RESEARCH ARTICLE

Determination of the Optimum Fattening Period of Tuj and Hemşin Lambs according to Different Fattening Systems [1]

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Abstract

This study aims to determine the optimum fattening period according to various fattening systems under controlled conditions for the first time in lamb fattening in Turkey. The material of the study consists of 39 Tuj and 39 Hemşin genotype male weaned lambs that are 2.5-3 months old. The Tuj and Hemşin lambs in the study have been separated into 3 equal groups through the systematic sampling method and subject to 90-day fattening. The amount of feed in terms of consumed dry matter for 1 kg of increase in live weight of lambs in the intensive system was calculated as 5.69 kg and 5.90 respectively for Tuj and Hemşin lambs. The optimum fattening period in the intensive system for Tuj and Hemşin lambs occurred between the 70th and 84th days. The marginal cost-marginal income equality was not achieved throughout the fattening in the extensive and semi-intensive fattening periods for both genotypes. Thus, it is estimated that the optimum fattening period in the extensive and semi-intensive systems is over 90 days. The fattening period with the highest marginal income was on the 70th, 84th, and 42nd days respectively for the extensive, semi-intensive, and intensive systems for Tuj lambs and this was on the 70th, 28th, and 56th days respectively for Hemşin lambs. In conclusion, it was observed that the optimum fattening period in Tuj and Hemşin lambs was earlier in the intensive fattening period compared to other fattening periods.

Keywords: Lamb fattening, Fattening systems, Optimum fattening period, Marginal cost, Marginal income

Tuj ve Hemşin Kuzularında Farklı Besi Sistemlerine Göre Optimum Besi Süresinin Belirlenmesi

Özet

Bu çalışma ile kuzu besisinde Türkiye'de ilk defa kontrollü koşullar altında farklı besi sistemlerine göre optimum besi süresinin tespit edilmesi amaçlanmıştır. Araştırma materyalini Tuj ve Hemşin genotiplerinden 39'ar baş 2.5-3 aylık yaşta sütten kesilmiş erkek kuzu oluşturmuştur. Çalışmada Tuj ve Hemşin kuzular sistematik örnekleme metoduyla eşit sayıda 3 besi grubuna ayrılmış ve 90 günlük besiye tabi tutulmuştur. Entansif sistemdeki kuzular için 1 kg canlı ağırlık artışı için tüketilen kuru madde cinsinden yem miktarı Tuj ve Hemşin kuzularında sırasıyla 5.69 kg, 5.90 kg olarak hesaplanmıştır. Tuj ve Hemşin kuzularında entansif sistemdeki optimum besi süresi 70. ve 84. günler arasında gerçekleşmiştir. Her iki genotip için ekstansif ve yarı entansif besi sistemlerinde marjinal maliyet-marjinal gelir eşitliği besi süresince yakalanamamıştır. Dolayısıyla ekstansif ve yarı entansif sistemlerde optimum besi süresinin 90 günün üzerinde olduğu tahmin edilmektedir. Marjinal gelirin en yüksek olduğu besi dönemi Tuj kuzularında; ekstansif, yarı entansif ve entansif sistemleri için sırasıyla 70., 84. ve 42. gün iken, Hemşin kuzularında aynı sırasıyla 70., 28. ve 56. gün olarak saptanmıştır. Sonuç olarak; Tuj ve Hemşin kuzularında optimum besi süresinin diğer besi sistemlerine göre entansif besi sisteminde daha erken olduğu görülmüştür.

Anahtar sözcükler: Kuzu besisi, Besi sistemleri, Optimum besi süresi, Marjinal maliyet, Marjinal gelir

INTRODUCTION

According to the 2013 data of TURKSTAT, 18.73% of Turkey's total red meat production is provided from sheep-lamb meat. The proportion of lamb meat in the total amount of sheep and lamb meat produced is 56.11% [1]. According to the 2011 data of the Food and Agriculture Organization (FAO), sheep carcass weight is

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16.0 kg on average in Turkey, 14.6 kg on average in the European Union (EU-28), 30.8 kg on average in the United States of America, 22.4 kg on average in Australia, and 19.2 kg on average in New Zealand [2]. The reasons for the low carcasses in Turkey can be pointed out as low yield indigenous races, high rate of early lamb slaughters, and transfer of animals to slaughter after pasture fattening without being subject to intensive fattening [3,4].

