Carcass traits of improved and indigenous lamb breeds of North-Western Turkey under an intensive production system

Alper Yilmaz¹, Bulent Ekiz¹, Mustafa Ozcan¹, Cuneyt Kaptan², Hulya Hanoglu², Ismail Erdogan², Omur Kocak¹

¹Department of Animal Breeding and Husbandry. Istanbul University, Turkey
²Marmara Livestock Research Institute. Bandirma, Turkey

Corresponding author: Dr. Alper Yilmaz. Department of Animal Breeding and Husbandry. Veterinary Faculty, Istanbul University. Avciilar, Istanbul 34320, Turkey - Tel. + 90 212 5916990 - Fax: + 90 212 4737241 - Email: yalper@istanbul.edu.tr

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ABSTRACT

The aim of study was to investigate the carcass quality of Turkish Merino, Ramlic, Kivircik, Chios and Imroz breeds in north-western Turkey under an intensive production system. After weaning at approximately 85 days of age, 46 lambs from Turkish Merino, Ramlic, Kivircik, Chios and Imroz breeds were fattened for 56 days. Slaughter weights were 47.39, 45.68, 47.27, 31.08 and 29.82 kg and chilled carcass weights were 23.35, 22.33, 23.51, 14.33 and 13.75 kg, respectively (P<0.001). Improved Turkish Merino and Ramlic and indigenous Kivircik lambs had higher carcass measurements than indigenous Chios and Imroz lambs. Chios lamb carcasses had the highest tail root fat yellowness and tail percentage while having the lowest fatness score, omental and mesenteric fat percentage and kidney knob and channel fat percentage. Turkish Merino lambs had higher shoulder percentage, lean percentage and lean/total fat ratio in the hind leg and produced less total fat in the hind leg than Ramlic and Kivircik lambs. These results indicate that improved Turkish Merino might be used to produce high quality lamb carcasses in north-western Turkey. Among indigenous breeds Kivircik showed an outstanding carcass production performance.

Key words: Turkish sheep, Carcass quality, Fattening, Lamb.
Le agnelli delle razze migliorate Turkish Merino e Ramlic e della razza autoctona Kivircik hanno evidenziato indici migliori rispetto a quelli delle razze autoctone Chios e Imroz. Le carcase degli agnelli di razza Chios hanno presentato un valore più elevato della componente gialla del colore del grasso alla base della coda e la percentuale più alta di coda, mentre sono stati registriati i valori più bassi per indice di adiposità, e per contenuto in grasso dell’omento e del mesentero, nonché della capsula e della pelvi renale. Negli agnelli di razza Turkish Merino è stata rilevata un’incidenza maggiore della spalla oltre ad un contenuto maggiore di carne magra; il rapporto carne magra/grassi totali è stato migliore in questa razza, per quanto concerne la muscolatura degli arti posteriori, rispetto alle razze Ramlic e Kivircik, con produzione complessiva di una minor quantità di grasso nel treno posteriore. Tali risultati indicano che la razza Turkish Merino migliorata potrebbe essere usata per produrre carcase di agnello di elevata qualità nel nord-ovest della Turchia. Tra le razze autoctone studiate, la razza Kivircik si è differenziata per le eccellenti performance qualitative della carcassa.

Parole chiave: Pecore turche, Qualità della carcassa, Ingrasso, Agnelli.

Introduction

Sheep breeding is a traditional and an important type of animal production in Turkey. Sheep population in Turkey has decreased drastically in the past 27 years, decreasing from 48.6 to 25.5 million sheep from 1980 to 2007. The great majority (97%) of this population is indigenous breeds with low production levels and only 3% is Merino type sheep (Turkish Statistical Institute, 2008). Yalcin (1986) stated that studies on the productivity of indigenous breeds under improved conditions can be helpful for the better evaluation of their potentialities. The challenge is to preserve natural resources while simultaneously producing enough food to satisfy the demands of a growing human population (Boyazoglu, 2002). In Turkey, as in most Mediterranean countries, lamb meat, sheep milk and products are generally preferred by the public (Sañudo et al., 1997; Gursoy, 2006). Turkey is a candidate country to the EU and this continuum along with people’s rising attitude to consume better quality lamb meat are forcing more studies on carcass quality in lambs.

