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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

2. Fattening and Carcass Characteristics of Lambs*

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Abstract: The aim of this study was to compare the fattening and carcass traits of lambs which were produced by two-way and three-way crossbreeding studies 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) which has been found to be the mutton breed which exhibits the best adaptation to the environmental conditions of the Marmara region.

It was determined that two-way and three-way crossbred lambs were similar with regard to fattening and carcass traits, and both showed better performance than Kıvırcık lambs. The crossbred lambs exhibited faster weight gain and consumed less feed per unit weight gain during the fattening program, yielding better quality carcasses than the Kıvırcık lambs. With this study, it was concluded that the meat production of lambs could be increased by the use of GBM rams and two-way or three-way crossbreeding studies in the region.

Key Words: Lamb, Crossbreeding, Fattening, Carcass characteristics

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

2. Kuzuların Besi ve Karkas Özellikleri

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 melezlemeler ile elde edilen kuzuların besi ve karkas özellikleri yönünden karşılaştırılması amaçlanmıştır.

İkili ve üçlü melez kuzuların besi ve karkas özellikleri yönünden birbirlerine benzer olduğu, bu kuzuların saf Kıvırcık kuzulara kıyasla daha yüksek performans sergiledikleri, melez kuzuların besi süresince hızlı canlı ağırlık artışı gösterdikleri ve kazanılan canlı ağırlıklar için Kıvırcık kuzulardan daha az yem tükettikleri ve daha kaliteli karkas verdikleri tespit edilmiştir. Bu araştırma ile ASB koçların kullanıldığı ve iki veya üç ırkın melezlendiği kullanma melezlemesi modellerinin bölge koşullarında uygulanması ile yöredeki kuzuların et verimlerinin artırılabileceği sonucuna varılmıştır.

Anahtar Sözcükler: Kuzu, Melezleme, Besi, Karkas özellikleri

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Introduction

In recent years, the number of scientific studies of the production of commercial slaughter lambs has risen. Slaughter lambs are expected to have fast growth characteristics, a high survival rate, to reach maturity for slaughter through a fattening program of 2-3 months' duration, and to yield better quality carcasses (1,2,3,4,5).

Although the number of sheep bred in Turkey is seemingly higher than in some countries that use advanced sheep-breeding techniques, the average carcass weight of sheep and lambs in Turkey is 15.7 kg (6). The average carcass weights of sheep and lambs in important sheep-breeding countries are 20.7 kg in Germany, 18.4 kg in France, 19.0 kg in the United Kingdom, 25.2 kg in the Netherlands, 20.2 kg in Australia and 30.3 kg in the United States (6). That the average carcass weight is lower in Turkey could be related to the inadequacy of the genotype structure of indigenous sheep breeds and the lack of scientific sheep-breeding programs in Turkey.

The Marmara region has a climate and grassland conditions which are suitable for the production of commercial slaughter lambs. In this region, the need of sheep breeders for more milk from the ewes leads them to wean lambs at early ages and these lambs are slaughtered without further fattening. Because of this practice, the potential meat production of the lambs is not fully realised and a financial loss is made (7).

A method used for the prevention of meat loss by early lamb slaughter is the production of better quality slaughter lambs by the crossbreeding of two or three breeds.

Özsoy and Vanlı (8) reported a significant improvement in the fattening characteristics of lambs obtained by two-way and three-way crossbreeding with Merino, Awassi and Red Karaman sheep breeds in eastern Anatolia. In this study, it was determined that two-way and three-way crossbred lambs showed heterosis of between 0.02% and 29%. It was also stated that in the environmental conditions of the region, more economical sheep breeding could be achieved by such crossbreeding studies rather than producing pure-bred Red Karaman lambs.

Osikowsky et al. (9) declared that the crossbred lambs produced by the crossbreeding of Merinofinn ewes with different mutton breeds exhibited growth and feed conversion characteristics superior to those of pure-bred lambs. The daily weight gain of crossbred lambs was 189 g-214 g.

