Some Meat Characteristics in Karya Lambs

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Abstract. A research was conducted during 2008 and 2009 to determine meat quality characteristics in 72 male and female Karya lambs in pasture, pasture plus feeding and intensive conditions. Significant differences were obtained between fattening groups in M. Longissimus Dorsi muscle for L* (lightness) and the highest value was calculated in intensive groups and male lambs. Also the meat colour appeared redder (high a* value) in this group and their male lambs. The intermusculer fat (marbling) was evaluated better in intensive group and male lambs. Regarding fatty acid composition, while SFA and MUFA were increased in intensive conditon, C16:0 was the highest, C18:0 and C18:1 n-9 were the lowest value in pasture lambs. İt is concluded that the pasture feeding increased P/S, CLA and n-6 PUFA/n-3 PUFA values.

Keywords: Karya lamb, meat quality, meat PH, marbling, fatty acid composition

Abstrak. Sebuah penelitian dilakukan sepanjang tahun 2008-2009 untuk menentukan sifat-sifat kualitas daging dari 72 anak kambing Karya jantan dan betina, pada penggembalaan di pastura, pastura plus pemberian pakan dan kondisi intensif. Didapatkan perbedaan siknifikan antara otot longisimus dorsi yang didaptkan diantara kelompok-kelompok kambing yang digemukkan dan nilai tertinggi dihitung dari kelompok-kelompok intensif dan anak-anak kambing jantan. Juga warna daging tampak lebih merah (tinggi) pada kelompok ini dan anak-anak yang jantan. Lemak intermuskuler (marbling) dievaluasi dan ternyata lebih baik pada grup intensif dan anak-anak domba jantan. Mengenai komposisi asam lemak smentara SFA dan MUFA meningkat pada kondisi intensif, C16:0 adalah yang tertinggi, C18:0 dan C18:1 n-9 adalah yang terendah ada anak-anak kambing yang digembalakan di pastura. Disimpulkan bahwa pemberian pakan di pastura meningkatkan nilai P/S, CLA dan n-6 PUFA/n-3.

Kata kunci : Kambing Karya, kualitas daging, pH daging, marbling, komposisi asam lemak

Introduction

Sheep breeding is one of the most important factors in obtaining animal protein and red meat production. With consideration toward quality and quantity, a variety of nutrients is important for a balanced diet. One of the most important conditions for such diet is that 40 to 50% of the protein consumed daily must be of animal origin (Göğüş, 1986).

There primary factors affecting the meat quality are animal-related factors (breed, sex, age) and environmental factors (fattening conditions, climate, slaughter procedures). Most studies report that there are differences between the carcass and the meat quality (color, pH, marbling, etc.) with pasture feeding and concentrated feeds in lambs (Priola et al., 2001). In general, lamb meat is accepted by the consumers as a natural product with unique characteristics and a known effect on human health, but the price is considered expensive (Beriain et al., 2000).

Fresh meat (newly slaughtered) is non-durable with less taste and an adhesive structure. The most important change is rigor mortis, which is a chain of events that starts spontaneously 5 to 6 hours after slaughtering and continues 6 to 12 hours in lambs. During rigor mortis, the muscle hardens and the pH drops, depending on the glycogen degradation. If the animal is slaughtered in unstressed conditions, and there is a sufficient amount of muscle glycogen, the pH drops to a normal level (5.5), and rigor mortis is shaped exactly. In

stressed animals, however, the pH drops below a normal level, and glycogen is quickly broken down during the slaughter. This meat is seen as pale, soft and exudative (PSE). If glycogen content is less, and pH only drops a little, the meat is seen as dark, firm and dry (DFD). Sheep meat is not affected like beef and pork meat, but pH changes after the slaughter have important effects on organoleptic (color, taste, juiciness, etc.) and technological (water holding capacity, shelf life, etc.) properties (Öztan, 2005).

Meat color is also an important element. Color changes occur because of myoglobin content; myoglobin absorbs and light reflection of certain wavelengths (Arslan, 2002). Meat color change also occurs as the chemical reaction of myoglobin, when combined with pH and oxidation, results in formations of oximyoglobin and metmyoglobin (Öztan, 2005). Based on the combination of the animal's age and the increasing amounts of myoglobin, the color intensity can rise. The color of the meat is less pale in unweaned than weaned lambs because of the lower percentage of iron content in the milk (Horcada vd., 1998). Differences in meat color are also inevitable due to fattening procedures. In general, animals fed on pasture are seen as having darker meat (Priola et al., 2001).