The sheep population in Marmara Region is about 825,000 and Turkish Merino, Ramlic, Kivircik, Chios and Imroz sheep breeds contribute to most of this population (Kaymakci, 2006). The climate in this north-western part of Turkey is predominantly Mediterranean. A relatively superior topography and denser population have contributed to make the region one of the most intensively cultivated in the country. Therefore sheep breeding in this region has to compete with field crops. Success in this competition will largely depend on the intensification of sheep breeding and, particularly, on improvements in quality lamb production (Yalcin, 1986; Yilmaz et al., 2004).

Turkish Merino was produced by cross-breeding indigenous Kivircik breed with German Mutton Merino in the form of upgrading to Merino, being followed by careful selection. Ramlic, which was produced to increase meat and wool production of indigenous Daglic breed by crossbreeding with Rambouillet, has approximately 65% Rambouillet and 35% Daglic genotype (Yalcin, 1986). Kivircik, Chios and Imroz are indigenous breeds. Kivircik and Imroz are among the very few indigenous sheep breeds in Turkey being thin tailed. The dominant sheep breed in the region Kivircik is believed by the public to have a better meat quality and its meat is usually sold more expensively than that of all other indigenous breeds in Turkey. Chios has a semi-fat tail and is the most prolific dairy indigenous sheep breed.
Carcass quality in Turkish lamb

in Turkey (Yalcin, 1986; Yilmaz et al., 2004). Mature live weight in Turkish Merino and Ramlic ewes is 50-55 kg, whereas it is 35-45 kg in Kivircik, Chios and Imroz ewes (Yalcin, 1986).

Turkey is very rich in indigenous sheep genetic resources. Among the public, certain breeds of sheep are believed to have better carcass quality characteristics. The present study aimed to comparatively determine the carcass quality characteristics of Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs under an intensive production system. The results of the study might be a help to determine the breeds in north-western Turkey that produce better quality carcasses and might aid breeding plans aimed at obtaining better quality lamb meat.

Material and methods

**Animals and fattening procedure**

Data were collected from Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs produced in Marmara Livestock Research Institute in 2006-2007. As the standard procedure of the Institute the ewes were hand mated to rams of the same breed between 15th June and 30th July 2006. After birth, lambs were kept with their dams in individual pens for 3 days. In this period, lambs were identified and birth date, birth weight, sex, birth type and all pedigree information of lambs were recorded. Then a flock composed of suckling lambs and their dams was formed. The suckling program of the lambs lasted for 85 days on average. During this program all the lambs were kept indoors and they also received grass hay and lamb grower feed in addition to their mother’s milk.

After weaning, ten lambs from the Turkish Merino, Ramlic, Kivircik and Chios breeds, and six lambs from the Imroz breed (forty-six lambs in total) were selected for fattening. The lambs, which were chosen for the fattening program, were male and born within ten days in the middle of the lambing season. Mean weaning ages of lambs chosen for fattening were 84.2±0.4, 85.2±1.7, 85.2±1.6, 82.7±2.5 and 83.0±8.2 days (P>0.05) for Turkish Merino, Ramlic, Kivircik, Chios and Imroz breeds, respectively. Lambs at similar ages were used to make the evaluation of the differences in carcass between genotypes at a fixed age (Diaz et al., 2003; Gutierrez et al., 2005). Weaning weight of chosen lambs also reflected the mean weaning weight of male lambs for their own breed. Mean weaning weights of lambs chosen for fattening were 32.1±0.4, 30.9±0.7, 31.3±1.3, 19.5±1.3 and 23.6±2.9 kg (P<0.001), respectively. Fattening pens for each genotype group (five pens in total) were built indoors, and lambs from the same breed were placed into the same pen. After a week of adapting to feed, the lambs were fattened for 56 days. Concentrate feed, which was given *ad libitum* to fattening lambs, was produced in the Institute. Also 100 g of alfalfa hay per lamb was given daily during the fattening program. Ingredients and composition of concentrate feed used in the study are given in Table 1.

**Slaughtering procedures and carcass quality measurements**

At the end of the 56-day fattening period, lambs from each genotype were randomly divided into two slaughter day groups (five lambs from Turkish Merino, Ramlic, Kivircik and Chios breeds, and three lambs from Imroz breed per slaughter day). In total, twenty-three lambs were slaughtered in each slaughter day. Second group lambs were slaughtered two days after the slaughter of the first group. Lambs were slaughtered after electrical stunning at the experimental slaughter unit at the Marmara Livestock Research Institute. Preslaughter
live weight was recorded after 12 h fasting with free access to water.

