Kafkas Univ Vet Fak Derg
23 (1): 117-122, 2017
DOI: 10.9775/kvfd.2016.15976

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

Research Article

The Relationship between Body Dimensions and Fat Deposits in Herik Lambs [1]

Bülent TEKE [1] Mustafa UĞURLU [1] Filiz AKDAĞ [1] Bülent EKİZ [2]

[1] *This research was produced from the Research Fund of the Scientific and Technical Research Council of Turkey. Project Number: 115O829*

[1] Ondokuz Mayis University, Faculty of Veterinary Medicine, Department of Animal Breeding and Husbandry, TR-55200 Samsun - TURKEY

[2] Istanbul University, Faculty of Veterinary Medicine, Department of Animal Breeding and Husbandry, TR-34320 Istanbul - TURKEY

Article Code: KVFD-2016-15976 Received: 26.04.2016 Accepted: 19.09.2016 Published Online: 23.09.2016

Citation of This Article

Teke B, Uğurlu M, Akdağ F, Ekiz B: The relationship between body dimensions and fat deposits in Herik lambs. *Kafkas Univ Vet Fak Derg,* 23, 117-122, 2017. DOI: 10.9775/kvfd.2016.15976

Abstract

The aim of this research was to determine the relationships between some body measurements and fat deposits in the Herik lamb, reared in the central Black Sea Region of Turkey. In this study, data on 20 single-born male Herik lambs, namely 10 with short, round, fat tail, and 10 with long, semi-fat tails, were used. They were finished for an average of 105 days under intensive management after weaning and slaughtered at an average body weight of 40 kg. Several body measurements were taken before slaughter. Carcasses were cut into sections which were separated into meat, bone and fat. Weights of tail, carcass and non-carcass fat were recorded and used in the calculation of the total body fat weight. The highest correlation coefficient was between tail fat weight and the upper tail circumference (r= 0.937, P<0.01), and the lowest was between the fat tail weight and tail length (r=0.059). The upper and lower tail circumferences explained 88% of total variation in the tail weight, and 71% of total variation in total body fat, respectively. In conclusion, lower and upper tail circumference can be used to predict fat tail weight, as well as total body fat, in Herik lambs. More detailed studies are needed for the determination of the relationship between body measurements and fat deposits and to improve the carcass characteristics of Herik lambs.

Keywords: *Body measurement, Carcass, Fat, Herik, Lamb, Meat*

Herik Kuzularında Bazı Kuyruk ve Beden Ölçüleri ile Yağ Depoları Arasındaki İlişki

Özet

Bu araştırmanın amacı, Türkiye'de Orta Karadeniz Bölgesinde yetiştirilen Herik kuzularında bazı beden ölçüleri ile yağ depoları arasındaki ilişkiyi belirmekti. Bu çalışmada 10 baş kısa yuvarlak yağlı kuyruklu ve 10 baş uzun yarım yağlı kuyruklu kuzu olmak üzere 20 erkek tekiz doğmuş Herik kuzusu kullanıldı. Kuzular sütten kesimden sonra ortalama 105 gün entansif koşullarda beslendi ve ortalama 40 kg da kesildi. Kesimden önce bazı beden ölçüleri alındı. Karkaslar parçalara ayrıldı. Karkas parçaları et, kemik ve yağa ayrıldı. Kuyruk, karkas ve karkasa ait olmayan yağlar tartıldı ve toplam beden yağ ağırlığı belirlendi. En yüksek korelasyon kuyruk yağı ağırlığı ile kuyruk kökü çevresi arasında (r=0.937, P<0.01), en düşük korelasyon ise kuyruk yağı ağırlığı ile kuyruk uzunluğu arasında bulundu (r=0.059). Kuyruk kökü ve en geniş kuyruk çevresi, kuyruk yağı ağırlığındaki varyasyonun %88'ini, toplam beden yağı ağırlığındaki varyasyonun ise %71'ini açıkladı. Sonuç olarak, Herik kuzularında kuyruk kökü ve en geniş yerindeki kuyruk çevresi hem kuyruk yağı ağırlığını hem de toplam beden yağı ağırlığını tahmin etmede kullanılabilir. Herik kuzularında kuyruk ölçüleri ile yağ depoları arasındaki ilişkiyi belirlemek ve Herik kuzularının karkas özelliklerini geliştirmek için daha fazla çalışma yapılmalıdır.