In different studies of lamb fattening and crossbreeding with indigenous White Karaman sheep and different mutton breeds like GBM, Hampshire Down, Dorset Down, Border Leicester, Turkish Merino and Ile de France, the performance of two-way crossbred lambs in terms of live-weight means was 37.93 kg - 43.00 kg, for daily live-weight gains it was 307 g - 370 g, and with regard to concentrated feed consumption levels for 1 kg live-weight gain it was 3.76 kg - 4.45 kg (2,3,4). In the lambs produced by crossbreeding Kıvırcık and the mutton breeds mentioned above, the live weights at the end of fattening were 28.5 kg - 33.29 kg, the daily fattening live-weight gains were 225.63 g - 317.14 g, and the concentrated feed-consumption levels for 1 kg live weight gain were 4.14 kg - 4.94 kg (10,11).

It can be seen from various studies of the slaughter and carcass characteristics of lambs that by crossbreeding with mutton breeds, improvements appropriate for the market demand in crossbred lamb carcasses can be made. Improvements in the amount of meat, particularly on valuable carcass parts, have been reported by some researchers (4,5,8,12).

In different combination crossbreeding studies with the Merino, Red Karaman and Awassi breeds, three-way crossbred lambs produced better carcass weight and dressing percentage characteristics. The carcass weights of pure-bred, two-way and three-way crossbred lambs were found to be 21.3 kg, 21.9 kg and 22.3 kg, respectively (8).

In a three-way crossbreeding study with Dağlıç, Merino and Chios sheep breeds, pure-bred Dağlıç lambs, Merino x F_1 (Chios x Dağlıç) and Ile de France x F_1 (Chios x Dağlıç) three-way crossbred lambs had live weights of 24.3 kg, 31.0 kg and 32.2 kg before slaughter, yielded 11.9 kg, 14.3 kg and 15.2 kg in chilled-carcass weight and produced chilled-carcass dressing percentages of 49.2%, 46.1% and 47.2% respectively (13).

In the lambs obtained by crossbreeding Kıvırcık ewes with Merino and Ile de France rams, the chilled-carcass weights were 19.40 kg - 20.43 kg, and the chilled-dressing percentages were 45.84% - 47.65% (10).

Akgündüz et al. (11) found the carcass characteristics of lambs produced by the crossbreeding of Kıvırcık ewes with GBM and Hampshire Down rams to be 15.6 kg - 19.2 kg for chilled carcass weight, and 48.8% - 50.1% for chilled-dressing percentage. It was also reported that crossbred lambs performed better with regard to leg width than pure bred Kıvırcık lambs. In GBM x F_1 (Chios x Kıvırcık) three-way crossbred and pure-bred Kıvırcık lambs, the chilled-carcass weights were 22.6 kg and 18.9 kg, the chilled-dressing percentages were 49.4% and 47.5%, and the MLD section areas were 11.9 cm^2 and 12.1 cm^2, respectively. In this study it was reported that there were statistically significant differences between the groups in terms of improvements in crossbred lambs in body length and breast depth (5).

In their study to determine the carcass characteristics of GBM x White Karaman, Hampshire Down x White Karaman, GBM x Awassi and Hampshire Down x Awassi crossbred lambs, Kadak et al. (4) reported that the chilled-carcass weights were 21.38 kg, 21.13 kg, 21.39 kg and 22.05 kg and chilled-dressing percentages were 47.91%, 47.13%, 47.89% and 48.52%, respectively. In the same study, the leg percentages were 32.52% - 34.16%, the shoulder percentages were 16.71% - 17.33%, the back percentages were 8.88% - 9.29%, the loin percentages were 8.04% - 8.24% and the percentages of the other parts were 23.18% - 27.19% in crossbred lambs.

The general aim of this study was to compare the growth, survival, fattening and carcass traits of lambs which were produced by two-way and three-way crossbreeding studies with Kıvırcık sheep, the predominant breed in the Marmara region, Chios sheep, most prolific breed in the region and GBM, which has been found to be the mutton breed which exhibits the best adaptation to the environmental conditions of the Marmara region. Our aim was to find out whether three-way crossbreeding would be necessary or two-way crossbreeding practices would be sufficient for improvement in the lamb production of the Kıvırcık sheep breed. In addition, the possibility of these crossbreeding models creating an alternative to pure Turkish Merino breeding was investigated. In this second part of the study, the performance of pure-bred and crossbred lambs in an intensive fattening program, and the slaughter and carcass characteristics of the lambs were investigated.