After the slaughter, head, skin, feet, lungs and trachea, liver, heart, spleen, omental and mesenteric fat, full gastro-intestinal tract and testicles were removed and weighed; and then hot carcass weight was recorded. Hot carcass included kidneys and perinephric - pelvic fat as described by Colomer-Rocher et al. (1987). In order to estimate empty body weight, gastro-intestinal tract content was removed, and the weight of the empty gastro-intestinal tract was recorded. Empty body weight was estimated by subtracting the weight of gastro-intestinal tract content from the preslaughter live weight.

The carcasses were chilled at 4°C for 24h, and then weighed to determine chilled carcass weight. Dressing percentage was calculated using slaughter weight (DP1) and also using empty body weight (DP2). Subcutaneous fat colour was measured at 24h post mortem using the L*, a*, b* system by a Minolta CR 400 colorimeter (Minolta Camera Co., Osaka, Japan) from the tail root. Colour coordinate value (L*: lightness, a*: redness, b*: yellowness) of each carcass was determined by calculating average of nine measurements. Chilled carcasses were also classified for fatness and conformation using 1-15 scales at 24h after slaughter as described by Fisher et al. (2000). Furthermore, body length, back length, hind leg length, chest depth, chest circumference, buttock circumference, internal chest depth were measured according to Yilmaz et al. (2002). Chilled carcasses were then split along the vertebral column into left and right halves. Kidney and kidney knob and channel fat (KKCF) were removed from half carcass and weighed. Kidney and KKCF were also expressed as a proportion of half carcass weight. The right side of carcass was separated into neck, shoulder, flank, ribs, hind leg and tail joints according to the methodology described by Colomer - Rocher et al. (1987), and weights of half carcass joints were recorded. *Musculus longissimus dorsi* (MLD) section area and back fat thickness were measured between the last thoracic

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**Table 1. Ingredients, chemical composition and nutritive value of concentrate feed.**

| Ingredients (%)                          |     |
|------------------------------------------|-----|
| Barley                                   | 74.00 |
| Sunflower cake                           | 24.00 |
| Calcium carbonate                        | 1.40 |
| Salt                                     | 0.50 |
| Vitamin + mineral premix                  | 0.10 |

| Chemical composition (% as fed)           |     |
|------------------------------------------|-----|
| Dry matter                               | 87.01 |
| Crude protein                            | 15.28 |
| Ether extract                            | 1.97 |
| Crude cellulose                          | 10.04 |
| Ash                                      | 2.95 |

Metabolizable energy Kcal/kg 2470
and first lumbar vertebrae according to description of Boggs and Merkel (1993).

Hind leg joint from right side of carcass was used to determine tissue composition and was dissected into lean, subcutaneous fat, intermuscular fat, bone and other tissues (major blood vessels, tendons, larger nerves and lymph nodes) according to the procedures of Fisher and de Boer (1994).

Statistical analyses

In terms of statistical evaluation of data, two-way ANOVA was performed using SPSS 10.0 statistical package (SPSS, 1999). The mathematical model used in the analyses included fixed effects of breed (Turkish Merino, Ramlic, Kivircik, Chios, Imroz), slaughter day (1, 2) and breed × slaughter day interaction.

Results and discussion

Slaughter traits

Slaughter results of the breeds are presented in Table 2. The slaughter weights and empty body weights in indigenous Chios and Imroz lambs were similar; however, they were much lighter than indigenous Kivircik and improved Turkish Merino and Ramlic lambs. These differences could be explained by the production type and mature body weight of these breeds. Yalcin (1986) reported mature body weight in indigenous Chios and Imroz ewes as 35-45 kg, whereas it was 45-55 kg in Turkish Merino and Ramlic ewes. Turkish Merino and Ramlic are dual-purpose sheep breeds, which were improved for meat and wool production. After wool lost its financial importance in Turkey, these breeds were particularly used in meat production. So, increased slaughter weight and empty body weight are expected in Turkish Merino and Ramlic lambs than Chios and Imroz lambs. Sañudo et al. (1997) noted that when lambs are slaughtered at the same age, small breeds had lower weights and more fat than large breeds. Fisher et al. (2000) found lower carcase weight in Welsh Mountain and Soay lambs than Suffolk lambs, and they attributed this result to the small mature size of Welsh Mountain and Soay breeds. The Kivircik breed, which is also an indigenous breed, had mean slaughter and empty body weights similar to those of Turkish Merino and Ramlic lambs. The meat quality of Kivircik is considered by the public to be the best among the sheep breeds in Turkey and it is also used for meat production (Yalcin, 1986). Turkish Merino and Kivircik in the present study had higher slaughter weights than reported by Ozcan et al. (2001) for the lambs of same breeds at five months of age. Yilmaz et al. (2003) reported similar slaughter weight for Kivircik and higher slaughter weight for Imroz lambs slaughtered at similar ages. The differences might be due to the differences in feed contents used in the fattening programs of these studies.