Meat has an important role in human health in terms of fatty acid composition. For the last 50 years, meat and dairy products have gained a negative image for consumers because of cholesterol, total fat and fatty acid content. In recent years there has been an increased interest in ways to manipulate the fatty acid composition of meat. Meat is seen to be a major source of fat in a diet. Saturated fatty acids, in particular, have been implicated in diseases, such as various cancers and coronary heart disease, associated with modern life, especially in developed countries. Also in recent years, development in CLA (conjugated linoleic acid), or ruminant fat, has occurred. Researchers reported that CLA reduces the formation of some types of cancer (Zyriax and Windler, 2000; Wood et al., 2003).

Another important feature of meat is marbling. Marbling occurs when fat is dispersed between muscle fibers, giving the meat a mosaic-like appearance. Meat taste and ripening are also related to marbling. Good marbling shows a better taste and a riper meat, which is more easily degradable, soft and juicy (Öztan, 2005).

Materials and Methods

Material

In total, 72 male and female Karya lambs (36 heads each year) were used as the material for this research. The lambs were fattened at Adnan Menderes University in the Agricultural Faculty's Sheep Breeding Unit within ADÜ-GKYP (Adnan Menderes University – Group Sheep Breeding Programme). The feed that was used for fattening was provided by a special feed factory.

Method

The sheep were synchronized with an intravaginal sponge and PMSG during the mating period. After birth, the lambs were placed in a controlled environment and were divided into three groups according to the breeding conditions in Aydın and the methods of Akçapınar et al., (2002); Küçük et al., (2002); Sanudo et al., (1998b); and Santos-Silva et al., (2002a, 2002b). Twelve lambs were used in each group each year. The first group was raised with their mothers from birth to the age of 4.5 months, and they weren't given additional feed. The second group was subjected to additional feeding and suckling. After being weaned, the third group was fattened in individual sections using an intensive system. After the fattening period (70 days), the lambs were slaughtered in a special

meat factory. Following the slaughter, the carcasses were put into cold storage at +4°C for a period of 24 hours. At the end of this period, *Musculus longissimus dorsi* (MLD) section areas, the region between the 12th and 13th ribs from the left half of the carcass, and the pH, color, marbling and fatty acid composition were determined. pH measurements were performed using the IQ 240 model pH-meter. The measurements were made immediately after the slaughter and after 24 hours. Minolta CR-400 spectrocolorimeter devices were used for the color measurements in this research. The measurements were made according to the CIELAB (1986) color scale, and the results were determined according to L* (lightness), a* (redness) and b* (yellowness). The meat samples were taken from *M. longissimus dorsi*, which was packaged as airtight and stored at 18^{o}C for fatty acid analysis. The fatty acid composition was determined by gas chromatography as reported in the method of Tokuşoğlu (2005). This method is YAME (Fatty Acid Methyl Esters in Meat and Meat Products). The marbling appeared in the intramuscular fat and was determined subjectively.

Results and Discussion

pH, Color and Marbling

The findings related to the pH, color and marbling properties are shown in Table 1. There were important differences between the groups and the years for the pH_0 obtained during the slaughter time in hot carcasses and the pH_{24} obtained after the slaughter in cold carcasses. The mean pH_0 and pH_{24} values were 6.58 and 5.72, respectively. pH is an important factor at every stage of the production of meat and meat products. Generally, a normal pH_{24} level is 5.6 - 6.2. The degree of maturation and the water holding capacity increase with a high pH level. However, the color of the meat is defective at a high pH. In contrast, meat is not consumed as fresh meat at a low pH level. In this research, pH_0 and pH_{24} were determined to be normal, which showed that the animals were not stressed and that the slaughter procedure and biochemical reactions occurring after the slaughter were normal.