Materials and Methods

Materials

The material of this study consisted of lambs produced by two-way and three-way crossbreeding with German Black-Headed Mutton, Kıvırcık and Chios x Kıvırcık (F_1) genotype groups in the years 1997-1998. Four genotype groups were formed in the study:

1. Pure-bred Kıvırcık lambs in the first control group,
2. Two-way crossbred lambs produced by the crossbreeding of GBM rams with Kıvırcık ewes,
3. Three-way crossbred lambs produced by the crossbreeding of GBM rams with F_1 (Chios x Kıvırcık) ewes,
4. Pure-bred Turkish Merino lambs in the second control group.

The reason for using Turkish Merino lambs as the second control group in the study was to investigate the possible superiority or similarity of the crossbred lambs to the Turkish Merino, which is the enhanced mutton breed of the region.

After weaning at the age of 3 months, 10 lambs from each genotype group were selected for the lamb-fattening program. The feed ration given in Table 1 was produced in the institute and lambs in individual boxes were exposed to this ration ad libitum during the fattening program.

Table 1. The feed contents of the ration used for the lamb-fattening program.

Feed contents	Amount
Barley	77.8 kg
Sunflower oilcake	20.0 kg
Salt	0.5 kg
Marble powder	1.5 kg
Vitamin + Mineral Premix	0.2 kg
TOTAL	100.0 kg

Methods

In order to determine the fattening characteristics of the lambs, 10 lambs from each genotype were selected.

In order to minimise environmental differences in these lambs, single-born, male lambs born in December were selected. The lambs were put into individual boxes. In order to determine the live weight, daily live-weight gain, daily feed consumption and feed consumed per 1 kg live-weight gain during fattening, data were recorded by fortnightly weighing of both the lambs and the feed they consumed. The fattening program lasted for 56 days.

In order to determine the slaughter and carcass characteristics, 5 lambs from each genotype group were slaughtered. The lambs with live weights closest to the live-weight means of their groups were chosen. Carcass analyses were conducted over two periods. In the first period, the weights of the head, feet and inner organs were determined. During the second period, the carcasses were kept for 24 hours at +4ºC and some carcass measurements were taken in cm. Then the carcasses were cut into parts (shoulder, back, leg, loin, and other parts) and the parts were weighed (14). The Musculus Longissimus Dorsi (MLD) section area and back-fat thickness were also determined.

The statistical comparisons between the genotype groups in respect of the fattening and carcass characteristics were made by variation analysis, and the significance between the groups was determined by the method of Least Significant Differences (15).

Results

Fattening Performance of Lambs

For the fattening program, the live weights are given in Table 2, the daily live-weight gains are given in Table 3, the daily feed-consumption figures are given in Table 4, and the intensive feed consumed per 1 kg live weight gain is given in Table 5.

Table 2. Live weights during fattening of Kıvırcık, two-way and three-way crossbred and Turkish Merino lambs (kg) (n:10).

Fattening Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Beginning live weight	20.58[a]	1.89	22.29[a]	0.83	23.04[a]	0.95	21.83[a]	1.09
14th day live weight	22.34[a]	1.61	25.66[a]	1.46	25.81[a]	0.73	24.26[a]	0.97
28th day live weight	24.81[a]	1.69	28.60[a]	1.93	29.54[a]	0.69	27.54[a]	1.29
42nd day live weight	28.07[a]	2.36	31.91[a]	1.83	33.19[a]	0.55	32.29[a]	1.59
56th day live weight	29.91[a]	2.79	34.79[a]	1.82	35.90[a]	0.58	36.33[a]	1.88
Live weight gain (0-56)	9.33[b]	1.59	12.50[ab]	1.09	12.86[ab]	1.18	14.50[a]	1.08

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

Table 3. Daily live-weight gain during fattening of Kıvırcık, two-way and three-way crossbred and Turkish Merino lambs (*) (g) (n:10).