The profitability and productivity of lamb fattening, sub-sector of livestock, depends on some technical and economic criteria. One or the most important economic factors contributing to the performance of lamb fattening in a profitable manner is the determination of the optimum fattening period. As is the case in other economic activities, lamb fattening is also under the effect of the "law of diminishing returns". Within the framework of this law, the daily live weight gain of animals subject to fattening gradually decrease after a certain period and after a certain point, the live weight gain obtained daily is unable to address fattening costs. Thus, the fattening activity should be completed at the point where the marginal income is equal or close to the marginal cost [5,6].

This study aims to determine the optimum fattening period for maximum profitability in the fattening of Tuj and Hemşin lambs according to various fattening systems under controlled conditions for the first time in Turkey.

MATERIAL and METHODS

This study was conducted upon the Board of Ethics Approval received through the Kafkas University Faculty of Veterinary Medicine Board of Ethics resolution no. 2011-005 of 03.03.2011. The study was conducted in the Kafkas University Faculty of Veterinary Medicine, Training, Research, and Practice Farm in 2012. The material of the study consists of 39 Tuj and 39 Hemşin male lambs that have been weaned at 2.5-3 months of age. The internal and external parasite medication was administered to lambs included in the scope of the study prior to fattening; and they were allowed to orient to the pasture and feed for a period of 10 days. Afterwards, the Tuj and Hemşin lambs were ordered according to their live weight and through the systematic sampling method, they were separated into the different fattening groups of extensive, semi-intensive, and intensive and in a way to include 26 lambs in each group, and the lambs were subject to fattening for a period of 90 days.

The lambs in extensive and semi-extensive fattening were grazed for 8 h a day in the pasture. Group feeding was performed in the feeding of the lambs in the sheep fold. In semi-intensive fattening (pasture + feed) and intensive fattening, the lambs were given concentrated feed prepared according to NRC (1985) as *ad libitum* [7]. In addition to concentrated feed, the lambs in intensive fattening were given quality roughage. The nutritional contents of the concentrated feed and roughage given to lambs have been provided in *Table 1*. Amounts of feed given to the lambs were recorded daily and the live weights of the lambs were recorded on an empty stomach in the morning in periods of 14 days and prior to being slaughtered on the 90th day. While there was constantly water in front of the animals in the intensive fattening group during the fattening process, water was provided to animals in the extensive and semi-intensive groups at least three times a day.

The sales price of concentrated feed, roughage, labor, electricity-water, pasture rent, and also carcass sales used in the calculation of marginal costs and marginal income in periods of 14 days were determined with 2012 current prices by conducting a market research in the province of Kars. General administrative expenditures, which are among marginal costs was accepted as 3% [8]. After the sheep fold amortization expense was calculated using the straight-line method, the daily amortization amount was determined. In the extensive fattening system, there are no concentrated feed, roughage, electricity-water, and sheep fold amortization expenses, in the semi-intensive fattening system, there are no roughage expenses, and in the intensive fattening system, there are no pasture lease fees.

The marginal income in the study were calculated by taking marginal live weight gain, actual cold carcass yield determined according to fattening groups, and carcass sales prices into account and in the calculation of the optimum fattening period, marginal cost and marginal income equation were utilized. Sheep fold maintenance-repair and litter floor expenses, and the secondary incomes of manure were not taken into consideration in the study as they were very low and did not reflect a significant difference between fattening groups. On the other hand, health-medication expenses were made before fattening and only once. Thus, they have not been included in the marginal cost. However, health-medication expenses have been added to the fattening material cost and included in the total cost of zero-day.

Table 1. *Nutritional contents and energy values of the concentrated feed and roughage used in the semi-intensive and intensive fattening systems*

Tablo 1. *Yarı entansif ve entansif besi sistemlerinde kullanılan konsantre ve kaba yemin besin madde içerikleri ve enerji değerleri*

Ingredient	Concentrate Feed	Roughage
Dry matter (%)	88.80	90.69
Crude protein (%)	17.12	10.35
Crude cellulose (%)	5.75	32.38
Crude fat (%)	3.54	2.00
Crude ash (%)	6.48	8.86
Metabolic energy (kcal/kg)	2710	2000

The SPSS 20.0 statistics package program was used in the study. The descriptive statistics of the data have been performed in the SPSS program and the T-Test and the One-Way Analysis of Variance were utilized in the significance check of difference between groups [9].

