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Studies on the Possibility of Improving Lamb Production by Two-way and Three-way Crossbreeding with German Black-Headed Mutton, Kıvırcık and Chios Sheep Breeds

1. Fertility, Lamb Survival and Growth of Lambs*

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Abstract: The aim of this study was to compare the fertility of ewes and the survival and growth traits of lambs which were produced by two-way and three-way crossbreeding with Kıvırcık sheep, the predominant breed in the Marmara region, Chios sheep, the most prolific breed in the region and German Black-Headed Mutton (GBM), the mutton breed which exhibits the best adaptation to the environmental conditions of the region.

In the study, it was determined that the fertility of the Kıvırcık, GBM x Kıvırcık and GBM x F_1 (Chios x Kıvırcık) genotypes were 76.66%, 81.13% and 85.29% for pregnancy and birth rates; 1.17, 1.25 and 1.66 for litter size; and 0.90, 1.02 and 1.41 for lamb production, respectively. The lamb survival rates of Kıvırcık, GBM x Kıvırcık and GBM x F1 crossbred lambs at weaning were 96.3%, 98.1% and 89.6%, respectively. The birth and weaning weights of the lambs were found to be 3.58 kg and 21.21 kg for Kıvırcık lambs, 4.27 kg and 24.98 kg for two-way crossbred lambs and 3.77 kg and 28.30 kg for three-way crossbred lambs.

The results of the study showed that crossbreeding with the Chios genotype could lead to a rise in lamb production. Lambs produced by two-way and three-way crossbreeding did not have significant survival problems, and when compared to the Kıvırcık lambs, the crossbred lambs exhibited better growth performance up to weaning.

Key Words: Sheep, Crossbreeding, Fertility, Survival Rate, Growth

Alman Siyah Başlı Etçi, Kıvırcık ve Sakız Koyun Irkları Arasında Yapılan İkili ve Üçlü Melezlemelerle Kuzu Üretiminin Artırılması Konusunda Araştırmalar

1. Dölverimi, Kuzularda Yaşama Gücü ve Büyüme

Özet: Bu araştırmada, Marmara Bölgesi'nin hakim ırkı olan Kıvırcık, bölgenin prolifik ırkı olan Sakız ve yapılan adaptasyon çalışmalarında Marmara Bölgesi koşullarına en iyi uyum gösterdiği tespit edilen etçi kültür ırkı Alman Siyah Başlı Etçi (ASB) Koyun ırkları arasında yapılan ikili ve üçlü melezlemelerin dölverimi, melez kesim kuzularının büyüme ve yaşama gücü yönünden karşılaştırılması amaçlanmaktadır.

Araştırmada, Kıvırcık, ASB x Kıvırcık ve ASB x F_1 (Sakız x Kıvırcık) genotiplerinin önemli dölverimi özelliklerinden gebelik ve doğum oranları sırasıyla %76,66, %81,13 ve %85,29; bir doğuma düşen kuzu sayısı 1,17, 1,25 ve 1,66; kuzu verimi ise 0,90, 1,02, 1,41 olarak saptanmıştır. Kıvırcık, ASB x Kıvırcık ve ASB x F1 melezi kuzuların sütten kesimdeki yaşama gücü oranları % 96,3, %98,1 ve %89,6 olmuştur. Aynı genotip sırası içinde kuzuların doğum ağırlıkları 3,58 kg, 4,27 kg ve 3,77 kg ve sütten kesim ağırlıkları 21,21 kg, 24,98 kg ve 28,30 kg olarak belirlenmiştir.

Bu çalışma ile Sakız genotipinin melezlemeler yolu ile sayısal olarak kuzu verimini artırabileceği, ikili ve üçlü melezlemeler ile elde edilen kuzuların yaşama gücü yönünden önemli sorunlar yaşamadıkları ve melez kuzuların Kıvırcık kuzulara kıyasla sütten kesime kadar geçen sürede daha hızlı büyüme gösterdikleri sonucuna varılmıştır.