Anahtar sözcükler: *Beden ölçüleri, Karkas, Yağ, Herik, Kuzu, Et*

INTRODUCTION

The fat tailed sheep is characterized by an accumulation of fat in the tail which provides an energy source when nutrition is insufficient [1,2]. The fat tailed sheep, which can walk long distances and overcome harsh environmental conditions such as high temperatures, is traditionally raised for meat production in arid or semiarid areas [2,3].

İletişim (Correspondence)
+90 362 312 19 19/3481
bulentteke@gmail.com

Turkey's sheep population is 31.1 million head and approximately 90-95% of all the sheep are fat and semi-fat tailed sheep [4]. Two tail types are seen in Herik sheep, namely short, round and long, semi-fat. The long, semi-fat tail is wide at the base and narrows towards the end [5] and the other tail type is short and round. Herik sheep are produced by crossbreeding the White Karaman and Red Karaman with Karayaka rams and are raised in the central Black Sea Region of Turkey, especially in Amasya Province [6].

Many authors have focused on the relationship between body weight and several body measurements in breeding strategies for small ruminants [7-9]. *In vivo* measurements, especially fat tail measurements, are commonly used in order to estimate carcass composition and fat deposits in breeding programs [10]. There have been many studies on the relationship between tail measurements and the fat deposits of sheep [2,11-14]. The aim of this research was to investigate the relationships between some tail and body measurements and fat deposits in Herik sheep in Turkey.

MATERIAL and METHODS

Animals and Measurements

This study was conducted on a private farm in Atakum, Samsun Province, Turkey. The farm is about 171 m above the sea level, and is located at a latitude of 41°24'N and a longitude of 36°08'E. The average temperature and humidity at the site were 22°C and 76% during the study. Fifty five millimetres of rain fell during the study period. A total of 20 single-born, male, Herik lambs, namely 10 short, round, fat-tailed lambs and 10 long, semi-fat tailed lambs, were used in this study. The lambs were born in April 2015 and kept with their dams until approximately 2.5 months of age. At weaning, the lambs were weighed (average 20.78±0.51 kg), and then kept in a finishing pen. The lambs were checked twice a day for health problems during the finishing period. Anthelmintics were administered for internal and external parasites and they were vaccinated against clostridia disease. The lambs were weighed weekly during the finishing period and slaughtered after reaching 40 kg slaughter weight (SW). The lambs were finished with two different feed concentrates for an average of 105 days. Diet 1 (18% CP, 2650 kcal/kg ME) was provided ad libitum until the lambs reached a body weight of 30 kg and Diet 2 (16% CP, 2650 kcal/kg ME) was provided ad libitum until the lambs reached the SW of 40 kg. In addition, the lambs were provided with 300 g of alfalfa hay per lamb per day, unlimited access to water and a mineral lick. The tail and body measurements were obtained before slaughter.

The body measurements included were withers height (WH), rump height (RH), heart girth (HG), chest depth (CD), body length (BL) and rump width (RW). WH was measured as the distance from the ground to the withers, RH was measured from the ground to the top of the rump, HG was measured as the circumference of the chest, CD was measured between the top of the withers and the lowest point of the chest, BL was measured from the articulatio humeri to the tuber ischii, and RW was measured between the outer edges of the major hip bones on the right and left sides. The tail dimensions included the upper circumference (UC), lower circumference (LC), upper tail thickness (UTT), upper width (UW), lower width (LW) and length of the fat-tail (TL). "Upper' and 'lower' measurements were taken at the base and the widest part of the fat-tail, respectively, as described by Safdarian et al.[14]. Circumference and width were measured with an ordinary flexible tape measure. The depth was measured with calipers and the length was measured with a ruler. All measurements were obtained while the animal was held in a standing position.