There were important differences between the groups judged for the L* (lightness) value ($P<0.01$); this parameter was affected by cold carcass weight negatively ($P<0.05$). While the lightness value was measured at the highest value in the third group (39.54), it was at the lowest level in the first group (36.02). These values were 37.37 and 38.59 in male and female lambs, respectively. For this reason, the darker meat was shown as belonging to pasture-fed lambs. On the other hand, there were no statistically important differences between the groups, sex and years for the a* (redness) value; they were 12.89, 12.50 and 12.96 in the groups, respectively. The red color was more intense in high a* values, and the meat obtained in the intensive group was also redder. The b* (yellowness) value was indicated for fat color; if the value was high, the fat color was yellow. In this research, there were important differences between the groups and the years for b*. The marbling point was higher in male and intensive groups, but the differences between these were not statistically significant. In general, the meat color was darker and redder in pasture-fed animals due to the animals' activity and the content available in the pasture. While the meat color was brighter and lighter in the intensive system group, the marbling was at a higher level.

In terms of the other research carried out for the lambs, the values were seen differently. L* values were observed at 42.72, 42.11, 42.02, 42.45 and 41.85, a* values were 17.50, 17.31, 19.23 and 17.95, and b* values were 8.45, 8.15, 8.65, 8.30 and 7.71 in Turkish Merino, Ramlıç, Kıvırcık, Sakız and İmroz lambs, respectively. pH_{24} changed between 5.63 and 5.70 in this research, and there were no important

Table 1. The least-squares means and standard errors of pH, color ve marbling

FACTORS	N	pH_0	pH_{24}	L* (Lightness)	a* (Redness)	b* (Yellowness)	Marbling Point	Marbling Shout
Year		*	*			***		
2008	18	6.70±0.08	5.77±0.03	37.75±0.49	12.66±0.89	5.29±0.27	1.88±0.21	288.34±20.83
2009	18	6.47±0.08	5.67±0.03	38.21±0.49	12.91±0.89	1.31±0.27	2.08±0.21	306.11±20.83
Group		*	*	**		*		
1 (Pasture)	12	6.34±0.10	5.61±0.04	36.02±0.67	12.89±1.21	2.59±0.37	1.92±0.28	291.67±28.35
2 (Pas+ feed.)	12	6.69±0.10	5.80±0.04	38.38±0.64	12.50±1.16	3.30±0.36	1.85±0.27	285.47±27.11
3 (İntensive)	12	6.72±0.09	5.74±0.04	39.54±0.61	12.96±1.09	3.99±0.34	2.15±0.26	314.53±25.69
Sex								
Male	18	6.55±0.08	5.69±0.03	38.59±0.49	12.99±0.89	3.23±0.27	2.06±0.21	306.07±20.83
Female	18	6.62±0.08	5.75±0.03	37.37±0.49	12.58±0.89	3.36±0.27	1.88±0.21	288.37±20.83
Reg. (Lin)			*	*				
Cold C.W.			0.025±0.01	-0.38±0.15	-0.05±0.28	-0.02±0.08	0.04±0.06	4.12±6.13
General	36	6.58	5.72	37.98	12.78	3.30	1.97	297.22

*P<0.05, **P<0.01, ***P<0.001

Differences between the breeds (Ekiz et al., 2009). L*, a* and b* values were obtained at 42.08, 20.17 and 5.89 in İvesi and Morkaraman lambs, respectively, and there were no important differences between the animals in terms of marbling (Esenbuğa et al., 2009). Many studies of the meat quality (pH, color and softness, etc.) of male and female lambs did not have statistically significant differences. The pH_{24} value was observed in male and female lambs at 5.74 and 5.60, respectively, and L* and a* values were 13.8 and 33.2 in Texel crossbreeds (Johnson et al., 2005). In addition, the meat color was viewed as darker in research related to male Ile de France lambs, while L*, a* and b* values were determined at 46.1, 7.60 and 9.79 and 49.23, 7.35 and 10.71 in the pasture and the intensive system groups, respectively; pH_{24} was between 5.46 - 5.75 (Priola et al., 2002). Meat color was determined to be darker in the intensive system in Skuddo lambs, and L* values were measured at 30.3 and 36.5, respectively, between the groups (Nuernberg et al., 2008). Color, pH, moisture and intramuscular fat characteristics were affected by slaughter weight and sex in Merinos (Tejeda et al., 2008).

