16.66±0.78	21.20±0.93	26.55±1.00	29.90±1.01
Sex	Sig.	P>0.05	P<0.01	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Single	153	4.29±0.07	10.00±0.15	14.05±0.25	18.20±0.38	22.65±0.44	27.15±0.48	31.10±0.49
Twins	10	4.09±0.25	8.07±0.55	11.83±0.89	15.68±1.36	20.11±1.61	26.40±1.75	28.78±1.77
Type of birth	Sig.	P>0.05	P<0.001	P<0.05	P>0.05	P>0.05	P>0.05	P>0.05
2	48	3.80±0.17^{b}	8.06±0.37^{b}	11.42±0.59^{b}	15.42±0.90^{b}	19.90±1.07^{b}	25.46±1.16	29.17±1.17
3	54	4.30±0.16^{a}	9.52±0.36^{a}	13.87±0.58^{a}	18.24±0.88^{a}	22.64±1.05^{a}	27.48±1.13	29.90±1.15
4	44	4.46±0.14^{a}	9.97±0.32^{a}	14.28±0.52^{a}	18.46±0.79^{a}	21.96±0.93^{ab}	26.60±1.01	29.97±1.02
5	17	4.21±0.22^{ab}	8.59±0.48^{b}	12.19±0.78^{b}	15.63±1.18^{b}	21.02±1.40^{ab}	27.56±1.52	30.73±1.54
Age of dam	Sig.	P<0.001	P<0.001	P<0.001	P<0.01	P<0.05	P>0.05	P>0.05
Overall mean	163	4.19±0.13	9.04±0.29	12.94±0.47	16.94±0.71	21.38±0.84	26.77±0.91	29.94±0.92

a, b: The differences between the means of groups carrying various letters in the same column are significant.

circumference of cannon bone hind limb in all age groups.

Generally, effects of the sex and birth type on the body measurements (body length, chest girth, withers height, chest depth and cannon bone circumference) were not significant (P>0.05). Male lambs had heavier body length, chest girth, and withers height and chest depth in all age groups than female lambs. In addition, single lambs had heavier body length, chest girth, withers height and chest depth in all age groups than twin lambs. The effect of dam age on body measurements was found to be significant (P<0.05-P<0.001) in all age groups except for 150th and 180th days.

Discussion

Growth characteristics are very important for sheep production. Rapid growth of lambs is desirable because it is a way of improving sheep production efficiency. Genetic and non-genetic factors (year, sex of lamb, type of birth, age of dam and mother's milk yield) can affect growth characteristics of lambs. In this study, overall mean birth weight, the 30th, 60th and 90th days live weights in Tuj lambs were higher heavier than those reported by Lacin and Aksoy (14). Also, the overall mean for birth weight, and the 30th days live weights were higher than those reported by Aksoy et al. (4) for Tuj lambs, while the 60th and 90th live weights were similar to those reported by Aksoy et al. (4).

Lambs born in 2010 were 0.54 kg heavier (P<0.001) than those born in 2011. The difference between years in birth weight may have been partly due to the differences in ambient temperature, maternal pre-natal effects during gestation and body conditions of dams. Male lambs were consistently heavier than female lambs. Male lambs at birth were 0.22 kg heavier (P>0.05) than female lambs. Published research indicates that males usually have higher birth weights (9, 10, 14).

Single lambs were consistently heavier than twins lambs. The average difference between single lambs and twins regarding birth weight was 0.20 kg. Similar effects of birth type on lamb birth weight were observed by Gbangboche et al. (8), Unal et al. (19) and Yilmaz et al. (21).

Lambs born from 4 years old dams had 0.66 kg higher birth weights than those born from 2 year-old dams. The results from the literature indicate that there is a consistent pattern in different breeds and flocks for the effect of age of dam on birth weight. An increase in birth weight was observed up to an age of 4 years in Karacabey Merino and Kıvırcık (13) and Ramlic ewes (6), six years in Awassi ewes (3) and up seven years in Awassi, Morkaraman and Tuj ewes (15).