RESULTS

The cold carcass yield for Tuj and Hemşin lambs were respectively determined as 41.58% and 41.93% in the extensive system, 45.80% and 45.35% in the semi-intensive system, and 48.42% and 48.05% in the intensive system. The difference between fattening systems within both genotypes in terms of cold carcass yield were determined to be statistically significant (P<0.001). On the other hand, the amount of feed in terms of roughage consumed for 1 kg live weight gain was determined for lambs in the intensive system and calculated as 5.69 kg for Tuj lambs and 5.90 kg for Hemşin lambs.

The optimum fattening periods of Tuj and Hemşin lambs according to fattening periods have been respectively provided in *Table 2* and *Table 3*. When the relation between marginal cost and marginal income is examined according to fattening systems, it can be observed that marginal income are higher than marginal cost for Tuj and Hemşin lambs in the intensive system until the 70th day of fattening. However, it was determined that the marginal income dropped under the marginal cost as of the 84th day in the fattening of Tuj and Hemşin lambs in the intensive system. According to this, the optimum fattening period for Tuj and Hemşin lambs in the intensive system was between the 70th and 84th days, when the marginal cost is equal to or close to the marginal income. On the other hand, it can be observed that the marginal income did not drop under the marginal cost in the extensive and semi-intensive fattening systems through-out the 90-day fattening period for both genotypes. Thus, the designation of the optimum fattening period in these two systems was not possible in the study process.

There was no statistical difference between fattening systems for Tuj and Hemşin lambs in terms of fattening initiation live weight averages (P>0.05) and it was determined that there was a statistically significant difference between the extensive system and other fattening systems at the end of the fattening (P<0.05).

On the other hand, when the total costs of Tuj and Hemşin lambs are examined, there is no statistical difference between fattening systems until the 42nd day (P>0.05). However, it was determined that there was a statistical difference between the extensive system and other fattening systems in terms of total cost as of the 42nd day and a statistically significant difference between the semi-intensive system and intensive system as of the 84th day (P<0.001).

The fattening period with the highest marginal income in the fattening of Tuj lambs were determined to be the 70th, 84th, and 42nd days respectively for the extensive, semi-intensive, and intensive fattening systems and for the Hemşin lambs these were respectively determined to be the 70th, 28th and 56th days.

DISCUSSION

One of the most important input elements in livestock is feed consumption [5,10]. In the study, the amount of feed consumed as dry matter for 1 kg live weight gain in the intensive fattening system was determined to be lower in Tuj lambs compared to Hemşin lambs. There are studies suggesting that the amount of feed as dry matter consumed for 1 kg live weight decreases as the fattening initiation live weight decreases in fattening activities and they support the findings of the study. On the other hand, as the live weight of the animal increased, the feed conversion rate decreased throughout the fattening period [11-14].

The determination of the optimum fattening period in livestock enterprises is of utmost importance in the profitability and efficiency of fattening activities [11]. As a matter of fact, the basic objective in fattening enterprises is the maximization of profits, just like in all economic enterprises. Profit maximization in businesses can be achieved through the control of some factors inside the business besides factors outside of the business [5,13,15]. The activity of fattening is under the impact of the law of diminishing returns. Thus, when marginal cost in fattening is equal to marginal income, fattening should be finalized. This is because; at this point the maximum profit of the period will have been achieved [11,16].

In the study, the optimum fattening period of Tuj and Hemşin lambs in the intensive system was determined to be between the 70th and 84th days, when the marginal cost is equal or close to the marginal income. In the study conducted by Cinemre et al.[17], 10 Karayaka and 10 Sönmez X Karayaka (F$_1$) male 2.5 month-old lambs were subject to 91 days of intensive fattening, and the optimum fattening period was determined to be 84 days for both genotypes. On the other hand, in the study of Akdemir et al.[18], a total of 80 lambs in the France X İvesi, Sakız X İvesi, and İvesi X İvesi genotypes were separated into four equal groups and fed with two different concentrated feed rations. The optimum fattening period in the studies varied depending on the fattening period, genotype, utilized concentrated feed, and the fattening periods in a year at the enterprise, and it was reported to be between 49 and 63 days.

