PAPER

MEAT PRODUCTION TRAITS OF LOCAL KARAYAKA SHEEP IN TURKEY 1. THE MEAT QUALITY CHARACTERISTIC OF LAMBS

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ABSTRACT

This study is an investigation into the meat quality parameters of Karayaka lambs at different slaughter weights (SWs). The single-born Karayaka male lambs (n=30) selected for this study were an average live-weight of 20 kg and weaned at 2.5-3 months of age. The animals with pre-specified SWs were divided into slaughter weight (SW) groups (30, 35, 40, 45 and 50 kg) using a fully randomized design. To determine the *M. longissimus dorsi et thoracis* (LD) muscle meat quality characteristics, six lambs from each weight group were slaughtered. Results revealed significant differences among the slaughter groups with regard to pH, color parameters (L*-lightness, a*-redness, b* -yellowness), cooking loss (CL), drip loss (DL), moisture (M), crude protein (CP) and intramuscular fat (IF) ratios. Increasing water holding capacities (WHCs) and hardness values were observed with increasing SW. Significant differences were also observed among the slaughter groups with regard to total monounsaturated fatty acid + total polyunsaturated fatty acid/total saturated fatty acid ratios and total cholesterol content.

- Keywords: Karayaka sheep, fatty acid composition, lambs, meat quality, slaughter weight -

INTRODUCTION

Mutton is a significant protein source for humans. Although Turkey is among those countries with rapidly increasing population, there has been an approximately 48% decrease in the country's sheep stocks in recent decades. According to the latest statistics, around 13.7% of Turkish red meat production comes from sheep-raising (TUIK, 2014). Such a ratio clearly indicates the significance of mutton in red meat production of Turkey. To meet animal protein requirements, and to provide a healthy and balanced nutrition, especially for children, but also for all ages, the quality and amount of red meat per unit animal definitely requires improvement. The link between beef, mutton and an increased risk of cardiovascular disease has repeatedly been the focus of concern (WOOD *et al.*, 1999; NUERNBERG *et al.*, 2008). Beef and mutton are regarded as having a higher saturated fatty acid content and cholesterol level than other red meat and poultry (KARACA and KOR, 2007). However, conjugate linoleic acid, a derivative of linoleic acid of unsaturated fatty acids, has anti-carcinogenic and beneficial effects on human health, such as decreasing body fatty acids and improving immunity. Previous research has revealed that lamb has higher rates of this fatty acid than other meat sources (INANÇ, 2006; KURBAN and MEHMETOĞLU, 2006). Along with ever developing and changing consumer demand, there is a need for studies about fatty acids and the cholesterol contents of muttons of local sheep breeds and such studies will unquestionably provide a great contribution to the preservation of local breeds and gene source. In lambs, meat quality is significantly affected by genotypes (ESENBUĞA *et al.*, 2001; PURCHAS *et al.*, 2002; MARTÍNEZ-CEREZO *et al.*, 2005), slaughter weights (SWs) (JEREMIAH *et al.*, 1998; PURCHAS *et al.*, 2002; MARTÍNEZ-CEREZO *et al.*, 2005), gender (DRANSFIELD *et al.*, 1990), pre-slaughter stress (TEIXEIRA *et al.*, 2005), carcass cooling ratio (TEIXEIRA *et al.*, 2005), raising system (VELASCO *et al.*, 2004; CARRASCO *et al.*, 2009) and maturation duration (TEIXEIRA *et al.*, 2005).

Karayaka sheep have low fertility (52-103%) (AKÇAPINAR *et al.*, 2002; AKSOY, 2008), milk production (40-45 kg) and live weight (35-50 kg) (SÖNMEZ *et al.*, 2009), while the quality of meat traits is better than that of other local breeds such as Red Karaman, Anatolian Merino and Awassi. Karayaka sheep constitute about 4-5% of the total Turkish sheep population and are extensively reared in the Black Sea Region of Turkey (ULUTAS *et al.*, 2008).

The present study was conducted to determine the meat quality traits of Karayaka lambs with different SWs.