Many factors (age, sex, breed, breeding system, slaughter process, muscle type and pH) can be effective in determining the color of the meat. The results are affected more by the research methods and the correlation between the properties. The results obtained in other research studies on similar subjects are different, and it is difficult to identify clear ideas on the subject.

Fatty acid composition

The results of fatty acid composition are provided in Table 2. There were significant differences between the groups. While the C10:0, C12:0, C14:0, C15:0, C16:0, C16:1 n-7, C20:0, C22:0 and C24:0 were at the highest level in pasture group, C17:0, C17:1 n-9, C18:0 and C18:1 n-9 were high in the intensive system. There were no important differences between the sexes except for C22:1 n-9. While the highest levels were found in C16:0, C18:0 and C18:1 n-9, these fatty acids were 80% of the total fatty acid composition. C16:0 were measured at 27.57%, 26.75% and 26.71%; C18:0 were measured at 14.08%, 16.28% and 18.48%; C18:1 n-9 were measured at 36.51%, 36.55% and 38.21%, respectively, between the groups.

The mean value of SFA (saturated fatty acid) was 53.81%, and this parameter was affected by the year (P<0.001). SFA was measured at its lowest value in the intensive system. The mean values of MUFA (monounsaturated fatty acid) and PUFA (polyunsaturated fatty acid) were

41.03% and 4.81%, respectively. While the MUFA was found to be at its highest level in the third group, PUFA was at its highest level in the second group. There were no important differences for the P/S between the groups and the sexes. Also, n-6 PUFA, n-3 PUFA and n-6 PUFA/n-3 PUFA were not affected by the considered factors.

In the past, red meat has gained a negative image based on its fatty acid content. The meat is most positively affected by pasture feeding. Significant differences were not found between the groups for MUFA and PUFA in this study, but the pasture feeding system affected these parameters. The feeding system affects higher fatty acid levels. For example, while milk feeding increased the C14:0 and C16:0, C18:3 pasture feeding raised the C18:3 fatty acid (Berian et al., 2000).

The results obtained in this study are compatible with other lamb meat-related research. For example, while C16:0, C18:0 and C18:1 were found to be 20.4%, 20.2% and 36.4% in pasture feeding, the same fatty acids were found at 19.7%, 17.9% and 34% in the intensive system. The P/S was calculated at 0.26 and 0.16, respectively, for the feeding system (Demirel et al., 2006). C16:0, C18:0 and C18:1 were found to have the highest value in total fatty acid composition in lamb meat bought in the market; the values were 24.2%, 14.4% and 41.9%, respectively. Also, SFA, MUFA and PUFA were 41.5%, 46.7% and 11.6%, respectively (Vatansever and Demirel, 2009). Significant differences were found for C12:0 ($P<0.001$), C16:1 ($P<0.001$), C17:0 ($P<0.01$), C17:1 ($P<0.05$), C18:1 ($P<0.01$), C20:0 ($P<0.01$) and C22:0 ($P<0.01$) in male and female Manchego lambs (Diaz et al., 2003). While the CLA level was raised in pasture feeding, the n-6 PUFA/n-3 PUFA level was decreased. C12:0, C14:0, C16:0, C18:1 t-11, C18:3 n-3, SFA and PUFA were found to be at the highest level in pasture-fed Scuddo lambs (Nuernberg et al., 2008). While C16:0 was 22.93% - 23.79%, C18:1 n-9 was 36.87% - 38.04%, SFA was 46.16% - 44.04%, MUFA was 40.35% - 41.19% and PUFA was 13.47% - 14.40% in male Merinos lambs in the intensive system, the same properties were 22.40% - 23.19%, 34.54% - 37.28%, 43.75% - 44.69%, 37.97% - 40.65% and 18.26% - 14.65% in females, respectively (Tejeda et al., 2008). C12:0 ($P<0.05$), C16:0 ($P<0.001$) and C18:1 n-9 ($P<0.001$) were found to be at the highest level in the intensive system in Merinos, but C18:3 ($P<.0.001$), C20:5 ($P<0.001$) and C22:5 ($P<0.05$) were found to be at the highest level in pasture feeding. The P/S was higher, and n-6 PUFA/n-3 PUFA was lower in the pasture group. Also, the CLA was superior in pasture feeding (Scerra et al, 2007).