Anahtar Sözcükkler: Koyun, Melezleme, Dölverimi, Yaşama Gücü, Büyüme

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Introduction

Sheep breeding has an important role in animal production in Turkey. Sheep have the ability to transform poor grasslands, which are widespread in Turkey, into valuable products like meat, milk, fleece and skin. The sheep population has to be of sufficient size and quality to fulfil the nutritional requirements of the increasing number of young people in Turkey and the demand in Turkey for products obtained from sheep. The sheep population of 30,238,000 in Turkey is a very important source in meeting this demand, but 97% of this population is composed of indigenous sheep breeds, which have low production levels (1,2).

Animal husbandry today uses industrial practices. Quality market lamb production is preferred in developed countries, where better sheep breeding techniques are applied. Various crossbreeding models are used rather than pure breeding. Prolific and high-milk-producing pure-bred or crossbred ewes are mated with mutton breed rams in lowland farms. The aim of this breeding technique is to obtain 1.5-2.0 lambs per ewe, and it is expected that the lambs will reach a mature slaughtering size in a short time and will have better quality carcass characteristics. In order to achieve these aims, two-way and three-way crossbreeding methods are used successfully in many countries (3).

Gillespie (4) described three-way crossbreeding as the most profitable method for the production of slaughter lambs. He also reported that dam lines produced by crossbreeding with highly prolific breeds can produce a higher lambing rate, greater milk yield in ewes and a higher survival rate in lambs. There have been studies carried out in different parts of Turkey concerning crossbreeding applications for the production of ewes which have higher fertility and milk production traits. These ewes are to be used as dam lines for the production of quality slaughter lambs (5,6). In these studies it was reported that crossbred ewes exhibited better fertility than pure-bred ewes.

In one study carried out to investigate the fertility traits of F_1 ewes produced by the crossbreeding of Booroola Merino rams with Hungarian Merino ewes, the litter sizes were found to be 1.50 for Hungarian Merino and 1.83 for F_1 ewes (7).

Crossbreeding studies have also been carried out to produce ewes with high fertility which give higher milk yields, and which are appropriate for commercial crossbreeding in western Anatolia and Thrace. As a result of the studies, the number of lambs produced per ewe giving birth in Tahirova, Acıpayam, Türkgeldi, Sönmez and Asaf sheep was 1.51, 1.30, 1.33, 1.64 and 1.27, respectively (6).

Altınel et al. (8) determined that the oestrus rate was 86.57%, the birth rate was 65.67% and the litter size was 1.32 for GBM x F_1 (Chios x Kıvırcık) crossbreeding. Gönül (9) reported that for F_1 (Chios x Dağlıç) ewes mated with mutton breeds, the conception rate, birth rate and litter size were 71.2%, 68.7% and 1.34, respectively. In a study of two-way crossbreeding between White Karaman ewes and GBM and Hampshire Down rams, the conception rates were 60.6% and 63.6%, the twinning rates were 31.2% and 25.0%, and the litter sizes were 1.31 and 1.26, respectively (10).

Başpınar (11) determined that the conception, birth and twinning rates of Kıvırcık ewes raised on a Bolu private farm were 89.7%, 89.7% and 4.2%. In another study carried out on Kıvırcık ewes in İnanlı State Farm, the birth rate was 95.6% and the litter size was 1.09 (12). At Çanakkale Kumkale State Farm, the conception rate, birth rate and litter size of Chios ewes were found to be 97.71%, 97.46% and 1.93, respectively (13).

In sheep breeding, in adddition to improved fertility traits in an ewe flock, it is also important for lambs to be resistant to the effects of environmental conditions. Başpınar et al. (14), in their study to determine the ram-line type to be used in the production of quality slaughter lambs in the Marmara region, reported that the survival rates of GBM lambs at 60, 120 and 180 days of age were 86.8%, 73.6% and 67.9%, respectively. In his study of three-way crossbreeding with Awassi, Red Karaman and Merino sheep breeds, Özsoy (15) reported that two-way and three-way crossbred groups exhibited better growth and survival than pure breeds. In another study, the survival rates up to 105 days of age of Chios x Kıvırcık (F_1) lambs and GBM x F_1 three-way crossbred slaughter lambs were found to be 89.51% and 89.66%, respectively (8).

Evrim et al. (16) reported that the survival rates of Kıvırcık lambs in environmental conditions in Thrace at 60 and 105 days of age were 97.0% and 94.6%, respectively. In another study, the survival rates of Kıvırcık and Hampshire Down x Kıvırcık (F_1) lambs up to weaning at 90 days of age were found to be 93.6% and 78.3%, respectively (17).