It should not be forgotten that in fattening, the optimum fattening period may vary depending on the fattening period, the age and genotype of the animal,

Table 2. *Optimum fattening periods of Tuj lambs according to the fattening system*
Tablo 2. Tuj kuzularında besi sistemlerine göre optimum besi süreleri

Day	Extensive Fattening System (n=13)					Semi-Intensive Fattening System (n=13)					Intensive Fattening System (n=13)				
	Average LW (kg/head)	Marginal LWG (kg)	Total Cost (TL)	Marginal Cost (TL)	Marginal Income (TL)	Average LW (kg/head)	Marginal LWG (kg)	Total Cost (TL)	Marginal Cost (TL)	Marginal Income (TL)	Average LW (kg/head)	Marginal LWG (kg)	Total Cost (TL)	Marginal Cost (TL)	Marginal Income (TL)
0	20.62a	-	2579.07a	-	-	20.55a	-	2570.43a	-	-	20.66a	-	2584.01a		-
14	21.99a	1.37a	2686.13a	107.06a	133.30a	22.77a	2.22a	2728.79a	158.36a	237.92a	22.52a	1.86a	2752.89a	168.88a	210.74a
28	24.49a	2.50a	2793.19a	107.06a	243.24a	26.15a	3.38b	2905.29a	176.50a	362.24b	24.43a	1.91a	2954.99a	202.10a	216.41a
42	24.95a	0.46a	2900.25a	107.06a	44.76a	28.88b	2.73b	3144.04b	238.74b	292.58b	28.57b	4.14c	3220.53b	265.54b	469.07c
56	26.58a	1.63a	3007.31a	107.06a	158.59a	32.09b	3.21b	3426.42b	282.38b	344.02b	32.27b	3.70b	3546.80b	326.27b	419.22b
70	29.45a	2.87a	3114.37a	107.06a	279.24a	35.86b	3.77a	3715.40b	288.98b	404.04a	36.22b	3.95a	3885.74b	338.94b	447.55a
84	30.89a	1.44a	3221.43a	107.06a	140.11a	40.52b	4.66b	4015.03b	299.63b	499.42b	38.58b	2.36a	4248.61c	362.86c	267.39a
90	31.19a	0.30a	3265.64a	44.21a	49.19a	41.22b	0.70a	4121.87b	106.85b	109.02a	40.56b	1.98b	4488.98c	240.37c	224.34b

*LW: Light Weight; LWG: Live Weight Gain; **a**, **b**, **c**: the difference between groups with different letters and same parameters according to the fattening systems is significant (P<0.05), the difference between groups with the same letter is not significant (P>0.05)*

Table 3. *Optimum fattening periods of Hemşin lambs according to the fattening system*
Tablo 3. Hemşin kuzularında besi sistemlerine göre optimum besi süreleri

Day	Extensive Fattening System (n=13)					Semi-Intensive Fattening System (n=13)					Intensive Fattening System (n=13)				
	Average LW (kg/head)	Marginal LWG (kg)	Total Cost (TL)	Marginal Cost (TL)	Marginal Income (TL)	Average LW (kg/head)	Marginal LWG (kg)	Total Cost (TL)	Marginal Cost (TL)	Marginal Income (TL)	Average LW (kg/head)	Marginal LWG (kg)	Total Cost (TL)	Marginal Cost (TL)	Marginal Income (TL)
0	22.42a	-	2801.37a	-	-	22.99a	-	2871.77a		-	22.92a	-	2863.12a	-	-
14	23.92a	1.50a	2908.43a	107.06a	147.17a	24.99a	2.00a	3031.66a	159.89a	212.24a	24.13a	1.21a	3032.78a	169.66a	136.05a
28	26.42a	2.50a	3015.49a	107.06a	245.29a	28.99b	4.00b	3209.69a	178.03a	424.48b	25.35a	1.22c	3235.66a	202.88a	137.17c
42	27.42a	1.00a	3122.55a	107.06a	98.12a	30.72b	1.73a	3449.97b	240.27b	183.59a	29.33b	3.98b	3501.98b	266.32b	447.50b
56	29.21a	1.79a	3229.61a	107.06a	175.63a	33.95b	3.23b	3733.88b	283.91b	342.76b	33.96b	4.63c	3830.68b	328.71b	520.58c
70	31.86a	2.65a	3336.67a	107.06a	260.01a	37.45b	3.50a	4024.39b	290.51b	371.42a	37.00b	3.04a	4170.41b	339.72b	341.81a
84	33.05a	1.19a	3443.73a	107.06a	116.76a	40.36b	2.91b	4325.55b	301.16b	308.81b	40.29b	3.29b	4534.05c	363.64c	359.92b
90	33.32a	0.27a	3487.94a	44.21a	46.49a	41.16b	0.80a	4432.60b	107.06b	115.90a	42.09b	1.80b	4776.83c	242.78c	202.39b

*LW: Light Weight; LWG: Live Weight Gain; **a**, **b**, **c**: the difference between groups with different letters and same parameters according to the fattening systems is significant (P<0.05), the difference between groups with the same letter is not significant (P>0.05)*

fattening initiation live weight, live weight gain, fattening type, feed, labor, and other elements constituting the cost [11,18].