MATERIAL AND METHODS

The present research was conducted in the sheep barns of the Agricultural Research Farm of Gaziosmanpaşa University (2011-HADYEK-046 numbered local ethics committee approval). Singleton-born Karayaka male lambs (n = 30) with an average live-weight of 20 kg and weaned at 2.5-3 months of age were considered for the study. The SWs and age of lambs at slaughter were 30 kg and 104.8±4.83 days; 35 kg and 119.2±4.29 days; 40 kg and 135.8±1.87 days; 45 kg and 154.6±1.99 days; 50 kg and 163.6±3.26 days, respectively. The animals with pre-specified SWs were divided into SW groups in a fully randomized design. Lambs housed together in 5 × 8 meter pens. Before the initiation of fattening, the lambs were disinfected against internal and external parasites. Following an initial one-week feeding adaptation period, the actual fattening was commenced and lambs were fed until they reach SWs of 30, 35, 40, 45 and 50 kg. Six lambs were slaughtered from each weight group. Lamb fattening feed (concentrated feed) and lentil straw (coarse fodder) were used as the feed material. During the fattening period, lamb-fattening feed was supplied *ad libitum* and coarse fodder was supplied at a ratio of 100 g/head/day. The nutrient contents of the concentrated feed and coarse fodder are provided in Table 1. Fresh water and licking stones were continuously supplied to animals during the experiments. The lambs with the desired SWs were taken into private pens. The animals were not fed for 12 hours prior to slaughter; they were then were transported for 10 minutes to a local licensed abattoir. After holding them in the paddock of the slaughterhouse for two hours, they were slaughtered following the standard commercial slaughter procedures (TSI, 1987). The lambs were brought to slaughter within ±1 kg of the expected SWs. After slaughter, the carcasses were kept at +4°C for 24 h and then the *M. longissimus dorsi et thoracis* (LD) muscles were isolated for meat quality analyses. Sufficient samples taken from these muscles were vacuumed and stored at +4 °C for analysis, at -20 °C for mois-

Table 1 - The chemical composition of concentrated feed and coarse fodder.

Nutrient content	Concentrated feed	Lentil straw
Dry matter (%)	92.00	91.30
Crude protein (%)	20.63	5.78
ADF (%)	26.39	55.59
NDF (%)	37.96	56.29
Crude fat (%)	2.60	1.49
Crude ash (%)	10.40	9.60
Metabolic energy (kcal/kg)	2658	2012

ADF:Acid Detergent Fiber
NDF:Neutral Detergent Fiber

ture (M), crude ash (CA), crude protein (CP), intramuscular fat (IF) and at -80 °C for defrosting and cooking loss (CL), texture, fatty acid composition and cholesterol analyses. The pH of the LD muscle samples was measured at the 45th minute and 24th hour after slaughter with a meat pH meter (Testo 205, Germany). Measurements were taken from three different locations of the samples and an average of those three measurements was taken as the pH value of that sample (RAMÍREZ and CAVA, 2007).

Meat color measurements were performed on the LD at the level of the 12th and 13th ribs, one and 24 hours after slaughter with a Konica Minolta CR-400 (Japan) spectro-colorimeter. Commission International de l'Eclairage (CIE) (1976) standards were used for the measurements (CIE, 1986). The color parameters (L*-lightness, a*-redness, b*-yellowness) were measured from five different sections of each sample. A data set was created by taking the average of measurements for each of the three parameters (ÖNENÇ *et al.*, 1999a,b). Then C (chroma = $(a^{*2}+b^{*2})^{1/2}$) and H° (hue = $\tan^{-1}(b^*/a^*)$ values were calculated (ÖNENÇ, 2003).

Water holding capacities (WHCs) were measured in accordance with the press method developed by Grau and Hamm (1956). A 25 g meat sample was taken from each main sample and ground in an Aura Type 103 (Turkey) brand mini chopper. Then, 1 g of chopped sample was placed in between two filter papers (Whatman 1 Qualitative Circles 125mm Ø Cat No: 1001 125); glass plates were placed above and below the filter papers and a 2.250 kg weight was placed on them. After five minutes, samples were taken out the filter papers and re-weighed (BARTON-GADE *et al.*, 1993). Then, WHC was calculated, using the equation of "WHC (%) = ((Initial sample weight – Pressed sample weight) / Initial sample weight) x 100".

To determine drip loss (DL), 20-25 g samples were taken from LD muscle and vacuumed into plastic bags. The vacuumed samples were stored at 4°C. The samples were then taken out of the vacuum bags three and seven days later, dried without any pressure, and reweighed. The ratio of the difference between the initial and final weights was calculated to find DL% after three and seven days (BOND and WARNER, 2007).