It was determined that the production traits of Kıvırcık lambs in semi-intensive conditions were 3.69 kg for birth weight, 14.99 kg for 60th day weight and 20.72 kg for 105th day weight (16).

In a study carried out to investigate the adaptation capability of mutton breeds to the environmental conditions of the Marmara region the birth, 60th day and 120th day weights of GBM lambs were found to be 4.8 kg, 23.7 kg and 39.1 kg, respectively (14).

Altınel et al. (8), reported the birth, 30th, 60th, weaning (105th day) and 120th day live weights of slaughter lambs (GBM x F_1 (Chios x Kıvırcık)). These were 4.28 kg, 12.23 kg, 18.53 kg, 30.33 kg and 32.75 kg respectively. He reported that slaughter lambs exhibited a rapid growth rate, especially at younger ages.

In studies carried out in different regions of Turkey aiming to produce quality slaughter lambs, the weights at birth, weaning and 120th days of age were 4.4 kg-5.2 kg, 26.25 kg-31.34 kg and 31.07 kg-34.12 kg, respectively (17,18,19,20).

There have been many studies carried out to investigate the major factors affecting the weights of lambs at birth and weaning. Several researchers have stated that the effects of genotype, birth type, sex and dam age are significant factors in the birth weight of lambs (8,18,19,21,22,23,24). In addition, the effects of dam's age, birth type, sex, genotype and birth year were reported to have a determining role in the weaning weight of lambs (8,18,19,23,24).

The general aim of this study was to compare the growth, survival rate, fattening performance and slaughter and carcass characteristics of crossbred lambs which were produced by two-way and three-way crossbreeding studies with Kıvırcık, a major sheep breed in the Marmara region, Chios, the most prolific sheep breed in the region and GBM, the mutton breed which exhibits the best adaptation to the environmental conditions of the region. The objective of our investigations was to find out whether three-way commercial crossbreeding would be necessary or the use of two-way commercial crossbreeding would be sufficient to bring about an improvement in the lamb production of the Kıvırcık breed. In addition to these characteristics of slaughter lambs, the fertility characteristics of F_1 (Sakız x Kıvırcık) and Kıvırcık ewes were compared. In this first part of the study, the results related to the fertility of ewes and the survival and growth of lambs were examined.

Materials and Methods

Materials

The material of this study consisted of German Black-Headed Mutton (GBM) rams, Kıvırcık rams, ewes and lambs, Chios x Kıvırcık (F_1) crossbred ewes, and lambs produced by two-way and three-way crossbreedings with these breeds. The study was carried out at the Marmara Animal Research Institute in the years 1997 and 1998.

Oestrus detection was performed daily by using teaser rams, and ewes were mated with selected rams (4 GBM and 6 Kıvırcık rams). The ewe flock was kept indoors during the winter months and then taken to pasture as the weather conditions improved. Before the mating season, 400-600 g/head of concentrated feed produced at the institute was given daily to the ewes. A similar program was also carried out to prepare the ewes for parturition.

The lambs were kept together with their dams in individual boxes for the first three days after birth. Then a flock composed of suckling lambs and their dams was formed. The suckling program of the lambs lasted for 90 days on average. During this program, grass hay and lamb grower feed were given to the lambs.

Methods

In order to determine the fertility characteristics of the ewes, the conception rate, rate of infertility of the ewes, birth rate, rate of single births, rate of prolific births, lamb production and litter size traits were determined for each genotype group.

The survival rates of the lambs were evaluated up to 120 days of age and all the lambs in the study were taken into consideration. The statistical analyses for fertility and survival rate traits were done using the chi-square test method (25).

The lambs were weighed monthly with a scale sensitive to 0.5 kg for the measurement of live weights at 30, 60, 90 and 120 days of age. The absolute 30th, 60th, 90th and 120th day live weights of the lambs were calculated by the interpolation method. The results for 10 male lambs, which were selected for the fattening program after weaning from each genotype, were not taken into consideration for the calculation of 120th day growth. The effects of some environmental factors which affect the growth of the lambs were determined using the Least-Squares Means Method and the significance between the groups was determined with a contrast test (26).