Ramlic, Kivircik and Imroz breeds had higher omental and mesenteric fat percentage than Turkish Merino and Chios breeds. Chios lambs had the lowest omental and mesenteric fat percentage, possibly because of their higher fat deposition in the tail (Sañudo et al., 1997, 1998). Full and empty gastro-intestinal tract percentages, gastro-intestinal tract content percentages, empty body weight and testicle percentages of Turkish Merino, Ramlic and Kivircik lambs were similar. Chios lambs had higher full and empty gastro-intestinal tract percentages than those of Turkish Merino, Ramlic and Kivircik lambs.

Head percentage of Chios is the highest in the present study. Chios is the highest milk producing and tallest breed among the indigenous breeds in Turkey and rams have long spiral horns (Yalcin, 1986). The high head percentage of Chios could be due to the
Table 2. Means and standard errors for slaughter weight (kg), empty body weight (kg) and percentages of non-carcass components (based on empty body weight) in Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs.

| Traits                      | Turkish Merino | Ramlic | Kivircik | Chios | Imroz | P  |
|-----------------------------|----------------|--------|----------|-------|-------|----|
|                             | Mean (SE)      | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) | Mean (SE) |    |
| Slaughter weight            | 47.39 (0.96)   | 45.68 (0.96) | 47.27 (0.96) | 31.08 (0.96) | 29.82 (1.24) | *** |
| Empty body weight           | 41.60 (0.87)   | 40.40 (0.87) | 41.96 (0.87) | 26.74 (0.87) | 26.18 (1.13) | *** |
| Head                        | 6.10 (0.11)    | 6.01 (0.11) | 5.90 (0.11) | 6.56 (0.11) | 6.30 (0.14) | **  |
| Skin                        | 11.14 (0.26)   | 11.49 (0.26) | 9.76 (0.26) | 10.58 (0.26) | 10.89 (0.34) | *** |
| Feet                        | 2.81 (0.06)    | 2.54 (0.06) | 2.39 (0.06) | 2.83 (0.06) | 2.52 (0.07) | *** |
| Lungs and trachea           | 1.65 (0.06)    | 1.65 (0.06) | 1.67 (0.06) | 1.88 (0.06) | 1.92 (0.08) | **  |
| Liver                       | 2.20           | 2.26     | 2.28     | 2.29     | 2.29     | ns  |
| Heart                       | 0.49 (0.01)    | 0.53 (0.01) | 0.43 (0.01) | 0.54 (0.01) | 0.54 (0.02) | *** |
| Spleen                      | 0.24           | 0.25     | 0.24     | 0.24     | 0.22     | ns  |
| Omental and mesenteric fat  | 1.36 (0.14)    | 2.06 (0.14) | 1.77 (0.14) | 1.04 (0.14) | 1.93 (0.18) | *** |
| Full gastro-intestinal tract| 23.06 (0.83)   | 22.00 (0.83) | 22.10 (0.83) | 27.16 (0.83) | 24.77 (1.07) | *** |
| Empty gastro-intestinal tract| 9.14 (0.25)   | 8.95 (0.25) | 9.48 (0.25) | 10.45 (0.25) | 10.74 (0.32) | *** |
| Gastro-intestinal tract content | 13.92 (0.72) | 13.05 (0.72) | 12.61 (0.72) | 16.71 (0.72) | 14.04 (0.93) | **  |
| Testicle                    | 0.76 (0.06)    | 0.81 (0.06) | 0.79 (0.06) | 0.54 (0.06) | 0.62 (0.07) | **  |

A, b, c: means with different letters differ significantly (P<0.05).
**=P<0.01, ***=P<0.001; ns: not significant.
higher horn growth of Chios. The feet percentages of Turkish Merino and Chios were significantly higher than those of the other breeds in the study. This could be explained by Turkish Merino’s carrying highest improved breed genotype and Chios’s being a dairy breed taller than the other indigenous breeds in Turkey. Karabacak (2007) found that feet weight of Turkish Merino was significantly higher than those of indigenous White Karaman, Daglic and Kivircik lambs.

