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Fattening performance and carcass traits of lambs obtained by crossing the Hasmer and Hasak sheep types with the Akkaraman breed

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Abstract: The present study investigated the fattening performance and carcass traits of lambs obtained by the crossing of the Hasak and Hasmer sheep types, developed at the Bahri Dağdaş International Agricultural Research Institute, with publicly owned Akkaraman sheep. Of each of these groups, 7 male and 7 female lambs of approximately 75 days of age were raised under an intensive feedlot system. The fattening period lasted 70 days, and, at the end of this period, 5 lambs were slaughtered from each group with the aim of determining carcass traits. In conclusion, the percentage of tail fat was reduced with the decreasing share of the Akkaraman genotype in the genome. However, crossing of Akkaraman sheep with Hasak and Hasmer types did not improve the fattening performance and carcass quality compared with purebred Akkaraman lambs.

Key words: Hasak, Hasmer, Akkaraman, fattening performance, carcass traits

1. Introduction

Across the globe as well as in Turkey, sheep and sheep products have great economic value. Sheep have a significant role in meeting the animal protein needs of the human population. In Turkey, the share of sheep breeding in the annual meat and milk production is 20.8% and 9%, respectively (1). The most commonly raised sheep breed in Turkey is the Akkaraman (Akk), which has a share of 45.8% in the overall ovine population (2). Meat production bears significance in sheep breeding. However, the tail weight, constituting up to 15%–20% of the carcass weight in Akkaraman sheep (3–7), is considered a major disadvantage. With the aim of reducing the size of the tail and improving meat yields, studies have been conducted in Turkey on the crossbreeding of the Akkaraman breed with globally well-known mutton breeds (3,5,8–10), and positive results have been achieved.

The first studies aimed at developing a mutton sheep breed were initiated at the Konya Central Livestock Research Institute in 1989 with the use of the German Blackheaded (GBH), Hampshire Down (HD), and Lincoln (L) mutton breeds. In these studies, the Merino (M) was crossed with all 3 imported breeds, whilst the Akk and Awassi (Aw) were crossed with only the GBH and HD. As a follow-up to this research, in a project initiated in 1997 with the financial support of the Ministry of Agriculture and Rural Affairs, it was agreed that the GBH × M and HD × M (F1) and (G1) crossbreeds would be united under the name Hasmer, and the GBH × Akk and HD × Akk (F1) and (G1) crossbreeds would be united under the name Hasak. The performance tests and selections performed under this project enabled the development of the above-mentioned types. Thereafter, the institute continued with the raising of these 2 types, performance tests were conducted, and selections (the selection of potential rams) were based on the results of these tests (11). In a 3-year study conducted on the Hasmer, Hasak, Hasiv, and Linmer types, performance tests demonstrated that the average daily gain (ADG) values were 258 g, 263 g, 302 g, and 272 g, respectively, in 1997; 284 g, 307 g, 330 g, and 264 g, respectively, in 1998; 270 g, 287 g, 272 g, and 255 g, respectively, in 1999 (in all 3 years $P < 0.05$). Furthermore, the feed conversion ratio (FCR) values of the 4 sheep types were 4.38, 5.00, 5.03, and 4.22 kg, respectively, in 1997 ($P < 0.05$); 4.28, 4.17, 4.14, and 4.06 kg, respectively, in 1998 ($P > 0.05$); and 4.30, 4.28, 4.09, and 4.76 kg, respectively, in 1999 ($P < 0.05$). Excluding the Hasmer group, differences observed between the years in the other genotypes were statistically significant (12).

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It was considered that, in addition to performance tests and selection studies, the use of these types as the sire line in crossing with local breeds (and particularly the Akkaraman) should be investigated to demonstrate to what extent this method can be used in producing quality lambs for slaughter. The aim of the present study was to investigate the fattening performance and carcass traits of Hasak × Akk and Hasmer × Akk crossbred lambs, obtained by the crossing of rams of the Hasak and Hasmer sheep types with publicly owned Akkaraman ewes, as well as of Hasak, Hasmer, and Akkaraman lambs reared at the Bahri Dağdaş International Agricultural Research Institute.