Slaughtering Procedures and Carcass Composition

The lambs were not fed but were provided ad libitum access to water in the 12 h immediately before slaughter. Lambs were slaughtered near their pen by severing the major blood vessels in the neck. Following skinning and evisceration, the hot carcass, including the tail fat, perinephric fat and kidneys, was weighed. Omental, mesenteric, scrotal and pericardial fats were separated from hot carcass fat and weighted. Cold carcass weights were recorded after storage at 4°C for 24 h. Weight of the tail, perinephric and pelvic fats were obtained from the cold carcass. The combined weights of omental, mesenteric, scrotal, pericardial, perinephric and pelvic fats were then recorded as the total non-carcass fat (NCF). The carcasses were split along the median plane into two equal halves with a band saw. The weights of the right and left halves were obtained. Subcutaneous fat depth was measured with calipers between the 12^{th} and 13^{th} ribs. Four measurements were taken, two on each side of the carcass, and their average was recorded as the subcutaneous fat depth. The left halves were sectioned according to a procedure reported by Akçapınar [15]. Each section (leg, foreleg, back, loin, neck, breast + flank) was then completely dissected into bone, fat (subcutaneous and intermuscular) and trimmed meat (TM), including the nerves and connective tissue, which were weighed separately. The amounts of subcutaneous and intermuscular fats (carcass fat, CF), muscle and bone were doubled to obtain the total carcass muscle, bone and fat. Total body fat (TBF) was calculated as NCF plus CF and FTW.

Statistical Analysis

The SPSS program was used for statistical analyses including descriptive statistics, Pearson's correlation coefficients and, multiple linear regression analyses, including residual standard deviations (RSD) [16].

RESULTS

The body measurements of the 20 Herik sheep included in the present study are presented in *Table 1*. Average body

Table 1. *Means and standard errors (SE) for body measurements of Herik lambs*

Tablo 1. *Herik kuzularının beden ölçülerinin ortalama ve standart hataları (SE)*

Characteristics	n	Mean	SE
Heart girth (HG), cm	20	69.08	0.40
Chest depth (CD), cm	20	25.93	0.52
Withers height (WH), cm	14	60.04	1.08
Rump height (RH), cm	14	55.86	0.92
Rump width (RW), cm	20	17.83	0.27
Body length (BL), cm	20	77.78	0.60
Upper circumference (UC), cm	14	43.57	2.68
Lower circumference (LC), cm	14	46.07	2.77
Lower tail width (LW), cm	14	26.54	8.03
Upper tail width (UW), cm	14	26.07	8.45
Tail length (TL), cm	14	32.86	0.67
Upper tail thickness (UTT), mm	14	39.95	2.36

Table 2. *Means and standard errors (SE) for certain carcass characteristics, carcass composition and fat deposits in Herik lambs.*

Tablo 2. *Herik kuzularının bazı karkas özellikleri, karkas kompozisyonu ve yağ depolarının ortalama ve standart hataları (SE)*

Characteristics	n	Mean	SE
Slaughter weight, kg	20	40.30	0.35
Hot carcass weight, kg	20	18.95	0.22
Cold carcass weight, kg	20	18.55	0.25
Dressing percentage, %	20	47.03	0.50
Back fat thickness, mm	20	4.30	0.24
Weight of fat deposits			
Total carcass fat, kg	14	5.01	0.15
Total non-carcass fat, kg	14	1.27	0.07
Tail fat weight, kg	20	1.71	0.14
Total body fat, kg	14	8.11	0.26
Proportions of fat deposits			
Total carcass fat, %	14	62.02	1.22
Total non-carcass fat, %	14	15.81	1.06
Tail fat, %	14	22.17	1.83
Weight of dissected tissues, kg			
Trimmed meat, kg	14	9.11	0.24
Bone, kg	14	3.01	0.12
Subcutaneous fat, kg	14	3.66	0.15
Intermuscular fat, kg	14	1.35	0.07
Proportions of dissected tissues			
Trimmed meat, %	14	48.37	1.18
Bone, %	14	15.98	0.54
Subcutaneous fat, %	14	19.46	0.78
Intermuscular fat, %	14	7.19	0.41
Tail fat, %	20	9.00	0.65