**Chilled carcass traits and fat colour**

Chilled carcass results of lambs are presented in Table 3. Turkish Merino, Ramlic and Kivircik had similar chilled carcass weights as 23.35 kg, 22.33 kg and 23.51 kg, respectively, and the differences with Chios (14.33 kg) and Imroz (13.75 kg) were significant (P<0.001). This was particularly the result of differences in mean slaughter weight between breeds.

As sheep producers in Turkey are usually paid on the basis of carcass weight, dressing percentage of lambs is important for them to be able to evaluate the potential carcass weight of their lambs marketed live (Esenbuga et al., 2001). Dressing percentages based on slaughter weight (DP1) were higher in Turkish Merino, Ramlic and Kivircik lambs than Chios and Imroz. DP1 results in Turkish Merino, Ramlic and Kivircik lambs were also higher than those reported for indigenous Awassi, Red Karaman and Tushin lambs (Esenbuga et al., 2001) and were similar to Rambouillet, Targhee, Columbia and Polypay lambs (Snowder et al., 1994). Dressing percentages based on empty body weight (DP2) were higher in Turkish Merino, Ramlic and Kivircik than Chios and Imroz lambs. Certain researchers explained these breed (or genotype) differences in dressing percentage by fatness level of carcasses (Sañudo et al., 1997). In terms of fatness score, Turkish Merino, Ramlic and Kivircik lamb carcasses had higher values than those of Chios and Imroz lambs. Therefore, higher dressing percentage in Turkish Merino, Ramlic and Kivircik than Chios and Imroz lambs could be due to differences among genotypes in fatness level.

Chilling loss percentage of Imroz breed was higher than the other breeds probably because of its lower back fat thickness. Caneque et al. (2001) and Velasco et al. (2004) also reported higher chilling loss in less fatty carcasses than those of fattier carcasses.

The conformation and fatness scores of Turkish Merino, Ramlic and Kivircik lambs were significantly higher than Chios and Imroz lambs. Turkish Merino had the highest conformation score and Kivircik had the highest fatness score while Chios had the lowest scores. Similarly Fisher et al. (2000) reported lower carcass conformation and fatness scores in Welsh Mountain and Soay lambs indicating thinner muscle and less fat cover of these breeds than in the Suffolk. It was reported in several studies that by the improvement in carcass weight, an increase in carcass measurements and conformation indexes would also be expected (Díaz et al., 2002; Santos et al., 2007).

Section areas of MLD in Turkish Merino, Ramlic and Kivircik carcasses were similar and were higher than Chios and Imroz carcasses. Back fat thickness of breeds varied. Ramlic had the thickest fat being followed by Kivircik while Imroz had the lowest back fat thickness. Turkish Merino lambs had lower back fat thickness than Ramlic lambs. Similar results were reported for MLD section area of Turkish Merino lambs slaughtered at similar ages to the lambs in the current study (Ozcan et al., 2001; Karabacak, 2007). Karabacak (2007) reported that Turkish Merino lambs had higher MLD section area than those of indigenous White Karaman, Kivircik and Daglic lambs. MLD
Table 3. Means and standard errors for certain chilled carcass traits and fat colour parameters in Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs.