There are many factors that affect the quality of sheep meat. These factors are animal-related (breeds, sex and age) and environmentally related (feeding practices, climate, slaughter procedures and hygiene). Most studies reported that there were differences in the carcass and meat quality in lambs fed with concentrated feed or on pasture. The basic differences are the meat color, final pH, smoothness, flavor, nutrient composition and fat distribution.

There were important differences between the groups for the L* value in *M. longissimus dorsi* in this study. The darkest color of meat belonged to females and animals fed on pasture. The a* value showed the redness of the meat; redder meat belonged to male lambs and animals fed on the intensive system. The marbling occurred in the intramuscular fat, and there were no important differences between the related factors.

In this research there were significant differences between the animal groups in terms of fatty acid composition. The highest values were C16:0, C18:0 and C18:1 n-9, and these fatty acids were 80% of the total fatty acids. While C16:0 was highest in the pasture group,

and C18:0 and C18:1 n-9 were at the lowest value, C18:0 and C18:1 n-9 were at the highest in the intensive system. The SFA value (52.68%) was the lowest in the intensive group, and any differences were due to the sex of the animal. While MUFA was calculated at the highest value (42.53%) in the third group, PUFA was determined to be the highest in the second group. The P/S value did not affect the factors. Additionally, while n-6 PUFA/n-3 PUFA

Table 2. The least-squares means and standard errors of fatty acid composition

Properties	Classification: Year		Classification: Group			Classification: Sex		Reg. (Lin)	General
	2008 (n=18) $\overline{X}\pm S_{\overline{X}}$	2009 (n=18) $\overline{X}\pm S_{\overline{X}}$	1 (n=12) $\overline{X}\pm S_{\overline{X}}$	2 (n=12) $\overline{X}\pm S_{\overline{X}}$	3 (n=12) $\overline{X}\pm S_{\overline{X}}$	Male (n=18) $\overline{X}\pm S_{\overline{X}}$	Female (n=18) $\overline{X}\pm S_{\overline{X}}$	Cold Carcass Weight (kg)	
C10:0	0.88±0.12	0.45±0.12*	0.84±0.16	0.67±0.16	0.48±0.15	0.77±0.12	0.55±0.12	-0.13±0.03***	0.66
C12:0	0.96±0.11	0.61±0.11*	1.22±0.16	0.79±0.15	0.36±0.14**	0.91±0.11	0.67±0.11	-0.10±0.03**	0.79
C14:0	5.68±0.51	6.15±0.51	7.93±0.69	6.10±0.66	3.71±0.63***	6.07±0.51	5.76±0.51	0.14±0.15	5.91
C15:0	0.57±0.03	0.85±0.03***	0.79±0.04	0.71±0.04	0.62±0.04*	0.75±0.03	0.67±0.03	-0.03±0.01	0.71
C16:0	25.82±0.56	28.20±0.56**	27.57±0.76	26.75±0.72	26.71±0.69	27.10±0.56	26.92±0.56	0.31±0.06	26.98
C16:1 n-7	2.64±0.14	3.72±0.14***	3.30±0.18	3.11±0.18	3.13±0.17	3.26±0.14	3.10±0.14	0.12±0.04**	3.18
C17:0	1.18±0.08	1.63±0.08	1.12±0.11	1.28±0.11	1.82±0.10***	1.32±0.08	1.49±0.08	-0.01±0.02	1.41
C17:1 n-9	0.64±0.05	0.93±0.05***	0.68±0.06	0.72±0.06	0.96±0.06**	0.78±0.05	0.80±0.05	0.02±0.01	0.79
C18:0	15.78±0.67	16.78±0.67	14.08±0.92	16.28±0.88	18.48±0.83**	15.89±0.67	16.67±0.67	-0.65±0.20**	16.28
C18:1 n-9	39.36±0.75	34.15±0.75***	35.51±1.02	36.55±0.97	38.21±0.92	36.10±0.75	37.41±0.75	0.69±0.22**	36.74
C18:2n-6	3.56±0.21	3.54±0.21	3.33±0.30	3.78±0.28	3.53±0.27	3.74±0.22	3.37±0.22	-0.15±0.08*	3.55
C18:3 n-3	0.81±0.08	0.84±0.08	0.79±0.10	0.88±0.09	0.78±0.09	0.87±0.08	0.78±0.08	-0.02±0.02	0.82
C20:0	0.24±0.09	1.26±0.09***	1.05±0.12	0.72±0.12	0.29±0.11***	0.68±0.09	0.69±0.09	0.02±0.03	0.70
C20:1 n-9	0.24±0.03	0.20±0.03	0.23±0.04	0.25±0.03	0.18±0.03	0.25±0.03	0.20±0.03	-0.18±0.01*	0.22
C22:0	0.30±0.08	0.16±0.08	0.32±0.11	0.22±0.11	0.15±0.10	0.31±0.08	0.15±0.08	-0.05±0.02*	0.23
C22:1 n-9	0.06±0.01	0.11±0.01*	0.09±0.02	0.12±0.02	0.05±0.02	0.12±0.01	0.06±0.01**	-0.02±0.01***	0.09
C24:0	0.11±0.06	0.13±0.06	0.19±0.08	0.11±0.08	0.07±0.08	0.18±0.06	0.06±0.06	-0.02±0.02	0.12
CLA	0.44±0.02	0.43±0.02	0.51±0.03	0.53±0.03	0.28±0.03***	0.45±0.02	0.43±0.02	0.01±0.01	0.44
SFA	51.53±0.84	56.10±0.84***	55.12±1.15	53.64±1.10	52.68±1.04	54.00±0.84	53.63±0.84	-0.49±0.25	53.81
MUFA	42.95±0.79	39.11±0.79**	39.81±1.08	40.75±1.03	42.53±0.98	40.50±0.79	41.56±0.79	0.79±0.23**	41.03
PUFA	4.82±0.27	4.81±0.27	4.63±0.36	5.20±0.35	4.61±0.33	5.06±0.27	4.57±0.27	-0.16±0.08*	4.81
P/S	0.09±0.01	0.09±0.01	0.08± 0.01	0.10±0.01	0.09±0.01	0.10±0.01	0.09±0.01	-0.02±0.01	0.09
n-6 PUFA	3.58±0.22	3.54±0.22	3.33±0.30	3.78±0.28	3.53±0.27	3.74±0.22	3.37±0.22	-0.15±0.06*	3.55
n-3 PUFA	0.81±0.08	0.84±0.08	0.79±0.10	0.88±0.10	0.80±0.10	0.87±0.08	0.78±0.08	-0.02±0.02	0.82
n-6 PUFA/ n-3 PUFA	4.97±1.09	5.94±1.09	4.53±1.48	4.73±1.41	7.10±1.34	5.31±1.09	5.60±1.09	-0.13±0.32	5.03

