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Slaughter and carcass characteristics of Herik male lambs raised under a finishing system

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Abstract: The aim of this study was to determine the slaughter and carcass characteristics of Herik lambs finished under intensive husbandry conditions. Twenty single male lambs, ten of which had long, semifat tails and ten of which had short, round, and fat tails, all with an average live weight of 20 kg, were used in the study. Concentrate feed and fresh water were given ad libitum and alfalfa hay as forage was given in the amount of 300 g/lamb per day. The lambs were slaughtered when they reached a final weight of 42 kg. The average hot and cold dressing percentages, based on empty body weight (36.400 kg) of Herik carcasses, were 52.56% and 51.74%, respectively. In this study, Herik lamb carcasses had measurements similar to other indigenous Turkish sheep genotypes, except for the carcasses of the Bafra breed. The carcass components of Herik male lambs, except for the foreleg, are similar to other indigenous breeds. Consequently, Herik lambs might be considered as an indigenous genetic source for meat production under the intensive fattening system.

Key words: Herik, lamb, slaughter traits, carcass traits

1. Introduction

Animal meat is an important source of protein for human nutrition. Meat protein provides the nutrients needed to help the bodies of mature humans to function properly and those of younger humans to grow and develop. Therefore, increasing meat production should be taken into consideration for human nutrition. Cattle, sheep, and poultry are used for meat production in Turkey (1).

Sheep production is an income source for Turkey's rural population. The majority of Turkey's sheep consists of indigenous sheep breeds; the Herik breed is one of them. Herik sheep are distributed throughout intersection points of the Black Sea coastline (Samsun, Trabzon, Rize) and inner regions (Amasya, Sivas, Çorum). This area is also an intersection point of the Karayaka and Akkaraman breeds. The Herik genotype is thought to have resulted from the irregular crossbreeding of the Akkaraman, a fat-tailed breed and raised predominantly in Central Anatolia, with the Karayaka, a long- and thin-tailed breed raised predominantly along the eastern half of the Black Sea coast and inland regions (2).

Sheep production is usually achieved under extensive husbandry conditions and can be dependent on pastureland. Sheep or lambs are finished with roughage and less than intensive husbandry conditions, including concentrated feeding. Nevertheless, supplementary feed can be used in order to provide appropriate carcass weights for the market and to increase the production per animal (2). In order to increase yields in sheep production, genotype and environmental conditions should be improved. Hence, it has been reported that in the intensive finishing conditions of 2–3 months in Turkey, a carcass weighing 18–20 kg can be produced from a postweaned lamb of 2–3 months old (3–7). Based on these data, we can conclude that intensive production systems are necessary to satisfy increasing consumer demand for meat.

At present, we must take into consideration safe, healthy, and quality red meat production in order to satisfy the needs of Turkey's consumers. Concordantly, numerous studies have been conducted to determine the slaughter and carcass characteristics used in developed countries (8–10). Recently, various studies have also been performed to determine the slaughter and carcass characteristics of indigenous breeds in Turkey (6,7,11–16). However, there has been very little information about the carcass characteristics and body measurements of Herik lambs under finishing systems (17); the current study has taken steps to investigate the slaughter and carcass characteristics of Herik lambs under intensive finishing conditions.

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2. Materials and methods

2.1. Animals, designation of groups, housing, and nutrition conditions

The study was performed on a private farm in Turkey's Samsun Province, where the altitude is approximately 171 m. The farm is situated at 41°N and 36°E. The average ambient temperature and humidity at the site were 22 °C and 76% during the study. Fifty-five millimeters of rain fell during the study period. In this study, the area allocated for each animal was 0.7 m^2 (2). The Ethical Committee for Experiments at Ondokuz Mayıs University approved this study (HADYEK 2014/37). Preparatory work was performed before the planning of this study and it was determined that the Herik lambs have two types of tails. Twenty single male lambs, namely ten with long, semifat tails and ten with short, round, and fat tails, with a beginning average live weight of 20 kg and a postweaning age of 2.5–3 months, were used in the study. Before the fattening period, the lambs were given 2 weeks of dietary adaptation, they were treated with anthelmintics to resolve any internal or external parasites, and they were vaccinated against clostridial disease. The lambs were finished with diet-1 until they reached a mean live weight of 30 kg, while diet-2 was used until they reached a live weight of 40 kg. Concentrate feed and fresh water were given ad libitum, whereas alfalfa was given in the amount of 300 g/lamb per day. They were finished for an average of 105 days under intensive fattening after weaning. The chemical composition (protein, fat, dry matter, and ash) of their diet was analyzed according to the Association of Official Analytical Chemists (18). The ingredients of experimental diets and the chemical composition of concentrate feed and alfalfa are presented in Table 1.