Fattening Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Beginning-14th day	125.57	34.45	240.71	47.89	197.86	35.89	173.43	40.10
14-28th day	176.57	17.74	210.29	41.67	266.43	21.51	234.71	38.01
28-42nd day	232.71	53.17	236.71	43.31	260.29	42.01	338.86	31.32
42-56th day	131.71	38.18	205.00	41.22	194.00	50.78	288.86	36.35
Beginning-28th day	151.00	23.96	225.57	42.78	232.14	22.34	204.00	24.57
Beginning-42nd day	178.00	26.45	233.57	24.20	241.57	18.18	249.00	17.51
Beginning-56th day	166.71	28.34	223.29	19.47	229.71	21.20	259.00	19.32

* There are no significant difference between the genotype groups (P>0.05).

Table 4. Daily feed consumption of Kıvırcık, two-way and three-way crossbred and Turkish Merino lambs (g) (n:10).

Fattening Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Beginning-14th day	541.9[a]	45.5	557.1[a]	88.5	614.0[a]	45.9	496.0[a]	70.7
14-28th day	977.7[a]	84.7	1008.3[a]	132.2	1101.1[a]	51.3	1002.0[a]	77.9
28-42nd day	1180.7[a]	57.2	1283.7[a]	115.1	1271.4[a]	92.6	1266.4[a]	63.6
42-56th day	900.0[b]	117.1	1071.6[ab]	89.9	1250.8[ab]	106.1	1363.1[a]	135.8
Beginning-28th day	759.7[a]	58.2	782.6[a]	103.3	857.7[a]	40.2	749.1[a]	62.1
Beginning-42nd day	899.9[a]	30.6	799.0[a]	141.2	852.7[a]	142.3	921.1[a]	39.1
Beginning-56th day	900.2[b]	43.3	980.1[ab]	35.7	1059.4[a]	28.7	1032.1[a]	38.9

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

Table 5. Concentrated feed consumption for 1 kg live-weight gain of Kıvırcık, two-way and three-way crossbred and Turkish Merino lambs (kg) (n:10).

Fattening Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Beginning-14th day	3.19[a]	0.57	2.55[a]	0.32	3.37[a]	0.49	3.97[a]	0.87
14-28th day	5.75[a]	0.57	5.69[a]	0.86	4.36[a]	0.52	4.94[a]	0.76
28-42nd day	6.91[a]	1.48	4.81[a]	0.41	4.27[a]	0.24	3.93[a]	0.41
42-56th day	6.66[a]	0.92	4.86[a]	0.75	5.34[a]	1.03	4.98[a]	0.28
Beginning-28th day	3.82[a]	0.23	3.91[a]	0.41	3.79[a]	0.28	3.66[a]	0.32
Beginning-42nd day	5.62[a]	0.73	4.37[ab]	0.33	3.99[b]	0.15	3.77[b]	0.23
Beginning-56th day	6.05[a]	0.74	4.54[b]	0.30	4.33[b]	0.11	4.05[b]	0.17

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

Slaughter and Carcass Characteristics

The slaughter and carcass characteristics of the lambs are presented in Tables 6, 7 and 8.

Discussion

When the fattening characteristics of the Kıvırcık, Turkish Merino, two-way and three-way crossbred lambs are evaluated, the Turkish Merino, two-way and three-way crossbred lambs seemed to have similar values for all characteristics, and the performance of these three groups was better than that of the pure-bred Kıvırcık lambs. It can be seen that the crossbred lambs exhibited faster live weight gain and consumed less feed per unit live-weight gain than the Kıvırcık lambs and produced similar results to the pure-bred Turkish Merino lambs.

In this study, the results found with two-way and three-way crossbred lambs were lower than those reported from F_1 lambs produced by the crossbreeding of Akkaraman ewes with different mutton breeds (2,3,4). The results were similar to the fattening performance of mutton breeds x Kıvırcık (F_1) lambs and the two-way and three-way crossbred lambs obtained by crossbreeding with Awassi, Red Karaman and Merino breeds (10,11). The daily live-weight gain of the two-way and three-way crossbred lambs was higher than that reported by Osikowsky et al. (9). The fattening performance of the crossbred lambs was proportionally lower than that of mutton breeds x Akkaraman (F_1) lambs. This might be explained by the lambs in this study being confined in boxes.

Table 6. Some slaughter and carcass characteristics of Kıvırcık, two-way and three-way crossbreed and Turkish Merino lambs (n:5).