length, wither height, heart girth and chest depth were 77.78, 60.04, 69.08 and 25.93 cm, respectively. Carcass composition and fat deposit percentages are presented in *Table 2*. Average cold carcass weight was 18.6 kg, composed of 48.37% muscle, 26.65% fat and 15.98% bone. Correlation coefficients among some body measurements and carcass composition traits are shown in *Table 3*. LC had a positive and significant correlation with FTW (r=0.937, P<0.01), which was positively correlated with TBF (r=0.806, P<0.05).

In the present study, the tail fat percentage was lower than in fat tailed breeds. However subcutaneous and intermuscular fat percentages were higher than those of fat tailed breeds. Multiple linear regression equations were produced for the relationships between tail fat and total body fat, and LC and UC, with:

FTW = - 998.16 + 70.30 (LC) - 5.09 (UC), $R^2 = 0.879$, (P<0.001), RSD = 243.03

TBF = 4494.23 - 31.49 (LC) + 108.19 (UC), $R^2 = 0.714$, (P<0.001), RSD = 517.94

A significant multiple linear regression was also determined for the relationship between TM, and SW and RW, with:

TM = - 3529.64 + 0.07 (SW) + 558.17 (RW), $R^2 = 0.554$, (P<0.05), RSD = 594.48

DISCUSSION

There are no published reports for the carcass characteristics of Herik lambs. Body measurements, carcass composition and fat deposits were therefore compared with reports for other sheep breeds.

In studies of White Karaman lambs slaughtered between 36.7-41.6 kg, body lengths were between 57.8 and 67.8 cm, wither heights between 64.3 and 65.3, heart girths between 80.2 and 85.5 cm, and chest depths between 25.3 and 31.6 cm [13,15,17]. The reported values for body lengths were between 58.7 and 67.2 cm, wither heights between 55.0 and 64.9 cm, heart girths between 88.0 and 89.9 cm, and chest depths between 28.3 and 30.5 cm for Karayaka lambs slaughtered at 41.0-44.7 kg [18-20]. Body length, heart girth and chest depth of Red Karaman lambs slaughtered at 40 kg were 67.7 cm, 78.7 cm and 29.00, respectively [21]. In the present study, body length, wither height, heart girth and chest depth were 77.78, 60.04, 69.08 and 25.93 cm, respectively. That meant that the body length of Herik lambs was greater than that of White Karaman and Red Karaman lambs, while the withers height, heart girth and chest depth were shorter.

The reported values for tail circumferences were between 59.1 and 63.1 cm, and tail widths between 26.2 and 32.9 cm, for White Karaman lambs slaughtered at

Table 3. *Correlation coefficients among some body measurements and carcass composition traits*
Tablo 3. *Beden* ölçüleri *ile karkas kompozisyon* özellikleri *arasındaki korrelasyon eşitlikleri*