2. Materials and methods

2.1. Animal material

Male and female lambs obtained by the crossing of Hasmer (31.25% HD, 31.25% GBH, and 37.5% M) and Hasak (31.25% HD, 31.25% GBH, and 37.5% Akk) rams developed at the Bahri Dağdaş International Agricultural Research Institute with publicly owned Akk ewes constituted the material for the study. Seven male and 7 female lambs were used of each genotype (excluding the Akk breed). The Hasmer and Hasak lambs were obtained from the institute, whilst the Akk and crossbred lambs were obtained from publicly owned holdings at which the research project was carried out.

Due to the reluctance of breeders to trade, female Akkaraman lambs were not able to be obtained. Within the first 10 days of the trial, 2 of the Hasmer lambs, 1 male and 1 female, were excluded from the study due to health problems.

2.2. Feed material

The lambs were fed on a concentrate ration, the composition of which is given in Table 1. The ration was prepared at the feed unit of the institute.

2.3. Method

The study was conducted at the premises of the institute. Male and female lambs were weaned at an average of 75 days of age (lambs ages were between 70–80 days of age) and were fattened for a period of 70 days. Nine groups were established, based on genotype and sex, and the animals were housed in paddocks within the same pen (1: Akk M, 2: Hasmer M, 3: Hasmer F, 4: Hasak M, 5: Hasak F, 6: Hasmer × Akk M, 7: Hasmer × Akk F, 8: Hasak × Akk M, 9: Hasak × Akk F). Following a 1-week acclimatization period, the fattening trial was initiated. During the acclimatization period the lambs were vaccinated and administered antiparasitic drugs. The body weights of the lambs at the beginning of the fattening period were determined by means of a digital scale sensitive to 100 g. Later, weighing was performed at 2-week intervals. The animals were weighed in the morning on an empty stomach. Throughout the fattening period, the lambs were given a limited amount of alfalfa hay (a daily amount of

Table 1. The calculated nutrient composition and raw material amounts of the ration fed to the experimental animals (given as the percentage of the ration).

Feed raw materials	Amount (%)	Calculated feedstuffs	Amount (%)
Barley	22.0	Dry matter	89.04
Wheat	15.0	Crude protein	15.74
Maize	35.0	Metabolic energy (kcal/kg)	2710
Sunflower cake	8.0	Calcium	0.84
Soy cake	15.0	Phosphorus	0.50
Molasses	2.0	Crude cellulose	4.96
Marble powder	1.5		
Vitamin–mineral mix*	0.1		
Salt	0.8		
DCP	0.6		
Total	100		

* The vitamin-mineral mix contained 15,000,000 IU of vitamin A; 3,000,000 IU of vitamin D3; 30,000 mg of vitamin E; 50,000 mg of Mn; 50,000 mg of Fe; 50,000 mg of Zn; 10,000 mg of Cu; 150 mg of Co; 800 mg of I; and 150 mg of Se per kg.

150 g) and ad libitum concentrate feed, the composition of which is given in Table 1. Furthermore, the animals were provided with rock salt and mineral licking blocks in the feeders and clean drinking water in water troughs on a continuous basis. Feed amounts given to the lambs as group and remaining in the feeders were weighed with an aim to determine feed consumption. At the end of the fattening period, 5 lambs from each genotype and sex, excluding purebred females, were separated for slaughter (in total 7 groups and 35 lambs). The 5 lambs from each group were selected randomly by drawing lots. The lambs were slaughtered and their carcasses were examined at a private slaughterhouse named Konet. The slaughtering traits, which were investigated after slaughter, included hot carcass, skin, head and feet, heart–lung–liver, and omental and mesenteric fat weights. The percentages of head–feet, hide, heart–lung–liver, and omental and mesenteric fat was calculated according to preslaughter body weight. Cold carcass weights were measured after the carcasses were chilled at +4 °C in a cold store. Subsequently, some other carcass traits (chest circumference, chest depth, chest width, body length, leg circumference, and leg width) were investigated and the weights of kidney and pelvic fat and the tail were measured. The carcass was divided into 5 major cuts (13), and their weight and percentile share in the carcass were determined. Furthermore, a transversal section was taken from the area between the last lumbar and first thoracic vertebrae in order to measure the dorsal longissimus muscle (LM) area and back fat thickness. With an aim to obtain information on the lean, fat, and bone percentages of the carcass (carcass composition) the left foreleg of each carcass was dissected on the same day of carcass jointing.