| Traits                               | Turkish Merino | Ramlic | Kivircik | Chios | Imroz | \( p \) |
|--------------------------------------|----------------|--------|----------|-------|-------|--------|
|                                      | Mean  | SE   | Mean  | SE   | Mean  | SE   | Mean  | SE   | Mean  | SE   | Mean  | SE   |      |
| Chilled carcass weight               | kg    |      |        |      |       |      |       |      |       |      |       |      |      |
|                                      | 23.35a | 0.53 | 22.33a | 0.53 | 23.51a | 0.53 | 14.33b | 0.53 | 13.75b | 0.69 | ***   |      |
| Dressing percentage-1 \(^{DP1}\)    | %     |      |        |      |       |      |       |      |       |      |       |      |      |
|                                      | 49.28a | 0.50 | 48.85a | 0.50 | 49.73a | 0.50 | 45.92b | 0.50 | 45.70b | 0.64 | ***   |      |
| Dressing percentage-2 \(^{DP2}\)    | "     |      |        |      |       |      |       |      |       |      |       |      |      |
|                                      | 56.14a | 0.55 | 55.23a | 0.55 | 55.98a | 0.55 | 53.54b | 0.55 | 52.10b | 0.71 | ***   |      |
| Chilling loss                        | "     |      |        |      |       |      |       |      |       |      |       |      |      |
|                                      | 1.80a | 0.18 | 1.82a | 0.18 | 1.97a | 0.18 | 2.27b | 0.18 | 2.92a | 0.24 | **    |      |
| Conformation score (1-15 scale)      | 9.60a | 0.37 | 8.40a | 0.37 | 8.60a | 0.37 | 5.10c | 0.37 | 5.83c | 0.47 | ***   |      |
| Fatness score (1-15 scale)           | 8.30a | 0.37 | 8.40a | 0.37 | 9.10a | 0.37 | 5.40c | 0.37 | 6.67c | 0.48 | ***   |      |
| MLD section area                     | mm\(^2\) | 1518.85 | 64.20 | 1467.60 | 64.20 | 1424.00 | 64.20 | 1009.90 | 64.20 | 1032.50 | 82.88 | ***   |
| Back fat thickness                   | mm    | 4.87c | 0.41 | 6.66a | 0.41 | 5.86c | 0.41 | 3.83c | 0.41 | 2.25c | 0.53 | ***   |
| Body length                          | cm    | 66.18a | 0.71 | 64.41a | 0.71 | 66.07a | 0.71 | 60.74b | 0.71 | 58.12c | 0.92 | ***   |
| Back length                          | "     | 61.40b | 0.83 | 59.60c | 0.83 | 62.55a | 0.83 | 58.48c | 0.83 | 58.00c | 1.07 | **    |
| Hind leg length                      | "     | 36.67c | 0.49 | 37.00a | 0.49 | 37.28a | 0.49 | 35.88c | 0.49 | 35.33c | 0.63 | ns     |
| Chest depth                          | "     | 27.46c | 0.29 | 27.40b | 0.29 | 28.24a | 0.29 | 24.84c | 0.29 | 25.33c | 0.98 | ***   |
| Chest circumference                  | "     | 78.62c | 0.83 | 77.74a | 0.83 | 78.48a | 0.83 | 67.70b | 0.83 | 67.03b | 1.08 | ***   |
| Buttock circumference                | "     | 61.24a | 0.82 | 59.69a | 0.82 | 59.91a | 0.82 | 50.69b | 0.82 | 50.70b | 1.06 | ***   |
| Internal chest depth                 | "     | 19.05a | 0.53 | 19.23a | 0.53 | 19.50a | 0.53 | 17.22b | 0.53 | 18.18b | 0.68 | *      |
| Fat colour parameters                |       |       |       |      |       |      |       |      |       |      |       |      |      |
| Lightness (L\(^*\))                  |       |       |       |      |       |      |       |      |       |      |       |      |      |
|                                      | 69.40 | 0.88 | 68.08 | 0.88 | 67.64 | 0.88 | 67.40 | 0.88 | 68.41 | 1.13 | ns     |
| Redness (a\(^*\))                    |       |       |       |      |       |      |       |      |       |      |       |      |      |
|                                      | 4.59  | 0.38 | 4.65  | 0.38 | 4.68  | 0.38 | 5.31  | 0.38 | 3.61  | 0.49 | ns     |
| Yellowness (b\(^*\))                 |       |       |       |      |       |      |       |      |       |      |       |      |      |
|                                      | 7.74c | 0.31 | 8.23c | 0.31 | 8.72c | 0.31 | 9.20c | 0.31 | 7.63c | 0.40 | **    |

*a, b, c, d* Means with different letters differ significantly \((P<0.05)\).

\*\*=P<0.05; **\*=P<0.01; ***\*=P<0.001; ns: not significant.

\(^{DP1}\): Dressing percentage based on slaughter weight; \(^{DP2}\): Dressing percentage based on empty body weight.
section area of Kivircik lambs in the present study was similar to that of Kivircik lambs at similar ages in Yilmaz et al. (2003)’s and was higher than those in Ozcan et al. (2001) and Karabacak (2007)’s studies. Yilmaz et al. (2003) found similar MLD section area results for Imroz lambs. Turkish Merino, Ramlic and Kivircik had higher MLD section areas and lower back fat thicknesses than Rambouillet, Targhee and Polypay breeds slaughtered at about 53 kg (Snowder et al., 1994).

In terms of body measurements, Turkish Merino, Ramlic and Kivircik lambs generally had similar results and these results were higher than those of Chios and Imroz lambs. This was particularly the result of different mean slaughter weights between breeds. Only for hind leg length the differences between breeds were not significant. This might be the result of the taller body appearance of Chios having a dairy purpose.