To determine the CL, 40-50 g samples were taken from the LD muscle, placed into vacuum bags and cooked in a water bath (70°C) for 40 min. The samples were then placed under a running tap for 30 minutes to lower the sample temperature to 25°C (MITCHAOTHAI *et al.*, 2006). Then the samples were taken out of the bags, blotted without any added pressure and reweighed. The CL was calculated using the equation of "CL (%) = ((Initial sample weight – Cooked sample weight) / Initial sample weight) x 100.

Textural characteristics were determined at room temperature, using the P36/R probe of a Texture Analyzer (TA.XP Plus - Stable Micro Systems, Godalming, UK) (MARTİNEZ *et al.*, 2004). Sample dimensions were arranged into 1x1x1 cm (cubic) cubes and before, during and after, probe speeds were respectively set as 1, 5 and 5 mm/s.

The M, CP and CA contents of the LD muscle samples were determined in accordance with AOAC (1990). The IF contents were determined, according to the heat extraction method with an Ankom (XT10, Spain) Extractor device (OKEUDO *et al.*, 2007).

The extraction of lipids for fatty acid analysis was performed with chloroform/methanol (2:1), as described by FOLCH *et al.* (1957). Triglycerides in the cold-extracted lipids were converted into fatty acid methyl esters, in accordance with AOCS (1993). The fatty acid composition of the samples were determined using a Perkin Elmer Clarus 500 (USA) gas chromatography device, equipped with a FID (Flame Ionization Detector) detector and a Thermo Scientific Tr 70 Capillary column (30 m x 0,25 mm and 0,25 µ film thickness). Helium (1 mL/min) was used as a carrier gas. Split ratio was set as 1/50, operational temperature for injection block as 250°C and for detector as 260°C. The temperature increase rate was 1°C/min, to increase the column temperature from 140°C to 180°C and 2°C from 180°C to 200°C. Samples were kept at a final temperature of 200°C for eight minutes. A Supelco 37 FAME mix (C4-C24) (Bellefonte, PA, USA) was used as the standard by which to define the fatty acids. The results were expressed in % methyl esters.

About 0.3-0.5 g of lipid samples was taken from the lipid, cold-extracted from the LD muscle, and the samples were placed into closed glass tubes. Then, 0.3 mL 33% KOH and 3 mL 95% ethyl alcohol solution was added, and the mixture roughly mixed and saponificated in a water bath at 60°C for 15 min. The tubes were cooled down, 10 mL hexane and 3 mL of distilled water was added and the roughly mixed samples were then kept for 10 minutes for phase separation. To determine cholesterol content, a 1 mL sample was removed from the hexane fraction into a test tube. The hexane was removed using nitrogen gas. A $FeCl_3$ stock solution was prepared with 840 mg $FeCl_3$ and 10 mL concentrated glacial acetic acid, and 1 mL of this stock solution was increased to 100 mL with a concentrated glacial acetic acid, to prepare the $FeCl_3$ working solution. Later on, the 1.5 mL $FeCl_3$ working solution was added to test tube and the resulting solution was roughly mixed. After 15 minutes, 1 mL of concentrated sulphuric acid was added and the samples were mixed in a tube mixer for 1 min. The tubes were placed in the dark for 45 min. The absorbance values of the resulting purple color were read at 560 nm wavelength of a UNICAM UV/Vis model spectrophotometer. Cholesterol standard curves were cre-

Table 2 - Meat quality characteristics of *M. longissimus dorsi et thoracis* (LD).