In both the fattening trial and the carcass study, data pertaining to the male and female lambs were analyzed separately. The results of the fattening trial were analyzed by a general linear model (GLM) procedure, such that the weights of the animals at the beginning of the fattening period were introduced as covariance factors because of the differences between the genotypes was observed at significant levels ($P < 0.05$) at the beginning of the fattening period, whilst the carcass traits were analyzed by one-way analysis of variance. The groups were compared in pairs using Tukey's test (14).

3. Results

3.1. Body weight and daily body weight gain

The body weights of the lambs at different phases of the study and their ADG are presented in Table 2. As can be seen in Table 2, the body weights of the male lamb groups

Table 2. Fattening performances of the lambs.

Traits	n	Initial weight (kg) Mean ± SE	Final weight (kg) Mean ± SE	ADG (g) Mean ± SE
Male lambs				
Hasak	7	21.9 ± 1.84	43.2 ± 0.83	304 ± 11.8
Hasak × Akk	7	21.9 ± 1.84	44.5 ± 0.90	324 ± 12.8
Hasmer	6	21.9 ± 1.84	45.4 ± 0.89	336 ± 12.7
Hasmer × Akk	7	21.9 ± 1.84	44.6 ± 0.87	325 ± 12.4
Akk	7	21.9 ± 1.84	44.5 ± 0.84	324 ± 11.7
P			0.49	0.49
Female lambs				
Hasak	7	20.5 ± 1.71	36.4 ± 0.61	229 ± 8.6
Hasak × Akk	7	20.5 ± 1.71	38.7 ± 0.63	261 ± 8.9
Hasmer	6	20.5 ± 1.71	39.1 ± 0.74	266 ± 10.5
Hasmer × Akk	7	20.5 ± 1.71	37.8 ± 0.70	248 ± 10.0
P			0.06	0.06

Initial weight: Body weight at the beginning of the fattening period, Final weight: Body weight at the end of the fattening period, SE: Standard error, P: Level of significance.
(The initial weight covariant was 21.9 ± 1.84 kg for the male lambs and 20.5 ± 1.71 kg for the female lambs because differences in initial weight were statistically significant ($P < 0.05$) when the study started.)

at the end of the fattening period ranged between 43.2 kg and 45.4 kg (P > 0.05). Furthermore, the body weights of the female Hasak, Hasak × Akk, Hasmer, and Hasmer × Akk lambs at the end of the fattening period ranged between 36.4 kg and 39.1 kg (P > 0.05).

The effect of lamb genotype on ADG throughout fattening period was not significant (P > 0.05) in male or female lambs (Table 2).

3.2. Feed consumption and feed conversion rate

As group feeding was employed in the present study, feed consumption values could not be subjected to analysis of variance. The daily feed consumption amounts of male Hasak, Hasak × Akk, Hasmer, Hasmer × Akk, and Akk lambs ranged between 1.436 kg and 1.661 kg (Table 3). The feed conversion rates calculated throughout the fattening period ranged between 4.4 kg and 5.1 kg in male lambs, and between 5.2 kg and 6.2 kg in female lambs.

3.3. Slaughter and carcass traits of lambs

Slaughter traits and carcass measurements are given in Table 4. In male lambs, the differences between the genotypes in terms of slaughtering characteristics investigated in the current study were not significant (P > 0.05), except for omental and mesenteric fat weight (P < 0.05). Chest circumference, chest depth, chest width, carcass length, and rump width values differed significantly between the groups (P < 0.05) in male lambs. In the present study, the LM cross-sectional area measured 15.5–19.0 cm^2 in male lambs (P < 0.05). Results obtained for carcass traits are given in Table 5. In male lamb carcasses, the differences observed between the genotypes for the weights of the leg, foreleg, rack, loin, tail, and kidney–pelvic fat were statistically significant (P < 0.05). Lamb genotype had a significant influence on the meat and bone weights in the left foreleg (P < 0.05), while differences among genotypes for fat weight were not significant (P > 0.05). In female lambs, genotypes differed from each other significantly for rack and tail weights (P < 0.05). In male lambs, percentages of leg, foreleg, rack, loin, tail, remainder, and heart–lung–liver differed significantly among genotypes (P < 0.05). In female lambs, differences between the genotypes for tail percentages were statistically significant (P < 0.05). Furthermore, differences among genotypes in terms of lean, fat, and bone percentages in the left foreleg were not significant (Table 6).