Carcass Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Live weight before slaughter (kg)	28.16^{b}	2.00	33.38^{a}	1.50	35.72^{a}	0.41	36.04^{a}	0.89
Hot-carcass weight (kg)	13.77^{b}	1.02	15.87^{ab}	0.64	17.35^{a}	0.35	17.41^{a}	0.33
Hot-dressing percentage (%)	48.66^{a}	0.52	47.59^{a}	0.89	48.59^{a}	1.14	48.33^{a}	0.33
Skin weight (g)	2556^{b}	134.90	3074^{ab}	198.48	3184^{ab}	170.49	3272^{a}	191.45
Head weight (g)	1554^{b}	83.22	1880^{a}	120.04	1824^{ab}	49.25	1854^{a}	46.75
Four feet weight (g)	646^{b}	46.43	804^{a}	33.11	802^{a}	17.15	917^{a}	22.78
Liver+heart+lungs weight (g)	1246^{b}	62.50	1506^{ab}	54.37	1754^{a}	49.56	1844^{a}	107.73
Spleen weight (g)	66b^{c}	5.10	60^{c}	6.32	82^{ab}	5.83	98^{a}	2.00
Four stomachs weight (full) (g)	3626^{b}	438.35	4390^{ab}	397.16	4602^{ab}	289.39	5044^{a}	241.69
Four stomachs weight (empty) (g)	936^{b}	102.64	1058^{ab}	61.92	1252^{a}	80.15	1282^{a}	60.37
Intestines weight (full) (g)	1848^{b}	135.29	2780^{a}	253.75	2720^{a}	120.17	2634^{a}	185.89
Inner fat weight (g)	284^{a}	29.77	344^{a}	26.38	306^{a}	24.00	310^{a}	31.14
Testicle weight (g)	80^{b}	17.61	164^{a}	27.13	186^{a}	31.72	104^{ab}	12.88

$^{a, b, c}$: The differences between the means of genotype groups denoted by different letters in the same line are significant ($P<0.05$)

Table 7. Some carcass characteristics of Kıvırcık, two-way and three-way crossbred and Turkish Merino lambs (n:5).

Carcass Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Chilled-carcass weight (kg)	13.72^{b}	1.06	15.66^{ab}	0.66	16.95^{a}	0.32	16.96^{a}	0.37
Chilled-dressing percentage (%)	47.94^{a}	0.60	46.98^{a}	0.99	47.47^{a}	1.13	47.08^{a}	0.25
Leg weight (g)	4180^{c}	288.79	4840^{bc}	156.84	5180^{ab}	139.28	5560^{a}	128.84
Shoulder weight (g)	2400^{b}	176.09	2920^{a}	111.35	3220^{a}	111.35	3180^{a}	106.77
Back weight (g)	1060^{b}	92.74	1220^{ab}	80.00	1320^{a}	37.42	1340^{a}	40.00
Loin weight (g)	1200^{b}	104.88	1340^{ab}	67.82	1580^{a}	48.99	1450^{ab}	86.60
Other parts weight(g)	4280^{a}	355.53	4760^{a}	254.16	5080^{a}	101.98	4940^{a}	143.53
Leg percentage (%)	30.54^{a}	0.29	30.97^{a}	0.52	30.56^{a}	0.42	32.80^{b}	0.58
Shoulder percentage (%)	17.51^{a}	0.14	18.69^{a}	0.57	19.00^{a}	0.55	18.76^{a}	0.52
Back percentage (%)	7.72^{a}	0.28	7.76^{a}	0.20	7.78^{a}	0.13	7.90^{a}	0.11
Loin percentage (%)	8.72^{a}	0.31	8.55^{a}	0.17	9.32^{a}	0.26	8.54^{a}	0.42
Other parts percentage (%)	31.13^{a}	0.24	30.34^{ab}	0.38	29.98^{b}	0.19	29.13^{b}	0.56
Kidney weight (g)	104^{a}	9.27	124^{a}	4.00	110^{a}	7.07	107^{a}	4.90
Kidney and kidney fat weight (g)	500^{a}	62.05	424^{a}	59.63	446^{a}	16.61	378^{a}	42.36
MLD section area (cm^2)	11.77^{b}	0.77	13.40^{ab}	0.74	14.52^{a}	0.58	15.19^{a}	0.47
Back-fat thickness (mm)	3.15^{a}	0.35	3.25^{a}	0.39	3.80^{a}	0.20	3.00^{a}	0.47

$^{a, b, c}$: The differences between the means of genotype groups denoted by different letters in the same line are significant ($P<0.05$).