2.2. Determination of slaughter and carcass traits

The lambs were weighed weekly during the finishing period and slaughtered after reaching approximately 42 kg. The lambs were slaughtered after fasting for 16 h with free access to water according to standard commercial procedures (19). The weights of the skin, head, feet, heart, lungs, liver, spleen, testicles, omental fats, full gastrointestinal system, and empty gastrointestinal system were recorded. Empty body weight was arrived at by subtracting the weight of gastrointestinal contents at the time of slaughter. Percentages of skin head, feet, visceral organs, and hot and cold dressing percentage were calculated based on the lambs' empty body weight (20,21).

The carcasses were chilled at 4 °C for 24 h, and then the cold carcass weight was recorded. Next, the cold carcass percentage and chilling loss were calculated. Carcass length, carcass width, carcass depth, chest circumference, chest depth, leg length, leg depth, leg width, and leg circumference were measured by using a tape and volumetric stick. Further, carcass and leg compactness were calculated using formulae of carcass length/cold carcass weight and leg length/leg weight, respectively (22).

After carcass measurements were taken, the carcasses were divided into two equal sides along the vertebrae. The left half of the carcasses was divided according to the carcass jointing method described by Akçapınar (23), which features seven main cuts: the neck, foreleg, back, loin, leg other pieces (breast + flank), and tail. Proportions of wholesale cuts were calculated based on carcass weight. The individual cuts were grouped into first quality (leg, back, loin), second quality (foreleg), and third quality (neck, breast + flank), according to Diaz et al. (9). After the carcasses were divided into two pieces, fat thickness

Table 1. Chemical composition of concentrate feed and roughage.

Chemical composition of diets	Diet-1	Diet-2	Roughage (dry alfalfa)
Dry matter (%)	92.19	91.86	91.77
Crude protein (%)	17.89	16.94	17.44
Crude cellulose(%)	8.07	10.60	29.18
Crude fat (%)	3.08	3.13	3.03
Crude ash (%)	5.72	7.87	10.45
ADF (%)	12.59	13.17	34.12
NDF (%)	44.82	46.21	48.23
Metabolic energy (kcal/kg)	2682.88	2497.35	2231.12

ADF: Acid detergent fiber; NDF: neutral detergent fiber.
Diet-1: Used from initial weight until lambs reached 30 kg live weight, concentrate feed.
Diet-2: Used from 30 kg live weight until lambs reached 40 kg live weight, concentrate feed.

was measured between the 12th and 13th ribs over the musculus longissimus dorsi (MLD) by using millimetric paper.

Slaughter and carcass traits and carcass components were determined with descriptive statistics (24).

3. Results

3.1. Slaughter traits

The means and standard errors for all slaughter characteristics are presented in Tables 2 and 3. The final weight, empty body weight, and hot dressing percentage based on empty body weight were 42.560 kg, 36.400 kg, and 52.56%, respectively. In terms of slaughter traits, the weights and percentages for the head, skin, feet, liver, and empty digestive system were 2.250 kg and 6.19%, 5.790 kg and 15.92%, 0.853 kg and 2.34%, 0.650 kg and 1.80%, and 2.592 kg and 7.12%, respectively.

3.2. Carcass traits

The means and standard errors for all carcass traits and carcass measurements of the lambs are presented in Tables 4 and 5. Cold carcass dressing percentage, chilling loss, carcass length, leg length, leg circumference, eye muscle area (MLD), leg compactness, and carcass compactness for Herik lambs were 51.74%, 1.55%, 55.97 cm, 38.65 cm, 56.77 cm, 14.54 cm^2, 7.77 kg/m, and 33.81 kg/m, respectively.

3.3. Carcass components

The means and standard errors for carcass components of lambs are presented in Tables 5 and 6. The percentage for the neck, foreleg, back, loin, leg, and other parts were 7.70%, 13.78%, 9.28%, 6.36%, 31.54%, and 21.22%, respectively. Carcass components' percentages of first, second, and third quality were 47.20%, 13.78%, and 28.92%, respectively.

Table 2. Slaughter traits in Herik lamb (mean ± standard error).