4. Discussion

In the present study, in terms of ADG of the male, Hasak and Hasmer lambs and their crossbreeds with the Akk had values generally higher than values reported in some other trials conducted in Turkey (3,4,6,9,12,15,16). Furthermore, the ADG values previously reported in Dorset Down × Akk (8), ASB × Akk, HD × Akk crossbreeds (9), HD × Akk crossbreeds (10), and Hasak (17) sheep were similar to the results obtained in the present study. The ADG determined in male Akk lambs proved to be greater than values determined in similar trials conducted in Turkey (3,4,6,12,18–22). Reasons for this may be differences in herd management systems and lambs given different diets in studies.

The FCRs determined in male Hasak and Hasmer lambs and their crossbreeds with the Akk were lower than the values reported in some crossbreeding trials previously

Table 3. Feed consumption and feed conversion rates of lambs.

Traits	n	Daily feed consumption (kg)	Feed conversion rate
Male lambs			
Hasak	7	1.464	4.8
Hasak × Akk	7	1.581	4.9
Hasmer	6	1.638	4.9
Hasmer × Akk	7	1.661	5.1
Akk	7	1.436	4.4
Female lambs			
Hasak	7	1.417	6.2
Hasak × Akk	7	1.346	5.2
Hasmer	6	1.465	5.5
Hasmer × Akk	7	1.317	5.3

The FCR values of the groups were calculated based on their daily feed consumption.

Table 4. Certain slaughter traits and carcass measurements of lambs (mean ± SE).

N = 5 animals per group	Male lambs					Female lambs	
	Hasak	Hasak × Akk	Hasmer	Hasmer × Akk	Akk	Hasak × Akk	Hasmer × Akk
Slaughter traits (kg)							
Preslaughter body weight	46.6 ± 0.71	48.4 ± 1.00	46.5 ± 0.53	47.8 ± 0.72	46.6 ± 0.93	39.2 ± 0.84	39.1 ± 0.71
Hot carcass weight	23.1 ± 0.52	23.1 ± 0.63	22.8 ± 0.44	23.3 ± 0.62	22.9 ± 0.63	19.3 ± 0.43	19.2 ± 0.42
Weight of head and feet	3.4 ± 0.11	3.5 ± 0.13	3.4 ± 0.52	3.4 ± 0.14	3.3 ± 0.23	2.7 ± 0.14	3.0 ± 0.22
Hide weight	6.5 ± 0.44	5.8 ± 0.53	5.5 ± 0.32	5.7 ± 0.31	5.8 ± 0.43	5.5 ± 0.51	4.9 ± 0.34
Weight of heart, lungs, and liver	2.2 ± 0.24	2.1 ± 0.12	2.5 ± 0.13	2.1 ± 0.11	2.5 ± 0.32	1.7 ± 0.14	1.7 ± 0.13
Omental and mesenteric fat weight (g)	640 ab ± 87	530 ab ± 102	404 b ± 82	658 a ± 44	500 ab ± 31	666 ± 79	664 ± 64
Carcass measurements (cm)							
Chest circumference	78.4 a ± 0.67	76.3 ab ± 0.43	76.6 ab ± 0.92	78.6 a ± 0.74	75.9 b ± 0.87	72.6 ± 1	72.7 ± 0.43
Chest depth	25.6 a ± 0.51	25.5 a ± 0.38	24.0 b ± 0.31	25.8 a ± 0.2	25.5 a ± 0.52	23.7 ± 0.52	23.8 ± 0.43
Chest width	18.3 a ± 0.42	17.0 b ± 0.27	18.3 a ± 0.33	17.2 b ± 0.33	16.3 b ± 0.12	16.2 ± 0.33	16.8 ± 0.32
Carcass length	54.2 b ± 0.73	55.8 ab ± 0.37	55.2 ab ± 0.73	56.4 a ± 0.81	57.2 a ± 0.66	53.4 ± 0.52	54.8 ± 0.71
Leg circumference	31.1 ± 0.72	32.4 ± 1.14	32.2 ± 0.63	32.2 ± 1.01	30.4 ± 1.21	29.9 ± 0.83	30.7 ± 0.34
Back length	57.0 a ± 0.83	56.8 a ± 0.58	59.8 a ± 1.11	54.6 a ± 0.67	54.8 a ± 0.73	55.6 ± 0.92	56.0 ± 0.61
Rump width	18.2 a ± 0.64	16.8 b ± 0.33	17.7 ab ± 0.41	18.1 a ± 0.29	16.5 b ± 0.22	15.7 ± 0.32	16.7 ± 0.51
Leg length	51.2 ± 0.43	51.6 ± 0.42	52.0 ± 0.74	51.6 ± 0.73	52.4 ± 0.52	51.8 ± 0.81	50.6 ± 0.53
LM area cm^2	18.6 a ± 0.81	16.0 b ± 0.26	19.0 a ± 1.08	17.5 ab ± 0.51	15.5 b ± 0.97	13.6 ± 0.74	14.9 ± 0.72
Back fat thickness (mm)	6.2 ± 0.69	5.2 ± 0.64	5.4 ± 0.37	6.1 ± 0.54	5.5 ± 0.97	7.7 ± 0.63	6.5 ± 1.0