Table 8. Some carcass measurements of Kıvırcık, two-way and three-way crossbred and Turkish Merino lambs (cm) (n:5).

Carcass Characteristics	Kıvırcık		Two-way crossbreed		Three-way crossbreed		Turkish Merino	
	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$	$\bar{x}$	$S\bar{x}$
Body length	57.80[a]	1.46	60.20[a]	0.66	61.20[a]	1.24	60.60[a]	2.07
Back length	49.00[a]	1.09	51.80[a]	1.02	51.40[a]	0.87	50.20[a]	0.49
Exterior leg length	38.60[a]	1.08	39.80[a]	0.49	39.80[a]	0.73	40.00[a]	0.84
Inner leg length	20.60[a]	0.68	21.20[a]	0.25	19.90[a]	1.03	20.80[a]	0.34
Leg circumference	31.60[b]	0.81	34.20[ab]	0.80	36.40[a]	0.93	36.80[a]	1.24
Leg width	10.70[b]	0.66	10.40[b]	0.81	14.40[a]	1.16	13.10[a]	0.40
Breast width	18.40[b]	0.81	19.80[a]	0.37	21.10[a]	0.80	20.90[a]	0.56
Breast depth	22.70[a]	0.94	22.60[a]	0.51	23.20[a]	0.37	22.60[a]	0.40
Breast circumference	64.20[a]	1.43	66.20[a]	0.85	67.70[a]	0.54	67.70[a]	0.66
Rump width	16.10[b]	0.66	16.30[b]	0.30	18.10[a]	0.24	18.50[a]	0.50
Rump circumference	53.20[c]	1.71	56.80[bc]	0.37	59.40[ab]	0.81	60.60[a]	0.75

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

While the two-way and three-way crossbred lambs and the Turkish Merino lambs were similar to each other in terms of slaughter and carcass characteristics, these three genotypes produced better results than the Kıvırcık lamb carcasses. In this study, the hot-carcass weights of the crossbred and Turkish Merino lambs were 15.87 kg - 17.41 kg and for the Kıvırcık lambs it was 13.77 kg. Similarly, the chilled-carcass weights of crossbred and Turkish Merino lambs were 15.66 kg - 16.96 kg and for the Kıvırcık lambs it was 13.72 kg. The chilled-dressing percentages of the genotypes were 46.98% - 47.94%, and the differences between the groups were not significant. When the MLD section area, which is an important characteristic for determining the valuable meat content of the carcass, was investigated, it was seen that the two-way and three-way crossbred lambs and the Turkish Merino lambs produced similar results (13.4 cm^2-15.19 cm^2). However, these results were superior to the results of the Kıvırcık lambs (11.77 cm^2). When the carcass measurements of the lambs were investigated, it was seen that the lambs of the genotypes other than Kıvırcık produced better results in terms of important carcass parts (leg and loin width and circumference).

The chilled-carcass weight found in the present study is lower than that of some crossbreeding studies (4,5,8,10) and higher than that reported in others (13). The major causes of these differences are that the lambs were of different ages and had different slaughter weights in these studies. However, the chilled-dressing percentage, MLD section area and the percentages of some carcass parts were similar to those of various studies (4,5,10,11,13).

In conclusion, it was determined that the two-way and three-way crossbred lambs were similar in terms of the fattening, slaughter and carcass characteristics and these results were higher than those of the Kıvırcık lambs. It is clear that the use of GBM rams in crossbreeding can improve fattening and carcass performance even in F_1 generation. The use of two-way or three-way commercial crossbreeding methods can increase the meat production of the lambs in the region. In light of the results of this study, it was concluded that in the environmental conditions of the Marmara region two-way and three-way crossbreeding is a viable alternative to Turkish Merino breeding.

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