Characteristics	n	Mean	SE
Final weight [(1)] (kg)	20	42.560	0.430
Empty body weight [(2)] (kg)	20	36.400	0.260
Head weight (kg)	20	2.250	0.020
Skin weight (kg)	20	5.790	0.120
Four-feet weight (kg)	20	0.853	0.010
Lung weight (kg)	20	0.490	0.010
Liver weight (kg)	20	0.650	0.020
Spleen weight (kg)	20	0.072	0.003
Hearth weight (kg)	20	0.211	0.006
Kidney weight (kg)	20	0.287	0.010
Testicle weight (kg)	20	0.337	0.177
Omental fat weight (kg)	20	0.522	0.044
Full digestive system weight (kg)	20	6.483	0.250
Empty digestive system weight (kg)	20	2.592	0.100

[(1)] Dressing percentage based on final weight.
[(2)] Dressing percentage based on empty body weight.

Table 3. Percentage of slaughter traits based on empty body weight in Herik lambs (mean ± standard error).

Characteristics	n	Mean	SE
Hot dressing percentage [(1)] (%)	20	45.03	0.55
Hot dressing percentage [(2)] (%)	20	52.56	0.36
Head percentage (%)	20	6.19	0.08
Skin percentage (%)	20	15.92	0.31
Four-feet percentage (%)	20	2.34	0.04
Lung percentage (%)	20	1.35	0.02
Liver percentage (%)	20	1.80	0.06
Spleen percentage (%)	20	0.19	0.01
Hearth percentage (%)	20	0.58	0.01
Kidney percentage (%)	20	0.78	0.04
Testicle percentage (%)	20	0.92	0.04
Omental fat percentage (%)	20	1.43	0.12
Full digestive system percentage (%)	20	17.81	0.69
Empty digestive system percentage (%)	20	7.12	0.28

[(1)] Hot dressing percentage is calculated based on final weight.
[(2)] Hot dressing percentage is calculated based on empty body weight.

4. Discussion

4.1. Slaughter traits

The Herik genotype is raised predominantly at the intersection point of Central Anatolia, where the Akkaraman sheep breed is also commonly found, and the inner Black Sea region, where Karayaka sheep are common. It has been determined that there has been irregular crossbreeding of the Akkaraman, a fat-tailed breed, and the Karayaka, a long- and thin-tailed breed (2). To date, there has been little information published about some of the body measurements and carcass compositions of male Herik lambs (17). A related comparison was conducted with Akkaraman, Karayaka, and other indigenous breeds.

Final weight included the weight of the digestive tract content in lambs before slaughter. The variation in weights of digestive tract contents before slaughter causes a problem when evaluating slaughter and carcass traits, such as dressing percentage, visceral percentages, and proportion of carcass components. Hence, a fasting period was applied before the slaughter, but this approach can still lead to imprecise assessments. In some studies, slaughter

Table 4. Carcass characters and carcass measurements in Herik lambs (mean ± standard error).

Characteristics	n	Mean	SE
Cold dressing percentage [(1)] (%)	20	51.74	0.366
Chilling loss (%)	20	1.55	0.695
Carcass length (cm)	20	55.97	0.726
Leg length (cm)	20	38.65	0.380
Leg circumference (cm)	20	56.77	0.428
Carcass width (cm)	20	22.50	0.620
Leg width (cm)	20	17.86	0.285
Leg depth (cm)	20	13.11	0.678
Chest circumference (cm)	20	69.13	0.413
Eye muscle area (cm^2)	20	14.54	0.371
Leg compactness (kg/m)	20	7.77	0.135
Carcass compactness (kg/m)	20	33.81	0.707

[(1)] Cold carcass dressing percentage is calculated based on empty body weight.

and carcass traits were calculated based on empty body weight to increase the precision of data on slaughter carcass traits (5,20,21).

In the present study, the final and empty body weights were 42.560 kg and 36.400 kg, respectively. Further, hot dressing percentages were based on final and empty body weights, which were determined to be 45.03% and 52.06%, respectively (Table 3). Empty body weight and the hot dressing percentage based on empty body weight were

Table 5. Weights of wholesale cuts for Herik lambs (mean ± standard error).

Characteristics	n	Mean	SE
Neck weight (kg)	20	1.450	0.030
Foreleg weight (kg)	20	2.594	0.038
Back weight (kg)	20	1.748	0.029
Loin weight (kg)	20	1.198	0.031
Leg weight (kg)	20	5.939	0.075
Other (shoulder + flank) weight (kg)	20	3.995	0.054
Tail weight (kg)	20	1.707	0.138
Kidney fat weight (kg)	20	0.167	0.01
Pelvic fat weight (kg)	20	0.184	0.01
First quality weight (kg)	20	8.886	0.092
Second quality weight (kg)	20	2.594	0.038
Third quality weight (kg)	20	5.445	0.066

Table 6. Proportion of wholesale cuts in Herik lambs (mean ± standard error).