SE: Standard error.
a, b: Differences between the mean values shown with different letters in the same row (when male and female lambs are evaluated independently) are statistically significant ($P < 0.05$).

Table 5. Certain carcass quality characteristics of lambs (mean ± SE).

N = 5 lambs per group	Male lambs					Female lambs	
	Hasak	Hasak × Akk	Hasmer	Hasmer × Akk	Akk	Hasak × Akk	Hasmer × Akk
Carcass traits (kg)							
Cold carcass weight	22.5 ± 0.44	22.7 ± 0.57	22.2 ± 0.47	22.7 ± 0.57	22.4 ± 0.54	18.8 ± 0.48	18.8 ± 0.24
Cold carcass dressing percentage (%)	48.3 ± 0.51	46.9 ± 0.42	47.7 ± 0.90	47.5 ± 0.84	48.1 ± 0.42	48.0 ± 0.82	48.1 ± 0.53
Leg weight	7.4 ab ± 0.17	7.4 ab ± 0.10	7.7 a ± 0.17	7.5 a ± 0.23	6.9 b ± 0.13	6.0 ± 0.25	6.3 ± 0.11
Foreleg weight	3.7 ab ± 0.11	3.8 ab ± 0.15	4.0 a ± 0.06	3.8 ab ± 0.13	3.5 b ± 0.08	3.0 ± 0.14	3.3 ± 0.09
Rack weight	2.3 a ± 0.13	2.1 a ± 0.11	2.1 a ± 0.13	2.1 a ± 0.04	1.6 b ± 0.15	1.6 a ± 0.07	1.9 b ± 0.10
Loin weight	1.9 a ± 0.10	1.7 a ± 0.02	1.7 a ± 0.10	1.7 a ± 0.05	1.5 b ± 0.05	1.5 ± 0.09	1.5 ± 0.05
Tail weight (g)	295 c ± 28	1498 b ± 408	111 c ± 9	640 c ± 145	3400 a ± 473	1242 a ± 154	584 b ± 73
Weight of kidney–pelvic fat (g)	605 a ± 60	572 ab ± 98	466 ab ± 48	621 a ± 69	376 b ± 25	527 ± 83	555 ± 82
Remainder weight	6.3 a ± 0.14	5.6 bc ± 0.15	6.1 ab ± 0.17	6.3 a ± 0.09	5.1 c ± 0.11	4.9 ± 0.03	4.7 ± 0.12
Left foreleg weight (g)	1857 ab ± 59	1878 ab ± 62	1972 a ± 57	1863 ab ± 66	1748 b ± 46	1471 ± 58	1612 ± 45
Tissue weights in the left foreleg (g)							
Lean	1145 ab ± 43	1113 ab ± 28	1179 a ± 44	1123 ab ± 25	1072 b ± 22	880 ± 36	968 ± 17
Fat	332 ± 16	359 ± 40	369 ± 34	358 ± 46	312 ± 34	281 ± 34	331 ± 26
Bone	380 ab ± 17	406 ab ± 12	424 a ± 20	382 ab ± 10	364 b ± 14	310 ± 15	313 ± 10