Traits	Slaughter weight (kg)					MSE	P
	30	35	40	45	50		
pH_{45m}	6.15^{c}	6.10^{c}	6.31^{b}	6.14^{c}	6.46^{a}	0.01	***
pH_{24h}	5.55^{c}	5.60^{c}	5.75^{ab}	5.70^{b}	5.80^{a}	0.01	***
Color $_{60m}$							
L*	33.99^{a}	33.90^{ab}	33.23^{b}	33.59^{ab}	32.10^{c}	0.10	***
a*	12.55^{a}	12.25^{a}	10.47^{b}	10.27^{b}	10.49^{b}	0.08	***
b*	3.15^{a}	3.04^{a}	1.30^{b}	1.07^{b}	0.94^{b}	0.07	***
C*	12.94^{a}	12.64^{a}	10.57^{b}	10.33^{b}	10.53^{b}	0.09	***
H°	14.38^{a}	13.41^{a}	6.50^{b}	5.90^{b}	5.34^{b}	0.29	***
Color $_{24h}$							
L*	41.04^{a}	39.70^{ab}	39.68^{ab}	39.58^{ab}	38.60^{b}	0.22	*
a*	13.27^{d}	14.35^{ab}	14.12^{bc}	13.75^{c}	14.61^{a}	0.06	***
b*	5.03^{a}	5.35^{a}	4.08^{b}	4.18^{b}	5.02^{a}	0.06	***
C*	14.21^{b}	15.36^{a}	14.64^{b}	14.39^{b}	15.37^{a}	0.07	***
H°	20.83^{a}	20.21^{a}	16.25^{c}	16.55^{c}	18.79^{b}	0.20	***
Drip loss (%)							
3rd day	8.10^{a}	8.71^{a}	7.15^{b}	9.67^{a}	9.94^{a}	0.20	***
7th day	12.22^{ab}	11.73^{ab}	9.35^{c}	13.20^{a}	10.94^{b}	0.24	***
Cooking loss (%)	28.25^{a}	27.23^{a}	26.11^{ab}	25.03^{b}	24.73^{b}	0.29	**
WHC (%)	34.37^{d}	36.20^{c}	36.28^{c}	37.74^{b}	39.15^{a}	0.21	***
Texture (kg/cm^2)	4.51	4.91	5.18	5.96	7.29	0.35	-

WHC: Water Holding Capacity; MSE: Mean Standard Error
-: Non-significant, *: P<0.05, **: P<0.01, ***: P<0.001
Means within a row with different letters differ significantly (P<0.05)

Table 3 - Compositional properties of *M. longissimus dorsi et thoracis* (LD) (%).

Traits	Slaughter weight (kg)					MSE	P
	30	35	40	45	50		
Moisture	75.92^{ab}	75.08^{cd}	76.18^{a}	74.46^{d}	75.33^{bc}	0.12	***
Protein	20.14^{ab}	20.82^{a}	20.13^{ab}	20.68^{a}	19.85^{b}	0.11	*
IF	2.59^{b}	2.67^{b}	2.41^{b}	3.44^{a}	2.98^{ab}	0.08	**
Ash	1.08	1.06	1.07	1.08	1.06	0.01	-

IF: Intramuscular Fat; MSE: Mean Standard Error
-: Non-significant, *: P<0.05, **: P<0.01, ***: P<0.001
Means within a row with different letters differ significantly (P<0.05)

ated and the cholesterol content of the samples was expressed as mg cholesterol/100 g sample (RUDEL and MORRIS, 1973).

Statistical analyses were performed using SPSS (1999) software. The Duncan's test was used to determine differences among the means (DÜZGÜNEŞ *et al.*, 1987).

RESULTS AND DISCUSSION

Mean values, for the meat quality traits of the LD muscles of Karayaka lambs with different SWs, are shown in Table 2, the compositional nutrient content in Table 3 and, fatty acid composition and cholesterol contents in Table 4.

Meat pH values have distinctive impacts on meat quality traits, such as color, WHC and texture. Therefore, the pH plays a significant role in the quality assessment of meat (KARACA, 2010). In the present study, pH measurements were performed 45 minutes (pH_{45m}) and 24 hours (pH_{24h}) after the slaughter. In both measurement times, the differences in muscle pH values of the slaughter groups were found to be significant (P<0.001; Table 2). Similar to the current findings, the significant effects of SWs on final pH values were reported in previous studies (BERIAIN *et al.*, 2000; YAKAN and ÜNAL, 2010); however, others reported insignificant effects (MARTÍNEZ-CEREZO *et al.*, 2005). Increasing pH_{24h} values were observed in this study with increas-

ing SWs and the relevant values varied between 5.55 – 5.80. Based on the assumption that a final pH value above 5.8 is considered undesirable, it can be said that the final pH ranges were both appropriate and inside normal range (YAKAN and ÜNAL, 2010).

WHC is closely related to pH and therefore it is considered as a significant parameter for meat quality assessments (YAKAN, 2008). The differences between WHCs of the slaughter groups were also found to be significant (P<0.001; Table 2). Increasing WHC values were observed with increasing SWs. LAWRIE and LEDWARD (2006) reported increasing WHCs with increasing pH values. However, current findings were contrary to those reports. Cold-induced contraction might have such effects on WHC. Such contractions have higher impacts on carcasses with high pH levels. Cold carcass contractions result in decreasing intra-myofibril spaces and water release from the meat (KARACA, 2010). The WHCs of lambs fed with concentrated feed were reported as between 9.76 - 28.27 (BERIAIN *et al.*, 2000; EKIZ *et al.*, 2009; YAKAN and ÜNAL, 2010).