Fat colour results of lambs are presented in Table 3. The differences between breeds for L* and a* values were not significant. Chios had the highest mean b* value and the differences with Turkish Merino, Ramlic and Imroz were significant. Mean fat b* value of Imroz carcasses was the lowest. As dark yellow carcasses are not generally preferred by the consumers (Priolo et al., 2002) this higher b* value of Chios carcasses might have a negative effect on the approval of Chios carcasses.

Carcass joint traits and dissected hind leg compositions

Results of carcass joint traits of lambs are presented in Table 4. Chios is a semi-fat tailed breed and therefore the tail percentage of Chios lambs were the highest in the study and were significantly higher than the tail percentages of Turkish Merino, Ramlic, Kivircik and Imroz lambs. As 35% genotype of Ramlic breed belongs to a fat tailed indigenous breed named Daglic, the tail percentage of Ramlic lamb carcasses were significantly higher than those of Turkish Merino and Imroz lambs. Indigenous Kivircik lambs also had a significantly higher tail percentage than Turkish Merino and Imroz lambs.

Kidney knob and channel fat (KKCF) percentage of Imroz carcasses was as high as Ramlic and Kivircik lamb carcasses. Turkish Merino was again at an intermediate level. Karabacak (2007) also reported that Kivircik lambs produced significantly higher KKCF than those of indigenous White Karaman and Daglic breeds. The lower KKCF percentage of Chios lambs might be the result of their higher fat deposition in the tail.

Turkish Merino had the highest shoulder and hind leg percentages among genotypes and the differences were significant for shoulder with Ramlic, Kivircik and Imroz and for hind leg with Kivircik. This can be recognized as the ability of Turkish Merino lambs for higher production of better quality carcass joints. Ozcan et al. (2001) also reported that Turkish Merino lambs had significantly higher hind leg percentage than Kivircik and two-way and three-way crossbred lambs of German Black-Headed Mutton, Kivircik and Chios breeds. Caparra et al. (2007) in Italian Merino and Barone et al. (2007) in Ile de France lambs reported similar shoulder and hind leg percentages to Turkish Merino lambs in the present study.

Dissected hind leg compositions of the breeds are presented in percentages in Table 5. Turkish Merino, Chios and Imroz had the highest lean percentage and the differences were significant with Ramlic. Kivircik lamb carcasses had a significantly higher subcutaneous fat percentage of Kivircik, intermuscular fat percentage of Ramlic and total fat percentages of both Kivircik and Ramlic were significantly higher than those of the other breeds in the present study. Parallel to the results...
Table 4. Means and standard errors for percentages of carcass joints in Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs.

| Traits     | Turkish Merino | Ramlic | Kivircik | Chios | Imroz |
|------------|----------------|--------|----------|-------|-------|
|            | Mean | SE  | Mean | SE  | Mean | SE  | Mean | SE  | Mean | SE  | P   |
| Neck       | 9.07b | 0.29 | 9.08b | 0.29 | 9.77ab | 0.29 | 9.79ab | 0.29 | 10.63a | 0.37 | *   |
| Shoulder   | 18.58a | 0.23 | 17.41c | 0.23 | 17.35c | 0.23 | 18.41ab | 0.23 | 17.66bc | 0.30 | *** |
| Flank      | 12.05a | 0.22 | 11.99a | 0.22 | 12.04a | 0.22 | 10.77b  | 0.22 | 10.75b  | 0.28 | *** |
| Ribs       | 24.23  | 0.50 | 25.09  | 0.50 | 25.45  | 0.50 | 23.58  | 0.50 | 24.22  | 0.65 | ns   |
| Hind leg   | 33.39a | 0.41 | 32.31ab | 0.41 | 31.42b  | 0.41 | 32.84a  | 0.41 | 33.13a  | 0.53 | *    |
| Tail       | 0.63c  | 0.12 | 1.49b  | 0.12 | 1.35b  | 0.12 | 2.88a  | 0.12 | 0.91c  | 0.16 | ***  |
| Kidney     | 0.57b  | 0.02 | 0.61b  | 0.02 | 0.60b  | 0.02 | 0.70a  | 0.02 | 0.70a  | 0.03 | ***  |
| KKCF       | 1.43bc | 0.18 | 1.99a  | 0.18 | 1.96a  | 0.18 | 0.98c  | 0.18 | 2.00ab | 0.23 | **   |

a, b, c: Means with different letters differ significantly (P<0.05).
* = P<0.05; ** = P<0.01; *** = P<0.001; ns: not significant.
KKCF: Kidney knob and channel fat.