SE: Standard error.
a, b, c: Differences between the mean values shown with different letters in the same row (when male and female lambs are evaluated independently) are statistically significant ($P < 0.05$).

Table 6. Proportion of carcass joints, certain slaughtering by-products, and left foreleg composition (mean ± SE).

N = 5 lambs per group	Male lambs					Female lambs	
	Hasak	Hasak × Akk	Hasmer	Hasmer × Akk	Akk	Hasak × Akk	Hasmer × Akk
Traits (%)							
Leg	32.9 ab ± 0.39	32.6 ab ± 0.61	34.7 a ± 0.46	33 ab ± 0.58	30.8 b ± 0.42	31.9 ± 1.03	33.5 ± 0.36
Foreleg	16.4 ab ± 0.61	16.7 ab ± 0.45	18 a ± 0.19	16.7 ab ± 0.37	15.6 b ± 0.69	16 ± 0.77	17.6 ± 0.42
Rack	10.2 a ± 0.41	9.3 ab ± 0.68	9.5 ab ± 0.58	9.3 ab ± 0.10	7.1 b ± 0.70	8.5 ± 0.38	10.1 ± 0.45
Loin	8.4 a ± 0.29	7.5 a ± 0.22	7.7 a ± 0.40	7.5 a ± 0.21	6.7 b ± 0.21	7.9 ± 0.44	8.2 ± 0.32
Tail	1.3 c ± 0.15	6.6 b ± 1.64	0.5 c ± 0.04	2.8 bc ± 0.58	15.2 a ± 1.79	6.6 a ± 0.72	3.1 b ± 0.37
Kidney–pelvic fat	2.7 ± 0.23	2.5 ± 0.48	2.1 ± 0.19	2.7 ± 0.29	1.7 ± 0.12	2.8 ± 0.19	3 ± 0.21
Remainder	28 ab ± 0.25	24.7 c ± 0.64	27.5 a ± 0.32	27.8 b ± 0.86	22.8 d ± 0.44	26.1 ± 0.82	25.0 ± 0.62
Head–feet	7.3 ± 0.04	7.2 ± 0.31	7.3 ± 1.1	7.1 ± 0.23	7.1 ± 0.32	6.9 ± 0.24	7.6 ± 0.42
Hide	13.9 ± 0.73	12 ± 0.81	11.9 ± 0.64	11.9 ± 0.63	12.4 ± 0.71	14 ± 1.37	12.6 ± 0.98
Heart–lung–liver	4.7 abc ± 0.27	4.3 c ± 0.16	5.4 a ± 0.23	4.4 c ± 0.08	5.4 ab ± 0.47	4.3 ± 0.29	4.4 ± 0.36
Omental–mesenteric fat	1.4 ± 0.19	1.1 ± 0.21	0.9 ± 0.16	1.4 ± 0.08	1.1 ± 0.06	1.7 ± 0.24	1.7 ± 0.17
Tissue percentages of the left foreleg (%)							
Lean	61.7 ± 1.0	59.3 ± 1.12	59.8 ± 1.22	60.3 ± 1.09	61.3 ± 1.44	59.8 ± 1.82	60 ± 0.99
Fat	17.9 ± 1.62	19.1 ± 1.71	18.7 ± 1.68	19.2 ± 1.84	17.8 ± 1.62	19.1 ± 0.48	20.5 ± 0.49
Bone	20.5 ± 0.7	21.6 ± 0.73	21.5 ± 0.69	20.5 ± 0.97	20.8 ± 0.55	21.1 ± 1.82	19.4 ± 1.18

SE: Standard error.
a, b, c, d: Differences between the mean values shown with different letters in the same row (when male and female lambs are evaluated independently) are statistically significant ($P < 0.05$).

conducted in Turkey (3–6). They were found to be similar to values reported for Dorset Down × Akk and Border Leicester × Akk crossbreeds (8), as well as for HD × Akk crossbreeds (9), but were greater than the rates reported for ASB × Akk (9), ASB × Akk, and HD × Akk crossbreeds (10) and Hasak sheep (17). The FCR determined in male Akk lambs was lower than values reported in some studies previously conducted in Turkey (3–6,17).