Consumers commonly assess the meat they buy based on fattiness, general appearance and color; regarding light colored meat as that of young animals, which they prefer to buy (SAÑUDO *et al.*, 2007). In the present study, the color parameters L*, a* and b* were measured over hot carcasses (60 minutes after slaughter) and cold carcasses (24 hours after slaughter) of LD muscle samples and significant differences were observed between slaughter groups with regard to L*, a*, b*, C* and H° values, in both measurement periods (P<0.05; Table 2). Similar to the current findings, BERIAIN *et al.* (2000) and MARTINEZ-CEREZO *et al.* (2005) reported significant effects of SWs on the color parameters. The decreasing L* values observed in this study were concomitant with increasing SWs. The a* values recorded at 24h in 50 kg group was higher than those recorded in 40 and 45 kg groups and similar to those recorded in 35 kg group. BERIAIN *et al.* (2000) carried out a study on Lacha and Rasa Aragonesa lambs with different SWs (12, 24 and 36 kg) and reported decreasing L* values and increasing a* values with increasing SWs. In other studies carried out with local lamb breeds, fed by concentrated feeds, L* values (24 hours after slaughter) were reported as between 37.91 – 42.72; a* values as between

Table 4 - Cholesterol content (mg/100 g meat) and fatty acid composition (%) of lipids of *M. longissimus dorsi et thoracis* (LD).

Traits	Slaughter weight (kg)					MSE	P
	30	35	40	45	50		
C8:0	0.210	0.170	0.172	0.156	0.154	0.01	-
C10:0	0.310	0.258	0.220	0.222	0.242	0.01	-
C11:0	7.188	6.156	6.123	5.664	5.530	0.14	-
C12:0	0.415	0.224	0.172	0.138	0.142	0.03	-
C14:0	2.927^{a}	2.940^{a}	2.725^{ab}	2.530^{ab}	2.380^{b}	0.07	*
C14:1	0.215	0.134	0.090	0.110	0.122	0.01	-
C15:0	0.300	0.204	0.165	0.104	0.200	0.02	-
C16:0	23.135	23.206	23.493	23.914	24.326	0.21	-
C16:1	1.055	1.278	0.928	1.234	0.808	0.11	-
C17:0	0.750	0.968	0.717	0.818	0.808	0.07	-
C17:1	0.550	0.695	0.537	0.612	0.584	0.05	-
C18:0	13.792^{b}	14.374^{b}	14.350^{b}	13.964^{b}	16.306^{a}	0.25	**
C18:1	37.867	39.622	39.980	43.132	40.294	0.59	-
C18:2 (n-6)	7.572^{a}	6.790^{ab}	7.380^{a}	5.334^{b}	5.878^{ab}	0.28	*
C18:3 (n-6)	0.028	0.098	0.012	0.008	0.014	0.01	-
C18:3 (n-3)	0.023	0.030	0.005	0.012	0.010	0.01	-
C20:0	0.140	0.060	0.065	0.042	0.036	0.01	-
C20:1	0.247	0.244	0.213	0.138	0.178	0.03	-
C20:3 (n-3)	0.180	0.102	0.060	0.058	0.102	0.01	-
C21:0	0.188	0.026	0.015	0.034	0.016	0.02	-
C22:1	2.725^{a}	2.442^{a}	2.527^{a}	1.722^{b}	1.832^{b}	0.11	**
ΣSFA	48.947^{ab}	48.586^{b}	48.217^{b}	47.586^{b}	50.140^{a}	0.21	**
ΣMUFA	42.660^{b}	44.414^{b}	44.275^{b}	46.948^{a}	43.818^{b}	0.38	*
ΣPUFA	7.779^{a}	6.980^{ab}	7.449^{a}	5.362^{b}	5.979^{ab}	0.27	*
(ΣMUFA+ΣPUFA)/ΣSFA	1.033^{bc}	1.059^{abc}	1.073^{ab}	1.102^{a}	0.995^{c}	0.09	*
ΣPUFA/ΣSFA	0.159^{a}	0.144^{ab}	0.154^{abc}	0.113^{c}	0.119^{bc}	0.05	*
Total cholesterol	199.799^{b}	194.143^{bc}	162.044^{d}	224.326^{a}	190.381^{c}	3.03	***