On the other hand, it can be observed that the marginal income did not drop below or equal the marginal cost throughout the 90-day fattening period in the extensive and semi-intensive fattening systems for both genotypes, and profit maximization did not happen. When it is considered that the law of diminishing returns applies for all economic enterprises, the optimum fattening period occurring on a day after the 90th day in case fattening is continued, is an undeniable fact according to the science of economics. However, it is considered that it is actually impossible to continue the fattening of the lambs in the extensive and semi-intensive system in the manner the study was planned.

Yet, in the province of Kars, where the study was conducted, just like the most of Turkey, the pasture season starts at the end of April each year and continues until the end of July or the beginning of August depending on the amount of precipitation. Thus, the pasture season in Turkey suitable for extensive and semi-intensive fattening is a period of approximately 90 days covering the months of May, June, July [5,19]. There are many scientific studies reporting that the desired live weight gain cannot be achieved in case grazing of animals is continued after the pasture season and additional feeding is required to compensate for this [19,20].

On the other hand, it is considered that having lambs in the extensive and semi-intensive system subject to the intensive system after the pasture season until the equality of the marginal income with the marginal cost is ensured is not suitable in terms of biologic efficiency. This is because; when determining the optimum feeding period slaughter weight, market demands, and biologic efficiency should be taken into consideration [21]. Extension of the fattening period in lamb fattening causes the accumulation of fat in the carcass and as the biologic age of the lamb gets older, the form of fattening is no longer lamb fattening. This is not desired in terms of biologic efficiency. According to the quality grading system of the United States of America, fat accumulation in the lamb carcass demonstrates positive effects to a certain point for preserving the freshness and color of the carcass and preventing the increase of losses and then demonstrates adverse effects after this point [22,23]. As a matter of fact, in the study conducted by Akçapınar [24] on two groups of lambs from the Akkaraman genotype with average slaughter weights of 40 and 45 kg, it was reported that as the slaughter weight increased, the fat rate and *M. Longissimus dorsi* area of the carcass increased and in addition to this, the rate of fat-free meat in the carcass decreased.

It is considered that continuing the fattening of lambs in the semi-intensive system in an intensive manner after the pasture season caused fat accumulation in the carcass. On the other hand, it is considered that in case lambs with low weight in the extensive fattening system are subsequently subject to the intensive fattening system, as the biological ages of the animals will have become older, it will no longer be lamb fattening.

In conclusion, the necessity to assess lamb fattening in terms of not only technical criteria but also in terms of economic criteria has been set forth. For the purpose of utilizing the limited resources of lamb fattening enterprises in an effective and efficient manner and maximizing profitability, the optimum fattening period should be calculated, and a decision should be made to finalize fattening in this manner.

It was determined that there was a statistical difference between the extensive system and the other fattening systems in terms of the live weight gain throughout the 90 day fattening period of the Tuj and Hemşin lambs. On the other hand, the optimum fattening period for both genotypes in the intensive system was determined to be between the 70th and 84th days. In the semi-intensive system, the marginal income did not drop below the marginal cost throughout the fattening period for both genotypes. Furthermore, even though there was no statistical difference between the semi-intensive and intensive fattening systems at the end of the fattening period in terms of fattening finalization live weight, in the semi-intensive system the total cost was calculated to be lower at a statistically significant level. In the final analysis, it was determined that the performance of lamb fattening by lamb fattening enterprises by employing the semi-intensive system would be more rational for the lamb fattening enterprise.

REFERENCES

1. TURKSTAT: Turkish Statistical Institute, Livestock Statistics. http://tuikapp.tuik.gov.tr/hayvancilikapp/hayvancilik.zul, *Accessed:* 01.12.2013

2. FAOSAT: Food and Agriculture Organization, Animal Production Statistics. http://faostat.fao.org/site/569/default.aspx#ancor, *Accessed:* 01.12.2013

3. Akçapınar H: Koyun Yetiştiriciliği. 2. Baskı. İsmat Matbaacılık, Ankara, 2000.

4. Ekiz B, Yılmaz A, Özcan M, Kaptan C, Hanoğlu H, Erdoğan İ, Yalçıntan H: Carcass measurements and meat quality of Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs raised under an intensive production system. *Meat Sci,* 82, 64-70, 2009.