In the current study, the differences among genotypes in terms of cold carcass dressing percentage were not significant ($P > 0.05$). The values determined in the present study were similar to values previously reported for Border Leicester × Akk (F1), Dorset Down × Akk (F1) (5), ASB × Akk, HD × Akk (9), ASB × Akk (10), and Hasak sheep (17); lower than values previously reported for Ile de France × Akk (F1) (5), HD × Akkaraman (F1) sheep (10), and Ile de France × Akk (F1) (22); and greater than values reported for HD × Akk (F1) sheep (6). In the present study, the cold carcass dressing percentage of male Akk was lower than some values previously reported for Akk sheep (4,5,17,19), and similar to some other values obtained in previous research (3,6,7).

An important point to note is that ADG, FCR, and cold carcass dressing percentage of Akk male lambs were similar to those of other genotypes in this research under intensive feeding regime.

In the present study, the LM cross-sectional area was 15.5–19.0 cm^2 in male lambs and the differences observed between the genotypes were statistically significant ($P < 0.05$). Furthermore, in the Hasak and Hasmer types, the LM cross-sectional area was 18.6 cm^2 and 19.0 cm^2, respectively. These values were greater than those measured in the Hasak × Akk (16.0 cm^2) and Akk (15.5 cm^2) groups ($P < 0.05$), while it was determined that values pertaining to the Hasmer × Akk (17.5 cm^2) crossbreeds fell within a range in between. Supporting the current result, numerous authors (23–25) also reported a significant genotype effect on the LM cross-sectional area. Percentages of leg, foreleg, and rack for lamb carcasses from Hasak × Akk and Hasmer × Akk crossbreeds were similar to those of Akk lambs. These results indicate that the use of Hasak and Hasmer genotypes in commercial crossbreeding with the Akk breed did not improve the percentages of leg, foreleg, and rack compared with purebred Akk lambs. On the other hand, loin percentages of crossbred lamb carcasses were higher than those of Akk lambs. As expected, the results obtained in the present study demonstrated that differences observed between the genotypes in terms of tail fat percentage were statistically significant ($P < 0.05$). In the present study, in parallel with the decreasing share of the Akk genotype in the genome, the percentage of tail fat was determined as 6.6%, 2.8%, and 1.3%, respectively, in Hasak × Akk, Hasmer × Akk, and Hasak lambs. This percentage was 15.2% in purebred Akk lambs and 0.5% in Hasmer lambs. The tail percentages of male Hasak, Hasmer, and Hasmer × Akk lambs were lower than those previously reported for Border Leicester × Akk (F1) (3), Ile de France × Akk (F1) (4), Dorset Down × Akk (F1) (5), HD × Akk (F1) (6), ASB × Akk (F1) , HD × Akk (F1) (9), ASB × Akk (F1), and HD × Akk (F1) sheep (10). The tail percentage determined in male Akk lambs in the present study was close to some values reported in previous research (3–7).

In conclusion, the percentage of tail fat being significantly lower in the Hasak and Hasmer types and their crossbreeds with the Akk breed, when compared with that of the Akk, suggests that such crossings may contribute to the reduction of the tail fat percentage of the Akk breed. However, such crossing did not improve the fattening performance and carcass quality compared with purebred Akk lambs. On the other hand, the levels of fattening performance, feed efficiency, and most slaughtering and carcass quality traits in Akk lambs were quite satisfactory. Therefore, instead of using Hasmer and Hasak genotypes as sire lines in order to improve the fattening performance and carcass quality of the Akk breed, breeding and improving Akk sheep, bred widely because of their utilization of low quality pastures and resistance to diseases, as a pure breed is suggested to local sheep farmers.

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