*P<0.05, **P<0.01, ***P<0.001

C10:0 Capric acid
C16:1 n-7 Palmitoleik acid
C18:1 n-9 Oleic acid
C22:0 Behenic acid
SFA Saturated fatty acid
C12:0 Lauric acid
C17:0 Heptadecanoic acid
C18:2 n-6 Linoleic acid
C22:1 n-9 Erusic acid
MUFA Monounsaturated fatty acid
C14:0 Miristic acid
C17:1 n-7 Cis10 Heptadecanoic acid
C18:3 n-3 Alfa Linolenic acid
C24:0 Lignoseric acid
PUFA Polyunsaturated fatty acid
C18:0 Stearic acid
C15:0 Pentadecanoic acid
CLA ConjugatedLinoleic acid
P/S Unsatureted/Saturated
C16:0 Palmitic acid
C18:1 n-9 Trans-Elaidic acid
C20:1 n-9 cis11 Eicosenoic acid

considered was 7.10 in the intensive system, it was 4.53 in pasture feeding. The CLA was raised in pasture feeding.

In recent years, the most important reason behind the concern for the amount of fat and fatty acids in meat and meat products is that these products have an important role in diets, and fatty acids are associated with some diseases. All saturated fatty acids found in meat are not related to heart and vascular disorders, as reported. Red meat includes lower rates of SFA and higher rates of MUFA and PUFA, despite what was commonly and previously thought, and this study demonstrates the difference. In general, the most studied aspect of the formation of fatty acid composition is feeding practice. However, protein development must be taken into consideration when changing the composition of fatty tissue, and raw materials used in the rations should be well adjusted. Nutritional requirements must be taken into account, and the properties of the body and muscle development should be avoided in target animals.

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