Body measurements of lambs show body frame of lambs. Birth year had a significant effect on body measurements in our study. Our findings are in agreement with those reported by Van Wyk et al. (20) for body measurements.
In this study the effects of sex and birth type on body measurements were not statistically significant. In this study, body length, chest girth and withers height at 90 days were lower than those reported by Ulusan

Table 2. Means (±SEM) of body length and withers height of lambs from birth to 180 days of age (cm)

Production trait	Body length							
	n	Birth	30 day	60 day	90 day	120 day	150 day	180 day
2010	74	29.07±0.42	39.14±0.49	44.16±0.66	47.57±0.63	50.90±0.71	55.58±0.72	57.79±0.88
2011	89	27.05±0.43	36.84±0.50	41.51±0.68	45.47±0.64	49.44±0.73	53.36±0.74	55.86±0.91
Years	Sig.	P<0.001	P<0.001	P<0.001	P<0.001	P<0.05	P<0.001	P<0.05
Male	87	28.05±0.42	38.35±0.49	42.92±0.67	46.74±0.63	50.44±0.72	54.27±0.73	56.50±0.90
Female	76	28.07±0.42	37.63±0.49	42.76±0.67	46.30±0.63	49.90±0.72	54.66±0.73	57.16±0.90
Sex	Sig.	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Single	153	28.71±0.20	39.31±0.24	43.56±0.32	47.89±0.30	51.97±0.34	55.02±0.35	56.61±0.43
Twins	10	27.41±0.74	36.67±0.86	42.12±1.17	45.16±1.10	48.37±1.25	53.92±1.27	57.04±1.56
Type of birth	Sig.	P>0.05	P<0.01	P>0.05	P<0.05	P<0.01	P>0.05	P>0.05
2	48	27.13±0.49^{b}	36.66±0.57^{c}	41.78±0.77^{b}	45.80±0.73^{bc}	48.85±0.83^{b}	54.20±0.84	57.40±1.03
3	54	28.64±0.48^{a}	38.96±0.56^{a}	44.76±0.76^{a}	48.01±0.72^{a}	50.93±0.81^{ab}	55.04±0.82	56.68±1.01
4	44	28.61±0.43^{ab}	38.85±0.50^{ab}	44.19±0.68^{a}	47.49±0.64^{ab}	51.41±0.72^{a}	54.99±0.73	57.51±0.90
5	17	27.86±0.64^{ab}	37.49±0.75^{bc}	40.62±1.02^{b}	44.79±0.96^{c}	49.47±1.08^{ab}	53.64±1.10	55.72±1.36
Age of dam	Sig.	P<0.01	P<0.001	P<0.001	P<0.001	P<0.01	P>0.05	P>0.05
Overall mean	163	28.06±0.38	37.99±0.45	42.84±0.61	46.52±0.57	50.17±0.65	54.47±0.66	56.83±0.81
Production trait	**Withers height**							
	n	Birth	30 day	60 day	90 day	120 day	150 day	180 day
2010	74	36.55±0.49	41.87±0.57	46.01±0.52	49.40±0.63	52.32±0.70	56.15±0.72	58.67±0.73
2011	89	35.86±0.51	38.27±0.59	43.70±0.53	46.37±0.64	50.55±0.72	53.96±0.74	56.18±0.75
Years	Sig.	P>0.05	P<0.001	P<0.001	P<0.001	P<0.01	P<0.001	P<0.001
Male	87	36.73±0.50	40.37±0.58	45.50±0.52	48.47±0.63	51.71±0.71	55.20±0.73	57.57±0.74
Female	76	35.68±0.50	39.78±0.58	44.21±0.52	47.30±0.63	51.15±0.71	54.91±0.73	57.28±0.74
Sex	Sig.	P<0.05	P>0.05	P<0.01	P<0.05	P>0.05	P>0.05	P>0.05
Single	153	36.11±0.24	40.91±0.28	45.54±0.25	48.44±0.30	52.05±0.34	55.00±0.35	57.20±0.36
Twins	10	36.30±0.87	39.24±1.01	44.17±0.91	47.33±1.11	50.82±1.24	55.11±1.28	57.64±1.29
Type of birth	Sig.	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
2	48	35.47±0.58	38.95±0.67^{b}	43.57±0.60^{b}	47.20±0.73^{b}	50.47±0.82	54.87±0.84	58.20±0.85
3	54	36.80±0.57	41.14±0.65^{a}	45.92±0.59^{a}	48.99±0.72^{a}	52.06±0.80	55.65±0.83	58.27±0.84
4	44	36.68±0.50	41.03±0.58^{a}	46.23±0.53^{a}	48.55±0.64^{ab}	52.36±0.72	55.30±0.74	57.25±0.75
5	17	35.87±0.76	39.17±0.87^{b}	43.70±0.79^{b}	46.79±0.96^{b}	50.84±1.08	54.39±1.11	55.97±1.12
Age of dam	Sig.	P>0.05	P<0.001	P<0.001	P<0.05	P>0.05	P>0.05	P>0.05
Overall mean	163	36.20±0.45	40.07±0.52	44.86±0.48	47.88±0.58	51.43±0.65	55.05±0.66	57.42±0.67