MSE: Mean Standard Error

-: Non-significant, *: P<0.05, **: P<0.01, ***: P<0.001; Means within a row with different letters differ significantly (P<0.05); SFA: Saturated Fatty Acid; MUFA: Mono-Unsaturated Fatty Acid; PUFA: Poly-Unsaturated Fatty Acid

16.08 – 21.26 and b* values as between 5.10 – 8.45 (EKIZ et. al., 2009; ESENBUĞA et. al., 2009; KARACA, 2010; YAKAN and ÜNAL, 2010).

Various researchers have shown carcass weight as the most significant factor indicating lamb carcass and meat quality (DİAZ *et al.*, 2002; VERGARA *et al.*, 1999). PEÑA *et al.* (2005) reported darkened meat color with increasing lamb carcass weights. Similar to the current findings, SAÑUDO *et al.* (2000) reported decreasing a* values and increasing L* values with decreasing carcass fat ratios.

Texture is another factor affecting meat quality. Consumers specify meat hardness as a significant quality indicator (KARACA, 2010). SHACKELFORD *et al.* (1991) reported that consumers and taste panelists indicated meats with a hardness value over 5.5 kg/cm^2 as hard meats. For Karayaka lambs in the present study, except for the SW groups of 45 kg (5.96 kg/cm^2) and 50 kg (7.29 kg/cm^2), the hardness values were within the limits specified by SHACKELFORD *et al.* (1991). Although not significant (P>0.05), increasing hardness values were observed in this study with increasing SWs (Table 2). The hardness value of entire SW groups of Karayaka lambs were lower than the values reported by ESENBUĞA *et al.* (2001) for Awassi and Red Karaman. The hardness value of 40 kg SW group of the present study were higher than those reported by EKIZ *et al.* (2009) for Merino, Ramlıç, Kivircik lambs (40-41 kg SW); and by PERLO *et al.* (2008), for Corriedale lambs (41 kg SW). Some other researchers reported the hardness values of lambs fed with concentrated feeds (24-30 SW) as between 3.35-4.01 kg/cm^2 (SANTOS-SILVA *et al.*, 2002a; EKIZ *et al.*, 2009; YAKAN and ÜNAL, 2010).

With regard to DL on 3rd and 7th days, the differences between the slaughter groups were found to be significant (P<0.001; Table 2). Increasing SWs resulted in increasing DLs on the third day. The highest DL on 3rd and 7th days was observed in the 50 kg (9.94%) and 45 kg (13.20%) weight groups.

The CL values decreased with increasing SWs (P<0.01; Table 2). Although GÖKALP *et al.* (1993) indicated lower CL values for high WHC meats, contrary results were observed in this study. EKIZ *et al.* (2009) slaughtered Merino, Ramlıc and Kivircik lambs fed with concentrated feeds at 40-41 kg weights and observed the CL, respectively as 27.14, 25.57 and 29.54%. The CL for 40 kg SW of the present study (26.11%) was higher than the value determined by EKIZ *et al.* (2009) for the same-weight Ramlıc lambs, and lower than Merino and Kivircik lambs. The CL determined for 30 kg SW groups of Karayaka lambs was similar to that reported by the same researchers for 26 kg Imroz lambs (28.91%) and higher than the value reported by Chios lambs (27.81%).

While the differences between SW groups were found to be significant with regard to CP and M contents (P<0.05), the differences in CA contents of the groups were insignificant (P>0.05; Table 3).

IF in 50 kg was similar to IF observed in all the other SW groups. The highest value was observed in the 45 kg (3.44%) groups and the lowest value was seen in the 40 kg (2.41%) SW groups. YAKAN (2008) reported a decreasing IF content in Bafra lambs with increasing SWs, with the highest value for 30 kg (4.20%) and the lowest value for 40 kg (2.80%) weight groups. The CP ratios for the Karayaka lambs in the present study were similar to the values determined by previous researchers for local, crossbred and heritage breeds of lamb (BERIAIN *et al.*, 2000; MACIT *et al.*, 2003; PERLO *et al.*, 2008; ESENBUĞA *et al.*, 2009). The LD muscle M contents of Karayaka lambs of the present study (74-76%) were similar to values reported by the other researchers for the same muscle (73-76%) (BERIAIN *et al.*, 2000; PERLO *et al.*, 2008; ESENBUĞA *et al.*, 2009).