Characteristics	n	Mean	SE
Neck (%)	20	7.70	0.148
Foreleg (%)	20	13.78	0.190
Back (%)	20	9.28	0.157
Loin (%)	20	6.36	0.175
Leg (%)	20	31.54	0.368
Other (shoulder + flank) (%)	20	21.22	0.286
Tail (%)	20	8.98	0.64
Kidney fat (%)	20	0.41	0.03
Pelvic fat (%)	20	0.83	0.10
First quality (%)	20	47.20	0.469
Second quality (%)	20	13.78	0.190
Third quality proportion (%)	20	28.92	0.338

reported to be 35.30 kg and 52.10% for Awassi (10), 37.00 kg and 59.30% for Akkaraman, 36.10 kg and 57.80% for Morkaraman, 37.10 kg and 59.20% for Turkish Merino (18), and 34.17 kg, 54.96% for Bafra (5) sheep. Empty body weight (36.400 kg) in Herik lambs was similar to that of Akkaraman, Morkaraman, and Turkish Merino, but higher than those of Awassi and Bafra lambs. Hot carcass percentage based on empty body weight in Herik lambs was lower than in Akkaraman, Morkaraman, and Turkish Merino and closer to those of Awassi and Bafra lambs. These differences can be explained by the purposes for which these breeds are mainly raised. The Akkaraman, Morkaraman, and Turkish Merino breeds are commonly used in meat production (2), while Awassi (2) and Bafra (25,26) sheep are used in milk production. Sheep used for milk production lack muscle and fat deposition, so decreased empty body weight and hot percentage is expected in Awassi and Bafra lambs. In this study, the head weight (2.250 kg), skin weight (5.790 kg), and full digestive system weight (6.483 kg) of Herik lambs were higher than the findings of Şahin and Akmaz (27) (1.84 kg, 4.69 kg, and 5.29 kg) for Akkaraman lambs, the findings of Macit (4) (1.78 kg, 4.26 kg, and 5.25 kg) for Morkaraman, and the findings of Aksoy (3) (1.86 kg, 3.70 kg, and 5.29 kg) for Tuj. As a result of the higher noncarcass components of Herik lambs, the hot dressing percentage of Herik lambs could be lower than those of indigenous lambs.

4.2. Carcass traits

Dressing percentage is an important factor in determining meat production and carcass quality and is classified as both hot and cold. The cold dressing percentage is the most important, due to market preference being that

carcasses are delivered after completion of a chilling process. This percentage is used to assess the carcass's quality in the slaughterhouse (28). It has also been reported that dressing percentage increases with lambs' body weights (5,10). Dressing percentages are calculated based on slaughter weight or empty body weight in studies of carcass characters (5,15,16). In the present study, the cold dressing percentage was calculated based on empty body weight (36.400 kg). The cold dressing percentages, chilling loss, and MLD area were determined to be 51.74%, 1.55%, and 14.54 cm^2, respectively (Table 4). MLD area was determined to be 11.80 cm^2, with a mean empty body weight of 35.30 kg in Awassi sheep (10). Yılmaz et al. (16) reported 56.14% and 15.18 cm^2 for Turkish Merinos, 55.23% and 14.67 cm^2 for Ramlıç, and 55.98% and 14.24 cm^2 for Kıvırcık when the lambs' mean empty body weights ranged between 40 and 42 kg. Cold dressing percentages and MLD areas were determined to be 52.53% and 15.09 cm^2 with a mean empty body weight of 34.17 kg in Bafra lambs (5). These results support the hypothesis that there is a positive relationship between dressing percentage and body weight. These results also indicate that cold carcass weight, cold carcass dressing percentage, and MLD area were at a satisfactory level for intensive fattening conditions among the indigenous breed of Herik lambs.