The model below was used to determine the extent to which the factors affected birth weight and live weight at older ages.

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

The symbols in this model are:

Y_{ijklm} = Live weight of lamb at the age examined,

μ = Average of the population for the characteristic examined,

a_i = Effect of genotype,

b_j = Effect of dam age,

c_k = Effect of birth type,

d_l = Effect of sex,

e_{ijklm} = Random error.

In the model used, it was assumed that there were no significant interactions between the factors investigated and the sum of the effects of a the subgroups of factor were assumed to be zero.

Results

Fertility

The fertility results for pure-bred Kıvırcık ewes, Kıvırcık ewes mated with GBM rams (two-way crossbreeding group) and Chios x Kıvırcık crossbred F_1 ewes mated with GBM rams (three-way crossbreeding group) are presented in Table 1. The fertility results for the Kıvırcık x Kıvırcık, GBM x Kıvırcık and GBM x F_1 (Chios x Kıvırcık) genotypes in relation to conception and birth rates were 76.66%, 81.13% and 85.29%; in terms of litter size the results were 1.17, 1.25 and 1.66; and for lamb production they were 0.90, 1.02 and 1.41, respectively. In terms of single and prolific birth rates, the differences between the groups were found to be statistically significant ($P<0.05$). According to these results, it can be seen that the three-way crossbreeding group produced higher results for lamb production and litter size traits.

Survival of Lambs

The survival rates of 156 live-born lambs up to 120 days of age are presented in Table 2. The survival rates of the Kıvırcık, two-way and three-way crossbred lambs at weaning (90^{th} day) were 96.3%, 98.1% and 89.6%, respectively. No statistical differences between the groups were determined for the factors investigated ($P>0.05$).

Growth of Lambs

The live weights of the lambs at birth and at 30, 60, 90 and 120 days of age are presented in Table 3. The effects and significance of some factors are presented in Table 4. The birth weights of the lambs were 3.58 kg for the Kıvırcık, 4.27 kg for GBM x Kıvırcık and 3.77 kg for the GBM x F_1 (Chios x Kıvırcık) genotypes. The weaning weights were 21.21 kg, 24.98 kg and 28.30 kg, respectively. Of the effects of the investigated factors, it was observed that genotype and birth type affected all ages, while dam age had an effect on weights at birth, and at 30 and 60 days. The effect of sex on weights at birth and 30 days was found to be statistically significant ($P<0.05$).

Table 1. Fertility of Kıvırcık, GBM x Kıvırcık and GBM x F_1 mating.

Investigated characteristics	Kıvırcık x Kıvırcık		GBM x Kıvırcık		GBM x F_1	
	n	%	n	%	n	%
Ewes exposed	60	-	53	-	34	-
Ewes pregnant	46	76.66 [a]	43	81.13 [a]	29	85.29 [a]
Ewes lambing	46	76.66 [a]	43	81.13 [a]	29	85.29 [a]
Ewes single lambing	38	82.61 [a]	33	76.74 [a]	11	37.93 [b]
Ewes prolific lambing	8	17.39 [a]	10	23.36 [a]	18	62.07 [b]
Lambs live born	54	-	54	-	48	-
Lamb production	0.90	-	1.02	-	1.41	-
Litter size	1.17	-	1.25	-	1.66	-

a, b: The differences between the means of genotype groups carrying different letters in the same line are significant ($P<0.05$)

Table 2. The number and survival rates of lambs at different ages.

Investigated Factors	Number of lambs born	30th day		60th day		90th day		120th day	
		n	%	n	%	n	%	n	%
Genotype									
K x K	54	54	100.0	52	96.3	52	96.3	51	94.4
GBM x K	54	53	98.1	53	98.1	53	98.1	51	94.4
GBM x F1	48	44	91.7	44	91.7	43	89.6	43	89.6
Age of dam									
1.5	13	12	92.3	12	92.3	12	92.3	12	92.3
2.5	34	34	100.0	34	100.0	34	100.0	33	97.1
3.5	18	18	100.0	17	94.4	17	94.4	16	88.9
4.5	60	56	93.3	56	93.3	55	91.7	55	91.7
5.5	5	5	100.0	5	100.0	5	100.0	5	100.0
6.5	17	17	100.0	16	94.1	16	94.1	15	88.2
7.5	9	9	100.0	9	100.0	9	100.0	9	100.0
Birth type									
Single	82	81	98.8	79	96.3	78	95.1	77	93.9
Prolific	74	70	94.6	70	94.6	70	94.6	68	91.9
Sex									
Male	81	78	96.3	78	96.3	77	95.1	75	92.6
Female	75	73	97.3	71	94.7	71	94.7	70	93.3
TOTAL	156	151	96.8	149	95.5	148	94.9	145	92.9

Table 3. Least-Square Means and Standard Errors of the live weights of lambs at different ages (kg).