5. Çiçek H, Cevger Y, Tandoğan M, Şahin EH: Estimation of optimum fattening period by cattles of Brows Swiss hybrid (F₁) fattening. *Kafkas Univ Vet Fak Derg,* 16 (1): 63-67, 2010.

6. Field TG, Taylor RE: Beef Production and Management Decisions. Pearson Education, Inc., Fourth Edition. New Jersey. 2003.

7. NRC: Nutrient Requirements of Sheep. Sixth Revised ed., Natl Acad Sci, Washington, D. C., 1985.

8. Aydın E: Kars ve Erzurum İlleri Sığır Besi İşletmelerinin Ekonomik Analizi. *Doktora Tezi,* Ankara Üniv. Sağlık Bil. Enst., 2011.

9. SPSS: Release 20.0. Standard version. Copyright SPSS Inc, 2012.

10. Aydın E, Sakarya E: Kars ve Erzurum illeri entansif sığır besi işletmelerinin ekonomik analizi. *Kafkas Univ Vet Fak Derg*, 18 (6): 997-1005, 2012.

11. Sakarya E, Günlü A: Limuzin x Jersey (F1) melezi ve Holştayn ırkı tosunlarda optimal besi süresinin tespiti üzerine bir araştırma. *Ankara Univ Vet Fak Derg*, 43, 113-120, 1996.

12. Arpacık R, Nazlıgül A, Beyhan Z, Atasoy F: Esmer ırk danalarda besi başı ağırlığının besi performansı ve besi ekonomisine etkisi. *Lalahan Hay Araşt Enst Derg,* 34 (1-2): 79-89, 1994.

13. Cevger Y, Güler H, Sarıözkan S, Çiçek H: The effect of initial live weight on technical and economic performance in cattle fattening. *Turk J Vet Anim Sci*, 27, 1167-1171, 2003.

14. İmik H, Günlü A, Tekerli M, Koçak S: Afyon ilinde yapılan sığır besiciliğinin ekonomik analizi ve kârlı bir besicilik için alınması gerekli önlemler. *Lalahan Hay Araşt Enst Derg,* 40 (2): 1-15, 2000.

15. Crotty R: Cattle, economics and development. Commonwealt Agricultural Bureaux. Printed by Unwin Brothers The Gresham Pres, England, 1980.

16. Müftüoğlu MT: İşletme İktisadı. 3. Baskı. Turhan Matbaası, Ankara, 1999.

17. Cinemre HA, Kılıç O, Oflaz M: Karayaka ve Sönmez X Karayaka (F1) melezi kuzularında optimum besi süresinin saptanması üzerine bir araştırma. *TZOP Çiftçi ve Köy Dünyası Derg,* 115, 27-30, 1994.

18. Akdemir Ş, Torun O, Özcan L, Pekel E: Kuzu besiciliğinde optimum besi süresi. *ÇÜZF Derg*, 7 (2): 129-140, 1992.

19. Işık S, Kaya İ: Vejetasyon döneminin mera kalitesi ile merada otlayan Tuj ırkı koyun ve kuzuların besi performansı üzerine etkileri. *Kafkas Univ Vet Fak Derg*, 17 (1): 7-11, 2011.

20. Karslı MA, Deniz S, Nursoy H, Denek N, Akdeniz H: Vejetasyon döneminin mera kalitesi ve hayvan performansı üzerine etkilerinin belirlenmesi. *Turk J Vet Anim Sci*, 27, 117-124, 2003.

21. Lawrence TJK, Fowler VR: Growth of Farm Animals, CABI Publising, CAB International Wallingford Oxon, UK, 225-227, 2002.

22. Tekel N, Şireli HD, Vural ME: Besi süresinin İversi erkek kuzularının besi performansı ve karkas özelliklerine etkisi. *Tarım Bil Derg*, 13 (4): 372-378, 2007.

23. Boggs DL, Merkel RA: Live Animal Carcass Evaluation and Selection Manual. Kendal/Hunt Publishing Company, Dubuque, Iowa, 1984.

24. Akçapınar H: Dağlıç, Akkaraman ve Kıvırcık kuzularının farklı kesim ağırlıklarında besi performansı ve karkas özelliklerinin karşılaştırılması. *TÜBİTAK VII. Bilim Kongresi Tebliğleri,* TÜBİTAK yayınları No: 555, Ankara, 1980.