It is well known that carcass weight increases with increasing slaughter weight for lambs. It has also been reported that an increase in the carcass weight of lambs was related to increasing carcass measurements (20,23). Empty body weights were used in some carcass character studies in order to increase the precision of measuring carcass characters (5,15,16). Empty body weight is determined by subtracting the weight of gastrointestinal contents from the slaughter weight. In this study, Herik lamb carcasses had values similar to Bafra lamb carcass values, except for carcass length, carcass compactness, leg length, and leg compactness. Although the mean empty body weight of Bafra lambs (34.17 kg) was similar to Herik lambs, their carcasses were less compact than those of Herik lambs. This result can be attributed to the long carcass length of Bafra lambs. Thus, it was reported that carcass and leg compactness decreased with increasing carcass measurements when lambs had similar slaughter weights (13,29). Turkish Merino, Ramlıç, and Kıvırcık carcasses had higher carcass compactness and leg compactness than Herik carcasses. This result can be attributed to the higher empty body weight of these breeds.

4.3. Carcass components

The leg, back, loin, and foreleg are important components for the quality and quantity of the meat of lamb carcasses, so they were used to assess meat development. In the present study, Herik lambs' leg, back, loin, and foreleg percentages and weights were determined to be 31.54% and 5.939 kg, 9.28% and 1.748 kg, 6.36% and 1.198 kg, and 13.78% and 2.594 kg (Tables 5 and 6). Some studies reported 29.98%, 36.93%, and 31.17% for leg percentage; 7.77%, 9.46%, and 8.65% for back percentage; 8.08%, 7.01%, and 6.08% for loin percentage; and 14.96%, 17.02%, and 16.81% for foreleg percentage in Akkaraman (27), Karayaka (7), and Bafra (5) lambs, respectively, when the lambs reached a mean live weight of 40 kg under intensive finishing performance. Leg percentages were reported to be 34.67% for Turkish Merino lambs at a weight of 40 kg (30). Abdullah and Qudsieh (10) reported 10.20% and 32.30% for loin and leg percentage in Awassi lambs. Other studies reported 5.35 kg, 5.37 kg, and 5.34 kg for leg weight; 1.24 kg, 1.14 kg, and 1.24 kg for back weight; 1.25 kg, 1.26 kg, and 1.22 kg for loin weight; and 3.14 kg, 2.99 kg, and 2.64 kg for foreleg weight in Morkaraman (3), Tuj (3), and Akkaraman (27) lambs, respectively, when the lambs reached a mean live weight of 40 kg under intensive finishing performance. The leg and loin weight of Karayaka sheep at approximately 40 kg slaughter weight were reported as 5.94 kg and 1.56 kg (12). The leg, back, and loin are the most valuable cuts of meat from the carcasses. Leg and back data of the Herik genotype revealed a satisfactory level, while loin and foreleg production were lacking during the process of intensive fattening among indigenous sheep breeds. Therefore, foreleg and loin proportion should be improved in the Herik genotype.

In terms of components, the wholesale cuts are classified as first quality (leg, back, loin), second quality (foreleg), and third quality (neck, breast, flank) (9). In the present study, the first, second, and third quality percentages were determined to be 47.20%, 13.78%, and 28.92% at 36.40 kg empty body weight (Table 6). First, second, and third quality percentages in Bafra were determined to be 45.90%, 16.81%, and 30.23% at 34.17 kg empty body weight, respectively. It has been reported that there is a positive relationship between carcass weight and slaughter weight for lambs (20,23) and previous studies have noted an increase in the percentage of third quality and a decreased percentage of second quality and loin meat when there is an increase in carcass weight (5,10,23). Therefore, this result can be attributed to the higher empty body weight of Herik lambs.

In this study, kidney and tail fat weights of the Herik genotype were determined to be 0.167 kg and 1.707 kg, respectively. It has been reported in other studies that kidney and tail fat weights were 0.130 kg and 3.200 kg for Morkaraman (4), 0.067 kg and 3.140 kg for Tuj (3), and 0.199 kg and 0.361 kg for Karayaka (13). The Akkaraman, Morkaraman, and Awassi breeds are known as fat-tailed ones, while the Karayaka, Bafra, and Kıvırcık have long and thin tails (2). Thus, Ünal et al. (11) reported that the

internal fat percentages of the fat-tailed sheep breeds are typically lower than those found in thin-tailed breeds.

With the above data in mind, the current study indicates that the hot dressing percentages of Herik male lambs were similar to those of Awassi and Bafra lambs, but lower than in Akkaraman, Morkaraman, and Turkish Merino lambs in an approximate empty body weight range of 35–37 kg. The carcass characteristics and components of Herik male lambs, except for the foreleg, were similar to other indigenous breeds. However, further work examining Herik lambs under different production systems is required to explain the important economic traits.

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