Characteristics	Tail Fat Weight (FTW)	Back Fat Thickness	Trimmed Meat (TM)	Non Carcass Fat (NCF)	Carcass Fat (CF)	Subcutaneous Fat	Intermuscular Fat	Total Body Fat (TBF)
Slaughter weight (SW)	0.276	-0.527*	0.578*	0.065	-0.004	0.030	-0.071	0.195
Heart girth (HG)	-0.105	0.126	0.410	0.159	0.020	0.196	-0.366	-0.077
Chest depth (CD)	0.176	0.225	0.476	-0.187	-0.214	-0.055	-0.330	-0.116
Withers height (WH)	-0.368	-0.223	0.229	-0.055	-0.489	-0.388	-0.206	-0.567*
Rump height (RH)	-0.346	-0.447	0.439	-0.121	-0.550*	-0.485	-0.130	-0.605*
Rump width (RW)	0.174	-0.365	0.738**	-0.160	-0.349	-0.321	-0.056	-0.182
Body length (BL)	-0.178	0.123	-0.323	-0.008	-0.168	-0.214	0.096	-0.351
Lower circumference (LC)	0.937**	0.127	-0.283	-0.419	0.427	0.516	-0.190	0.806**
Upper circumference (UC)	0.911**	0.170	-0.365	-0.285	0.455	0.552*	-0.205	0.842**
Lower tail width (LW)	-0.264	0.018	0.018	0.162	-0.221	-0.152	-0.142	-0.273
Upper tail width (UW)	-0.283	-0.021	0.063	0.210	-0.242	-0.204	-0.078	-0.285
Tail length (TL)	0.059	0.203	-0.050	0.106	-0.103	-0.230	0.266	0.013
Upper tail thickness (UTT)	0.785**	-0.219	0.097	-0.305	-0.026	0.096	-0.252	0.465
Tail fat weight (FTW)	1.000	-0.016	-0.189	-0.467	0.264	0.315	-0.108	0.743**

** P<0.05; ** P<0.01*

36.7 kg [17], 31.9 kg [22] and 41.6 kg [13]. In that study, the tail width, tail length and tail thickness of crossbred lambs (Chios x White Karaman F_1) was 17.80, 25.5 cm and 25 mm, respectively. In the present study, the LC, UC, LW, UW, TL and UTT were 43.57, 46.07, 26.54, 26.07, 32.86 cm and 39.95 mm, respectively. Also in the present study, the tail circumferences of Herik lambs were less than in their studies, while the tail length and tail width results of our study were in accordance with the results of their studies [13,17,22].

Yardımcı et al.[13] reported the dressing percentage, and percentages of tail fat, muscle, fat and bone as 48.4%, 15.29%, 48.9%, 15.08% and 19.6%, respectively, for White Karaman lambs slaughtered at 41.6 kg. Tufan and Akmaz [23] reported the dressing percentage, and percentages of tail fat, muscle, fat, bone and back fat thickness as 50.3%, 16.20%, 44.7%, 21.4%, 15.3% and 3.75 mm, respectively for White Karaman lambs slaughtered at 40.17 kg. Kadak [24] reported the dressing percentage, and muscle, fat and bone percentages of White Karaman lambs at 42 kg SW to be 51.3%, 58.5%, 18.4% and 19.0%, respectively. Arslan [21] measured cold carcass weight, and the percentages of tail fat, muscle, fat, bone and back fat thickness as 21.2 kg, 22.0%, 45.7%, 17%, 14.4% and 4.48 mm, respectively for Red Karaman lambs at 40.0 kg. Macit [25] reported cold carcass weight, dressing percentage, tail fat weight, tail fat percentage and fat thickness as 19.6 kg, 48.9%, 3.2 kg, 16.3% and 2.7 mm, respectively, for the Red Karaman breed at 40.5 kg body weight. Öztürk [26] reported dressing percentage and tail fat percentage of 48.4% and 15.72%, respectively, for the Red Karaman at 39.83 kg. Aydoğan [27] reported cold carcass weight, and percentages of muscle, fat and bone as 17.5 kg, 49.8%, 31.5% and 16.6% respectively, for Karayaka at 35.2 kg body weight.

In the present study, the average body weight of the lambs at slaughter was 40.3 kg. Mean cold carcass weight was 18.6 kg, with a composition of 48.37% muscle, 26.65% fat and 15.98% bone. Moreover, the fat thickness and tail fat percentage were 4.30 mm and 9.00%, respectively. The carcass fat percentage in Herik lambs was higher than for the fat tailed breeds (White Karaman and Red Karaman), but tail fat percentages in White Karaman and Red Karaman lambs were higher than in Herik lambs. In comparison with the fat tailed breeds, the tail fat percentage decreased, but the carcass fat percentage increased in Herik lambs.