a, b, c: The differences between the means of groups carrying various letters in the same column are significant.

and Aksoy (18) for the age of 2-3 and 4-6 with male and female in Tuj ewes; but body length, chest girth, withers height, circumference of cannon bone forelimb and circumference of cannon bone hind limb at 180 days were higher than those reported by Ulusan and Aksoy (18) for age of 2-3 and 4-6 with male and female in Tuj ewes.

Although the works has been done on this subject, the determination of growth and body measurements (every month) for 6 months and the number of data analyzed may have the potential to increase the importance of values obtained.

The results of this study suggest that the influence of birth year and age of dam on growth characteristics and body measurements of lamb are very important and ought to be taken into account in sheep production. The growth characteristics and body measurements for birth year, sex, type of birth and age of dam may be useful in obtaining precise estimates of breeding values that are necessary for of animal breeding.

Table 3. Means (±SEM) of chest girth and chest depth of lambs from birth to 180 days of age (cm)

Production trait	Chest girth							
	n	Birth	30 day	60 day	90 day	120 day	150 day	180 day
2010	74	35.62±0.48	48.86±0.67	56.79±0.94	62.09±1.08	67.40±1.10	73.32±1.06	76.91±1.06
2011	89	33.67±0.49	46.31±0.69	51.73±0.96	58.57±1.11	64.66±1.13	70.20±1.09	72.10±1.09
Years	Sig.	P<0.001	P<0.001	P<0.001	P<0.001	P<0.01	P<0.001	P<0.001
Male	87	34.94±0.48	47.62±0.68	54.14±0.95	60.08±1.09	65.72±1.11	71.35±1.08	74.14±1.07
Female	76	34.36±0.48	47.55±0.68	54.38±0.95	60.58±1.09	66.33±1.11	72.17±1.08	74.86±1.07
Sex	Sig.	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Single	153	35.69±0.23	48.03±0.33	55.94±0.45	62.65±0.52	68.77±0.53	73.09±0.52	76.25±0.51
Twins	10	33.60±0.84	47.14±1.19	52.58±1.65	58.01±1.90	63.29±1.94	70.44±1.87	72.76±1.87
Type of birth	Sig.	P<0.05	P>0.05	P<0.05	P<0.05	P<0.01	P>0.05	P>0.05
2	48	33.34±0.56^{b}	46.62±0.79^{b}	52.44±1.09^{b}	58.12±1.26^{b}	63.72±1.28^{c}	70.49±1.24	74.54±1.24