Investigated factors	Birth weight			30th day weight			60th day weight			90th day weight			120th day weight		
	n	$\bar{X}$	$S\bar{x}$	n	$\bar{X}$	$S\bar{x}$	n	$\bar{X}$	$S\bar{x}$	n	$\bar{X}$	$S\bar{x}$	n	$\bar{X}$	$S\bar{x}$
Genotype															
K x K	54	3.58^{b}	0.12	54	8.43^{b}	0.45	52	14.26^{b}	0.81	52	21.21^{b}	1.19	41	26.57^{b}	1.56
GBM x K	54	4.27^{a}	0.11	53	10.12^{a}	0.42	53	17.55^{a}	0.76	53	24.98^{a}	1.07	41	33.12^{a}	1.44
GBM x F_1	48	3.77^{a}	0.23	44	9.96^{ab}	0.84	44	18.61^{a}	1.52	43	28.30^{a}	2.12	33	34.19^{a}	2.77
Ageofdam															
1.5	13	2.91^{c}	0.22	12	6.51^{d}	1.42	12	13.16^{b}	2.57	12	22.13^{a}	3.32	12	27.90^{a}	4.33
2.5	34	3.68^{b}	0.15	34	8.76^{cd}	0.53	34	16.33^{b}	0.96	34	23.65^{a}	1.37	29	29.97^{a}	1.79
3.5	18	4.01^{ab}	0.20	18	10.42^{ab}	0.69	17	19.31^{a}	1.25	17	25.74^{a}	2.00	10	34.55^{a}	2.80
4.5	60	4.48^{a}	0.15	56	11.21^{a}	0.54	56	18.25^{ab}	0.98	55	25.00^{a}	1.35	34	31.18^{a}	1.76
5.5	5	4.28^{ab}	0.35	5	10.20^{abc}	1.14	5	18.04^{ab}	2.05	5	26.32^{a}	3.40	5	31.34^{a}	4.43
6.5	17	3.98^{ab}	0.20	17	8.99^{bcd}	0.65	16	17.22^{ab}	1.18	16	25.73^{a}	1.70	16	32.23^{a}	2.37
7.5	9	3.74^{b}	0.27	9	10.05^{abc}	0.86	9	17.64^{ab}	1.55	9	25.21^{a}	2.04	9	31.85^{a}	2.66
Birth type															
Single	82	4.38^{a}	0.11	81	11.26^{a}	0.41	79	20.09^{a}	0.74	78	27.57^{a}	1.12	47	34.20^{a}	1.49
Prolific	74	3.35^{b}	0.12	70	7.63^{b}	0.47	70	14.19^{b}	0.86	70	22.09^{b}	1.19	68	28.38^{b}	1.57
Sex															
Male	81	4.05^{a}	0.11	78	9.92^{a}	0.41	78	17.80^{a}	0.74	77	25.13^{a}	1.12	45	32.69^{a}	1.51
Female	75	3.68^{b}	0.12	73	8.98^{b}	0.45	71	16.48^{a}	0.81	71	24.52^{a}	1.09	70	29.89^{a}	1.43
TOTAL	156	3.87	0.08	151	9.45	0.32	149	17.14	0.46	148	24.83	0.78	115	31.29	0.98

a, b, c, d: The differences between the means of groups carrying different letters in the same column are significant ($P<0.05$).

Table 4. Effects of some factors on the live weights of lambs at different ages (kg).