In the current study, some tail dimensions were significantly and closely correlated with FTW and TBF. The highest correlation coefficients were observed between circumference measurements and tail thickness. The LC had a positive and significant correlation with FTW (r=0.937, P<0.01) which was positively correlated with TBF (r=0.806, P<0.05). UC was also positively and significantly correlated with FTW (r=0.911, P<0.01), which was positively correlated with TBF (r=0.842, P<0.01).

Zamiri and Izadifard [11] reported that in Ghezel rams. LC had the highest correlation with FTW (r=0.84). Safdarian et al.[14] reported a high correlation between the FTW and UC in Torki-Ghashghaii sheep (r=0.88). Yardımcı et al.[13] reported that tail circumference was positively and significant correlated with FTW (r=0.88, P<0.01), which was also significantly correlated with TBF (r=0.72, P<0.01) in White Karaman lambs. Atti and Hamouda [12] reported that UC and middle tail circumference were highly correlated with FTW, with r=0.87 and r=0.85, respectively, in Barbarine lambs. In the present study, the correlations between tail circumference measurements and tail fat weight were higher than in these studies. The LC and UC could therefore be used to predict the FTW and TBF.

Safdarian et al.[14] reported a high correlation between the FTW and TBF (r=0.70) and Atti and Hamouda [12] reported that FTW was significantly and highly correlated with TBF (r=0.91). In the present study, a high, positive correlation coefficient (r=0.743, P<0.01) was determined between the FTW and TBF. The results of our study are in accordance with the results of their studies.

Safdarian et al.[14] reported correlation coefficients of r=0.62 and r=0.66 the upper thickness and lower thicknesses of the tail, respectively, with FTW. Atti and Hamouda [12] reported correlations of the upper tail depth and middle tail depth with FTW of r=0.62 and r=0.54, respectively. Furthermore, Zamiri and Izadifard [11] reported that FTW was positively and significantly correlated with upper and lower fat tail thickness in Mehreman rams, with r=0.40 and r=0.37, respectively and also in Ghezel rams, with r=0.25 and r=0.37, respectively. In the present study, we found a significant correlation between the UTT and FTW (r=0.785, P<0.01). This result was in agreement with the results of earlier studies [11,12,14].

The most remarkable result of the present study was obtained for FTW, subcutaneous fat and intermusclar fat percentage. Yardımcı et al.[13] reported that the tail fat, subcutaneous fat and intermuscular fat percentages were 15.29%, 10.2% and 4.88% in White Karaman sheep of 41.6 kg body weight. Kashan et al.[2] reported that in Chaal (fat tailed), Zandi (fat tailed), Zel x Chaal (semi-fat tailed) and Zel x Zandi (semi-fat tailed) sheep, tail fat percentages were 13.6, 15.8, 7.2 and 7.5%, respectively, that subcutaneous fat percentages were 13.8, 14.9, 17.6 and 18.5%, respectively, and that intermuscular fat percentages were 5.7, 8.1, 9.3 and 9.4%, respectively. Kyanzad [28] reported that as the tail fat percentage decreased, the subcutaneous fat and intermuscular fat percentage increased in thin tailed x fat tailed crossbred lambs. In the present study, the tail fat percentage, subcutaneous fat percentage and intermuscular fat percentage were 9.00, 19.46 and 7.19%, respectively.

Safdarian et al.[14] reported that the UC and LC constituted 85% of the variation in FTW in Torki-Ghashghaii sheep and Zamiri and Izadifard [11] reported that the LC accounted for 70% of the total variation of the FTW in Ghezel rams. Yardımcı et al.[13] reported an R^2 value of 0.81 for the prediction of FTW in White Karaman sheep, based on tail dimensions. In addition, Atti and Hamouda [12] reported that the FTW (R^2=0.75) and TBF (R^2=0.69) of Barbarine sheep could be estimated by using only tail measurements as independent variables. In the present study, LC and UC accounted for 88% and 71% of the total variation in FTW and TBF, respectively. The FTW and TBF prediction equations obtained in the current study were more accurate than the equations reported by Atti and Hamouda [12].