3	54	35.11±0.55^{a}	48.43±0.77^{a}	55.57±0.59^{a}	63.15±1.23^{a}	68.07±1.26^{a}	73.19±1.22	74.38±1.21
4	44	35.29±0.49^{a}	48.61±0.69^{ab}	57.11±0.96^{a}	62.72±1.10^{a}	67.77±1.12^{ab}	72.24±1.08	75.79±1.08
5	17	34.85±0.73^{ab}	46.68±1.03^{b}	51.91±1.43^{b}	57.34±1.65^{b}	64.56±1.68^{bc}	71.13±1.63	73.30±1.62
Age of dam	Sig.	P<0.001	P<0.05	P<0.001	P<0.001	P<0.001	P>0.05	P>0.05
Overall mean	163	34.65±0.44	47.59±0.62	54.26±0.86	60.33±0.99	66.03±1.01	71.76±0.98	74.50±0.97
Production trait	**Chest depth**							
	n	**Birth**	**30 day**	**60 day**	**90 day**	**120 day**	**150 day**	**180 day**
2010	74	13.52±0.29	17.26±0.34	20.03±0.31	21.63±0.35	23.88±0.30	25.60±0.32	26.51±0.32
2011	89	11.52±0.30	16.07±0.35	18.09±0.32	20.33±0.36	22.17±0.31	23.13±0.33	23.66±0.33
Years	Sig.	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
Male	87	12.67±0.29	16.78±0.35	19.21±0.31	21.05±0.35	23.04±0.31	24.36±0.32	25.17±0.33
Female	76	12.38±0.29	16.56±0.35	18.91±0.31	20.91±0.35	23.01±0.31	24.37±0.32	25.01±0.33
Sex	Sig.	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
Single	153	12.89±0.14	17.23±0.17	19.16±0.15	21.41±0.17	23.27±0.15	24.59±0.15	25.39±0.16
Twins	10	12.16±0.51	16.11±0.61	18.96±0.54	20.56±0.61	22.79±0.53	24.15±0.56	24.79±0.57
Type of birth	Sig.	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05	P>0.05
2	48	12.21±0.34	16.69±0.40	18.71±0.36^{b}	20.70±0.41^{b}	22.52±0.35^{b}	24.12±0.37	24.71±0.38
3	54	12.59±0.33	16.92±0.39	19.54±0.35^{a}	21.71±0.40^{a}	23.53±0.35^{a}	24.73±0.36	25.26±0.37
4	44	12.76±0.29	16.77±0.35	19.83±0.31^{a}	21.67±0.36^{ab}	23.20±0.31^{ab}	24.32±0.32	25.29±0.33
5	17	12.53±0.44	16.29±0.53	18.15±0.47^{b}	19.85±0.53^{c}	22.86±0.46^{b}	24.30±0.49	25.09±0.50
Age of dam	Sig.	P>0.05	P>0.05	P<0.001	P<0.001	P<0.05	P>0.05	P>0.05
Overall mean	163	12.52±0.26	16.67±0.32	19.06±0.28	20.98±0.32	23.03±0.28	24.37±0.29	25.09±0.30

a, b, c: The differences between the means of groups carrying various letters in the same column are significant.

Table 4. Means (± SEM) of circumference of cannon bone forelimb and hind limb of lambs from birth to 180 days of age (cm)