Table 5. Means and standard errors for dissected leg composition percentages in Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs.

| Traits              | Turkish Merino | Ramlic | Kivircik | Chios | Imroz | P   |
|---------------------|----------------|--------|----------|-------|-------|-----|
|                     | Mean | SE  | Mean | SE  | Mean | SE  | Mean | SE  | Mean | SE  |     |
| Lean                | 62.63a | 0.73 | 58.90b | 0.73 | 58.24b | 0.73 | 61.65a | 0.73 | 62.38a | 0.95 | *** |
| Subcutaneous fat    | 13.71bc | 0.72 | 15.61b | 0.72 | 18.11a  | 0.72 | 11.98c | 0.72 | 12.29c | 0.93 | *** |
| Intermuscular fat   | 3.18b  | 0.36 | 5.44a  | 0.36 | 3.46b  | 0.36 | 2.79b  | 0.36 | 3.39b  | 0.47 | *** |
| Total fat           | 16.88b | 0.83 | 21.04a  | 0.83 | 21.58a  | 0.83 | 14.77b  | 0.83 | 15.69b | 1.07 | *** |
| Bone                | 19.72b  | 0.68 | 19.23b  | 0.68 | 19.35b  | 0.68 | 22.82a  | 0.68 | 20.97ab | 0.88 | **   |
| Other tissues β     | 0.59  | 0.10 | 0.50  | 0.10 | 0.60  | 0.10 | 0.62  | 0.10 | 0.71  | 0.12 | ns   |
| Lean/total fat ratio| 3.79a  | 0.22 | 2.90b  | 0.22 | 2.72b  | 0.22 | 4.32a  | 0.22 | 4.30a  | 0.28 | ***  |
| Lean/bone ratio     | 3.20  | 0.11 | 3.08  | 0.11 | 3.06  | 0.11 | 2.75  | 0.11 | 3.00  | 0.14 | ns   |

a, b, c: Means with different letters differ significantly (P<0.05).
** = P<0.01; *** = P<0.001; ns: not significant.
β: Major blood vessels, tendons, larger nerves and lymph nodes.
of the present study Yilmaz and Altinel (2003) reported that Turkish Merino lambs produced a significantly higher percentage of lean and lower percentage of fat than Kivircik lambs in the whole carcass. Caparra et al. (2007) reported higher lean percentage and lean/fat ratio and lower total fat percentage in Italian Merino than those of Turkish Merino lambs in the present study. These differences might be due to the lower slaughter weight of Italian Merino lambs.

In the intensive fattening in this study Ramlic and Kivircik lambs reached the slaughter and chilled carcass weights as high as Turkish Merino. However, the total fat percentage in the hind leg was significantly higher in Ramlic and Kivircik lambs. This might be a sign that intensification in fattening might result with more fat content in Ramlic and Kivircik lambs. Also lean/total fat ratio of Ramlic and Kivircik was significantly lower than the other breeds in the present study.

Bone percentage of Chios lambs was the highest resembling the breed’s taller body appearance and the differences with Turkish Merino, Ramlic and Kivircik lambs were significant. The differences among breeds in terms of lean/bone ratio and other tissues percentages in hind leg were not significant.

Conclusions

In the present study aiming to comparatively investigate the carcass quality traits of Turkish Merino, Ramlic, Kivircik, Chios and Imroz lambs in intensive fattening, it was observed that improved Turkish Merino and Ramlic and indigenous Kivircik lambs had higher quality carcass production than indigenous Chios and Imroz lambs. Moreover, Turkish Merino lambs which were bred in the same conditions and slaughtered at similar ages had lower fat deposition parameters than Ramlic (omental and mesenteric fat percentage, back fat thickness, KKCF percentage and intermuscular and total fat percentage in the hind leg) and Kivircik (omental and mesenteric fat percentage, KKCF percentage and subcutaneous and total fat percentage in the hind leg) lambs. These results show that Turkish Merino can be used to obtain high quality lamb carcasses in intensive fattening in this region. It can also be declared that the studies to achieve an improved breed resulting with Turkish Merino have achieved their goals and that the use of Turkish Merino might be encouraged in crossbreeding programs to produce slaughter lambs with better carcass quality. However, as the population sizes of improved Turkish Merino and Ramlic breeds are more limited than indigenous Kivircik and as Kivircik lambs showed similar results to Turkish Merino in most of the carcass quality results, the indigenous Kivircik breed can also be alternatively recommended in intensive lamb production in north-western Turkey. Detailed investigations on carcass traits at different slaughter ages of these breeds might be beneficial for the higher quality carcass producing breed choice in this region.

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