In conclusion, **s**ome tail dimensions, especially UC, LC and UTT, were significantly correlated with FTW and TBF. Moreover, UC and LC accounted for 88% of total variation in FTW and 71% of total variation in the TBF. Therefore, our results indicate that FTW and TBF in live Herik lambs can be estimated from the UC and LC. However, further work with a larger number of Herik lambs is required to fully understand the relationships.

Acknowledgements

This research was produced from Research Fund of The Scientific and Technical Research Council of Turkey (TUBİTAK), Project Number: 115O829. The authors are grateful to this project and Gregory T. Sullivan of GPEM at the University of Queensland in Brisbane, Australia for editing the English in an earlier version of this manuscript.

REFERENCES

1. Atti N, Bocquier F: Adaptation des brebis Barbarine à l'alternance sous-nutrition-réalimentation: Effets sur les tissus adipeux. *Ann Zootech*, 48, 189-198, 2009.

2. Kashan NE, Manafi Azar J, Afzalzadeh GH, Salehi A: Growth performance and carcass quality of fattening lambs from fat-tailed and tailed sheep breeds. *Small Ruminant Res*, 60, 267-271, 2005. DOI: 10.1016/j.smallrumres.2005.01.001

3. Pourlis Aris F: A review of morphological characteristics relating to the production and reproduction of fat-tailed sheep breeds. *Trop Anim Health Prod*, 43, 1267-1287, 2011. DOI: 10.1007/s11250-011-9853-x

4. FAO: Sheep population in Turkey. http://faostat3.fao.org/browse/Q/QA/E, 2015.

5. Yarkın I: Herik koyunu yapağisi üzerinde arastirmalar. *Ankara* Üniv. *Zir. Fak. Yıllığı*, 14, 133-149, 1964.

6. TAGEM: Türkiye Evcil Hayvan Genetik Kaynakları Tanıtım Kataloğu, www.tagem.gov.tr, 2009.

7. Eyduran E, Waheed A, Tariq MM, Iqbal F, Ahmad S: Prediction of live weight from morphological characteristics of commercial goat in Pakistan using factor and principal component scores in multiple linear regression. *J Anim Plant Sci,* 23, 1532-1540, 2013.

8. Jahan M, Tariq MM, Kakar MA, Eyduran E, Waheed A: Predicting body weight from body and testicular characteristics of Balochi male sheep in Pakistan using different statistical analyses. *J Anim Plant Sci,* 23, 14-19, 2013.

9. Khan MA, Tariq MM, Eyduran E, Tatliyer A, Rafeeq M, Abbas F, Rashid N, Awan MA, Javed K: Estimating body weight from several body measurements in Harnai sheep without multicollinearity problem. *J Anim Plant Sci,* 24, 120-126, 2014.

10. Vatankah M, Talebi MA: Genetic parameters of body weight and fat-tail measurements in lambs. *Small Ruminant Res*, 75, 1-6, 2008. DOI: 10.1016/j.smallrumres.2007.06.012

11. Zamiri MJ, Izadifard J: Relationship of fat-tail weight with fa t-tail measurements and carcass characteristics of Mehraban and Ghezel rams. *Small Ruminant Res*, 26, 261-266, 1997. DOI: 10.1016/S0921-4488(97)00013-8

12. Atti N, Ben Hamouda M: Relationships among carcass composition and tail measurements in fat-tailed Barbarine sheep. *Small Ruminant Res*, 53, 151-155, 2004. DOI: 10.1016/j.smallrumres.2003.08.016

13. Yardımcı M, Şahin EH, Çetingül İS, Bayram İ, Altunbaş K, Şengör E: Estimation of carcass composition and fat dopts by means of subcutaneous adipocyte area and body and tail measurements in fat tailed Akkaraman lambs. *S Afr J Anim Sci*, 38, 282-289, 2008.