In ruminants, almost all of the fats are localized as triglycerides in adipose, and fatty acids are localized as C16 and C18. In general, more than 80% of the fatty acids are composed of C14:0 (myristic acid); C16:0 (palmitic acid), C18:0 (stearic acid) and C18:1 (oleic acid) (KARACA, 2010). The order of those primary fatty acids in the present study was observed as C18:1, C16:0 and C18:0 in all SW groups and only the differences in the C14:0 and C18:0 fatty acids were found to be significant (P<0.05; Table 4). With regard to unsaturated fatty acids, the differences in C18:2 (n-6) (linoleic acid) and C22:1 (erucic acid) fatty acids of the weight groups were found to be significant (P<0.05). On the other hand, differences in the monounsaturated fatty acid contents of the groups were insignificant (P>0.05). The differences between the SW groups were also found to be significant, with regard to total monounsaturated fatty acids, total polyunsaturated fatty acids, total unsaturated fatty acid/total saturated fatty acid ratios and total polyunsaturated fatty acid/total saturated fatty acid ratios (P<0.05). The highest total saturated fatty acid content was observed in the 50 kg (50.14%) and the lowest in the 45 kg (47.58%) SW group. In general, a decreasing total of saturated fatty acid contents were observed with increasing SWs. While such decreases comply with the findings of some previous research (DÍAZ *et al.*, 2005; ORIANI *et al.*, 2005; YAKAN and ÜNAL, 2010), they differed from an other study (SANTOS-SILVA *et al.*, 2002b). The total unsaturated fatty acid / total saturated fatty acid ratios of Karayaka lambs of the present study varied between 0.99-1.10. Such values were reported in previous studies as between 0.09 – 0.95 for the lambs fed with concentrated feeds (ROWE *et al.*, 1999; DÍAZ *et al.*, 2002; KARABACAK, 2007). The total unsaturated fatty acid / total saturated fatty acid ratios of the Karayaka lambs in the present study were higher than the other studies. Such differences were mainly due to differences in genotype and the age of slaughter, since

genotype, age of slaughter, gender and type of fat stores, and the anatomic location of muscles and fats are major factors affecting the fatty acid composition of meat.

The differences in cholesterol levels of the SW groups were found to be significant (P<0.001; Table 4). The highest total cholesterol level was observed in the 45 kg (224.32 mg/100 g meat), the lowest value in the 40 kg (162.04 mg/100 g meat) weight groups. YAKAN and UNAL (2010) carried out a study on Bafra lambs and reported the highest total cholesterol levels for the 45 kg (63.00 mg/100 g meat) and the lowest levels for the 35 kg (53.80 mg/100 g meat) SW groups. BUNCH *et al.* (2004) reported the total cholesterol level of Wool lambs with 46-54 kg SWs and fed with concentrated feed, as 117 mg/100 g meat; as 73 mg/100 g meat for Callpyge Wool x St. Croix lambs; 50 mg/100 g meat for Callpyge Wool x Wool lambs; 149 mg/100 g meat for Dorper x Wool lambs and 131mg/100 g meat for Dorper x St. Croix lambs. Similarly, SALVATORI *et al.* (2004) reported the total cholesterol level of extensively fed Ile de France x Parliarola and Gentile di Puglia Sopravissana lambs respectively as 63.0 and 60.3 mg/100 g meat. In another study carried out on Corriedale and Corriedale crossbreds, the total cholesterol level was reported as 62.03 for the lambs fed with concentrated feeds and as 57.76 mg/100 g meat for range-fed lambs (ROWE *et al.*, 1999). The total cholesterol values of the LD muscle of the Karayaka lambs in the present study were higher than thoses values reported by ROWE *et al.* (1999), SALVATORI *et al.* (2004) and BUNCH *et al.* (2004).

CONCLUSIONS

In conclusion, with regard to meat quality parameters, except for CA and hardness, the differences in entire traits of LD muscle of the different SW groups of Karayaka lambs of the present study were found to be significant. Increasing SWs resulted in increasing WHC and hardness values, and decreasing CL values, but the differences between the hardness values of the samples were not found to be significant. Among the fatty acids, except for C14:0, C18:0, C18:2 (n-6) and C22:1, differences in the entire fatty acid contents of SW groups were found to be insignificant.

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