Investigated factors	Birth weight		30th day weight		60th day weight		90th day weight		120th day weight	
	n	E.S.	n	E.S.	n	E.S.	n	E.S.	n	E.S.
Genotype		*		*		*		*		*
K x K	54	-0.2895	54	-1.0208	52	-2.8749	52	-3.6198	41	-4.7349
GBM x K	54	0.4003	53	0.6728	53	0.4070	53	0.1516	41	1.8315
GBM x F1	48	-0.1108	44	0.3480	44	2.4679	43	3.4683	33	2.9035
Age of dam		*		*		*				
1.5	13	-0.9675	12	-2.9348	12	-3.9746	12	-2.6948	12	-3.3864
2.5	34	-0.1854	34	-0.6886	34	0.8035	34	-1.1741	29	-1.3155
3.5	18	0.1394	18	0.9711	17	2.1738	17	0.9181	10	3.2671
4.5	60	0.6083	56	1.7588	56	1.1125	55	0.1733	34	-0.1143
5.5	5	0.4149	5	0.7476	5	0.9065	5	1.4940	5	0.0453
6.5	17	0.1171	17	-0.4584	16	0.0804	16	0.9007	16	0.9408
7.5	9	-0.1268	9	0.6042	9	0.5049	9	0.3830	9	0.5629
Birth type		*		*		*		*		*
Single	82	0.5164	81	1.8146	79	2.9484	78	2.7398	47	2.9042
Prolific	74	-0.5164	70	-1.8146	70	-2.9484	70	-2.7398	68	-2.9042
Sex		*		*						
Male	81	0.1911	78	0.4708	78	0.6601	77	0.3046	45	1.3990
Female	75	-0.1911	73	-0.4708	71	-0.6601	71	-0.3046	70	-1.3990
Expected means	156	3.8681	151	9.4495	149	17.1400	148	24.8295	115	31.2920

*P<0.05

Discussion

In terms of the fertility characteristics of two-way and three-way crossbred genotypes and pure-bred Kıvırcık sheep, the conception and birth rates were between 76% and 85%. In the F_1 ewe group with a 50% Chios genotype, the number of prolific births was higher than in the Kıvırcık and GBM x Kıvırcık two-way crossbred genotype groups.

The conception and birth rates determined in this study were lower than results previously reported for Kıvırcık and Chios ewes (11,12,13); however, they were higher than the conception and birth rates given in several crossbreeding studies (8,9,10). The litter size of 1.66 determined in the three-way crossbreeding group was higher than the results reported in crossbreeding studies and in studies of pure-bred Kıvırcık sheep, but lower than the results reported for pure-bred Chios ewes and Booroola Merino crossbred ewes (6,7,8,9,11,12,13). These results show that the prolific birth trait, which has a significant role in commercial crossbreeding studies, could be improved by using the Chios genotype.

One of the desired characteristics of slaughter lambs is a high survival rate at the age of weaning. In this study, the survival rates of the Kıvırcık and GBM x Kıvırcık lambs were higher than those reported for Kıvırcık lambs: 93.6% - 94.6%. The survival rates of the three-way crossbred lambs were lower than the results reported for Kıvırcık lambs; however, they were similar to each other and both were higher than other results for the survival of GBM and different crossbred lambs (8,16,17). Although these results indicate that the Kıvırcık and GBM x Kıvırcık crossbred lambs had higher survival rates than the three-way crossbred lambs, the differences between the groups were not statistically significant.

Two-way and three-way crossbred lambs showed similar growth levels. They produced better results than the Kıvırcık lambs and the differences were statistically significant. The birth weight determined in this study for the Kıvırcık lambs was lower than results for pure-bred lambs reported in other studies (13,14,16). The birth weights of the crossbred lambs were similar to results for lambs in different crossbreeding studies (8, 17, 18, 19, 20, 21).

Of the factors affecting the live weights of lambs at different ages, the effects of genotype and birth type on live weight at all ages, the effects of dam age on weights at birth, 30 and 60 days of age, and the effect of sex on weights at birth and at 30 days of age were found to be statistically significant. The results are in accordance with those in the literature (18,19,21,22,23).

In conclusion, when the results of the two-way and three-way crossbreeding studies with Chios, Kıvırcık and GBM sheep breeds are evaluated, it can be stated that use of the Chios genotype can improve the number of lambs produced. Both two-way and three-way crossbred lambs can reach a weight of 20 kg, ideal for a fattening program which is faster than that for Kıvırcık lambs, showing better growth performance up to the age of weaning.

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