14. Safdarian MM, Zamiri MI, Hashemi M, Noorolahi H: Relationships of fat-tail dimensions with fat-tail weight and carcass characteristics at different slaughter weights of Torki-Ghashghaii sheep. *Meat Sci*, 80, 686-689, 2008. DOI: 10.1016/j.meatsci.2008.03.007

15. Akçapınar H: Dağlıç, Akkaraman ve Kıvırcık kuzuların entansif beside büyüme ve yemden yararlanma kabiliyeti üzerinde karşılaştırmalı araştırmalar. *Ankara* Üniv *Vet Fak Derg*, 28, 112-129, 1981. DOI: 10.1501/Vetfak_0000000912

16. SPSS: Statistical package for the social sciences, Release 22.0, SPSS Inc, Chicago, Il, USA, 2013.

17. Ünal N: Survival rate, growth characteristics and some body measurements of Akkaraman and Sakız (Chios) x Akkaraman F_1 lambs. *Turk J Vet Anim Sci,* 26, 109-116, 2002.

18. Özcan H: Devlet üretme çiftliği Merinos x Karayaka melezlerin beden ölçüleri ve yapağı vasıfların üzerinde araştırmalar. Ankara Üniv. Vet. Fak. Yayınları, No: 122, Ege Matbaası, Ankara, 1960.

19. Arıtürk E, Utkanlar N, İmeryüz F, Müftüoğlu Ş, Öznacar K: Karaköy Harasında yetiştirilen üç yaşlı Karayaka koyunlarında beden ölçüleri, canlı ağırlık, yapağı verim ve özellikleri. *Lalahan Zoot Araşt Enst Derg*, 3, 9-27, 1963.

20. Atasoy F, Ünal N, Akçapınar H, Mundan D: Karayaka ve Bafra (Sakız x Karayaka G_1) koyunlarında bazı verim özellikleri. *Turk J Vet Anim Sci*, 27, 259-264, 2003.

21. Arslan M: Saf ve Melez (Dorset Down x Morkaraman (F_1), Corriedale x Morkaraman (F_1)) Morkaraman kuzuların besi performansı, kesim ve karkas özellikleri. Doktora Tezi, Yüzüncü Yıl Üniv Sağlık Bil Enst, 1998.

22. Unal N, Akcapınar H, Atasoy F, Aytac M: Some reproductive and growth traits of crossbred genotypes produced by crossing local sheep breeds of Kivircik x White Karaman and Chios x White Karaman in steppe conditions. *Arch Tierz*, 49, 55-63, 2006.

23. Tufan M, Akmaz A: Slaughter and carcass traits of Guney Karaman, Kangal-Akkaraman and Akkaraman lambs at different slaughter weights. *Turk J Vet Anim Sci*, 25, 495-504, 2001.

24. Kadak R: Akkaraman, Morkaraman ve Ivesi ırkı kuzuların farklı kesim ağırlıklarında besi performansı ve karkas özelliklerinin karşılaştırılması. Doktora Tezi, Fırat Üniv. Sağlık Bil. Enst., 1983.

25. Macit M: Growth and carcass characteristics of male lambs of the Morkaraman breed. *Small Ruminant Res*, 43, 191-194, 2002. DOI: 10.1016/S0921-4488(01)00268-1

26. Öztürk Y, Küçük M, Karslı MA: A study on growth, slaughter and carcass traits of Morkaraman and Kivircik x Morkaraman (F_1) lambs in semi-intensive condition. *Kafkas Univ Vet Fak Derg*, 18, 1-6, 2012. DOI: 10.9775/kvfd.2011.4351

27. Aydoğan M: Karayaka, Ile De France x Karayaka (F_1) ve Sakız x Karayaka (F_1) kuzularının büyüme, besi performansı ve karkas özelliklerinin karşılaştırılması. *Ankara Üniv Vet Fak Derg*, 32, 111-130, 1985. DOI: 10.1501/Vetfak_0000000333

28. Kyanzad MR: Crossbreeding of the three Iranian sheep breeds with emphasis on growth and carcass characteristics of the lambs. *PhD Thesis.* University of Utra, Malaysia, 2001.