Production trait	Circumference of cannon bone forelimb							
	n	Birth	30 day	60 day	90 day	120 day	150 day	180 day
2010	74	5.74±0.08	6.29±0.06	6.57±0.08	6.82±0.10	7.17±0.10	7.58±0.09	7.84±0.10
2011	89	5.87±0.08	6.35±0.07	6.89±0.08	7.10±0.11	7.77±0.10	8.02±0.10	8.11±0.10
Years	Sig.	P>0.05	P>0.05	P<0.001	P<0.01	P<0.001	P<0.001	P<0.001
Male	87	5.90±0.08	6.40±0.06	6.77±0.08	7.01±0.10	7.56±0.10	7.86±0.10	8.00±0.10
Female	76	5.71±0.08	6.24±0.06	6.69±0.08	6.90±0.10	7.39±0.10	7.73±0.10	7.95±0.10
Sex	Sig.	P<0.01	P<0.01	P>0.05	P>0.05	P<0.05	P>0.05	P>0.05
Single	153	5.89±0.04	6.45±0.03	6.83±0.04	7.10±0.05	7.66±0.05	7.95±0.05	8.16±0.05
Twins	10	5.72±0.14	6.19±0.11	6.63±0.14	6.82±0.18	7.28±0.17	7.65±0.17	7.79±0.18
Type of birth	Sig.	P>0.05	P<0.05	P>0.05	P>0.05	P<0.05	P>0.05	P<0.05
2	48	5.61±0.10^{b}	6.06±0.07^{b}	6.53±0.09^{b}	6.74±0.12^{b}	7.29±0.11	7.69±0.11	7.92±0.12
3	54	5.82±0.09^{a}	6.41±0.07^{a}	6.89±0.09^{a}	7.08±0.12^{a}	7.50±0.11	7.81±0.11	8.04±0.11
4	44	5.84±0.08^{a}	6.45±0.07^{a}	6.81±0.08^{a}	7.07±0.11^{a}	7.49±0.10	7.77±0.10	7.97±0.10
5	17	5.95±0.12^{a}	6.36±0.10^{a}	6.69±0.12^{ab}	6.95±0.16^{ab}	7.61±0.15	7.91±0.14	7.98±0.15
Age of dam	Sig.	P<0.05	P<0.001	P<0.001	P<0.01	P>0.05	P>0.05	P>0.05
Overall mean	163	5.80±0.07	6.32±0.06	6.73±0.07b	6.96±0.09	7.47±0.09	7.80±0.09	7.97±0.09
Production trait	Circumference of cannon bone hind limb							
	n	Birth	30 day	60 day	90 day	120 day	150 day	180 day
2010	74	6.34±0.08	7.09±0.08	7.58±0.09	7.95±0.10	8.23±0.10	8.68±0.09	8.97±0.09
2011	89	6.54±0.09	7.14±0.08	7.67±0.09	8.08±0.11	8.69±0.10	8.98±0.10	9.20±0.09
Years	Sig.	P<0.01	P>0.05	P>0.05	P>0.05	P<0.001	P<0.001	P<0.01
Male	87	6.50±0.08	7.22±0.08	7.67±0.09	8.11±0.10	8.55±0.10	8.87±0.10	9.11±0.09
Female	76	6.38±0.08	7.00±0.08	7.59±0.09	7.92±0.10	8.36±0.10	8.79±0.10	9.06±0.09
Sex	Sig.	P>0.05	P<0.01	P>0.05	P<0.05	P<0.05	P>0.05	P>0.05
Single	153	6.60±0.04	7.33±0.04	7.76±0.04	8.13±0.05	8.71±0.05	9.03±0.05	9.30±0.05
Twins	10	6.28±0.15	6.91±0.14	7.50±0.16	7.90±0.18	8.20±0.18	8.63±0.17	8.87±0.16
Type of birth	Sig.	P<0.05	P<0.01	P>0.05	P>0.05	P<0.01	P<0.05	P<0.05
2	48	6.17±0.10^{b}	6.83±0.10^{b}	7.45±0.10^{c}	7.81±0.12^{b}	8.24±0.12^{b}	8.71±0.11	9.03±0.11
3	54	6.52±0.09^{a}	7.19±0.09^{a}	7.80±0.10^{a}	8.13±0.12^{a}	8.48±0.11^{ab}	8.84±0.11	9.08±0.11
4	44	6.55±0.08^{a}	7.27±0.08^{a}	7.73±0.09^{ab}	8.11±0.11^{ab}	8.49±0.10^{ab}	8.78±0.10	9.05±0.09
5	17	6.52±0.13^{a}	7.17±0.13^{a}	7.53±0.14^{bc}	8.01±0.16^{ab}	8.61±0.15^{a}	8.99±0.15	9.18±0.14
Age of dam	Sig.	P<0.001	P<0.001	P<0.001	P<0.05	P<0.05	P>0.05	P>0.05
Overall mean	163	6.44±0.08	7.12±0.08	7.63±0.08	8.01±0.09	8.46±0.09	8.83±0.09	9.08±0.08

a, b, c: The differences between the means of groups carrying various letters in the same column are significant

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Yazışma Adresi:
Yrd. Doç. Dr. Mehmet SARI
Kafkas Üniversitesi Veteriner Fakültesi
Zootekni Anabilim Dalı Kars-Türkiye
E-posta: msari_40@hotmail.com