The effect of breed on instrumental meat quality traits of weaning kids from Turkish indigenous goat breeds

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SUMMARY

Introduction - Meat quality has always been very important to the consumer due to its can affect consumer preferences. The indigenous goat breeds is an important source of meat production source for Turkey. Nevertheless, meat quality characteristics of Turkish native sheep breeds are virtually unknown for native goat breeds, especially among those that are reared for their meat.
Aim - The aim of the study was to determine the effect of breed on instrumental meat quality characteristics in Longissimus-dorsi (LD) and Semitendinosus (ST) muscles from weaning male kids born to Angora, Hair, Honamli and Kilis Turkish indigenous pure goat breeds.
Materials and methods - Angora (n=6), Hair (n=6), Honamli (n=6) and Kilis (n=6) kids were slaughtered at 3 months of weaning age and Longissimus-dorsi (LD) and Semitendinosus (ST) muscles samples were collected to determine meat quality characteristics. Meat quality characteristics was assessed by instrumental analysis.
Results - A significant breed effect was observed for some instrumental measurements of meat quality (pH, drip loss, cooking loss, frozen-thawing loss, water holding capacity, shear force and color characteristics) in LD and ST muscles ($p<0.05$). Total protein content in LD and ST muscles were similar between kids, but effect of breed on dry matter, ash and intra-muscular fat was significant in LD and ST muscles ($p<0.05$).
Discussion - Meat quality traits of kids born to Turkish native goat breeds differ and this result may be sourced due to variety in growth or development and distribution of fat deposits among breeds studied.
Conclusions - It was concluded that there is a measurable effect of breed on meat quality characteristics and chemical composition in weaning male kids born to Turkish indigenous goat breeds. Differences in meat quality characteristics among breeds may be help production of alternative kid meat or might be used to offer kid meat for consumers with different demand.

KEY WORDS

Goat, native breeds, kid, meat quality, longissimus-dorsi, semitendinosus.

INTRODUCTION

Meat has always been very important food to the consumer due to its essential nutrients[1]. Moreover, quality characteristics of meat from meat-producing animals can affect consumer preferences[2]. With rising income levels in developing countries, the consumption of animal origin protein, especially red meat consumption is increasing day-by-day[3]. Additionally, nowadays consumers prefer meat with better quality such as lean, easy cooked (less tender) and more delicious[4]. Red meat demand has been increased with economic developments in Turkey, but the consumption of goat meat has continuously decreased probably due to low organoleptic quality, low supply and unattainable price in especially kids meat.

Turkey has more than 10 million goats and its known 17 different breeds and types, which well suited to the harsh climatic conditions, poor pasture that are the characteristics of rocky and rugged the hills and uplands areas and resistant to most local diseases[5,6]. Therefore, the native goat breeds have significant potential as an important red meat production source for Turkey. The most commonly raised native goat breeds in Turkey are Angora, Hair, Honamli and Kilis. Therefore, these breeds constitutes nearly 92% of the goat population in the Turkey[5,6]. Angora goat breed is reared for fibre production and the only true producer of mohair in the world, additionally this breed use for milk and meat production[5]. Hair goats are remarkable differences in their body sizes and they are bred mainly for meat and milk production[5]. Honamli and Kilis goats breeds are reared for their meat, milk, and wool[5,6].

Dhanda et al.[7] and Santos et al.[8] reported that breed or genotype is one of the most important factors affecting kids meat quality. Moreover, indigenous breeds constitutes a large part of goatherds for meat production in many Mediterranean countries. Additionally, the breeding of goat is carried out under extensive conditions, in which there is no additional or supplementary feeding practices[5]. Therefore, it is possible to offer meat with different properties such as less tender, lean or not by the determination of meat quality traits obtained from native goat breeds. Knowledge related to carcass

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characteristics and meat quality in low weight weaning kids from Turkish native goat breeds is limited. To take advantage of the different schemes of breed utilization, the carcass and meat quality characteristics of the native breeds should be known. Numerous studies have examined meat quality characteristics of Turkish native sheep breeds[2,9], but there is little data from comparative studies for meat quality of kids from Turkish native goat breed.

The present study was, therefore, conducted to comparatively determine meat quality characteristics in Longissimus-dorsi (LD) and Semitendinosus (ST) muscles from weaning male kids born to Angora, Hair, Honamli and Kilis Turkish indigenous goat breed.

MATERIAL AND METHODS

The experimental procedures were approved by the Local Animal Care and Ethics Committee of Kır ehir Ahi Evran University, Kırşehir, Turkey, ensuring compliance with EC Directive 86/609/EEC for animal experiments. A total of 24 male kids of Angora (n=6), Hair (n=6), Honamli (n=6) and Kilis (n=6) breeds were used as experimental animals. Kids were obtained from the national sheep and goat-breeding project in Ankara (Angora), Tokat (Hair), Antalya (Homanlı) and Kilis (Kilis) provinces of Turkey. Each breed were raised in different locations and all kids were born in same breeding season (between May-August, 2016). Management and feeding procedures for all kids were similar until weaning. Following the kidding period, all kids were kept with their dams indoors in multiple boxes until 90 days of weaning age. Kids were fed with does milk yet we were not able to measure the amount of milk consumed by the kids. Also, some good quality alfa alfa hay were present free by the 3rd week after birth in the barn for the kids. Two weeks onwards kidding, does grazed during daytime and met with the kids at night in the barn in order to allow them to suckle until weaning. Kids were slaughtered in different abattoirs with similar conditions, according to the standard commercial slaughtering procedures, at 90 days of weaning age, which is the usual end-user preference about the slaughter age in the region. None of the kids were fed overnight (approximately 16 h) before the slaughter process. Then, all kids were transported to an abattoir in their location.

Following slaughter, the carcasses of all kids were chilled for 24 h at 4°C. After chilling, approximately 150-200 g muscle samples were collected from the central parts of the mid-section of the whole LD and ST muscles, which were taken from the left side of the carcasses, to determine the meat quality traits. These samples were trimmed of subcutaneous fat and fascia. After homogenizing of muscle samples, dry matter, total protein (N × 6.25), intramuscular fat and ash contents were analyzed according to AOAC[10] (1990) procedures. The water holding capacity and frozen-thawing loss of meat samples were determined as described by Aksoy et al.[1]. Water holding capacity (approximately 25 g meat samples) were determined by the filter-paper press method. Approximately 50 g meat samples from both muscles were vacuum packed and stored -20°C for one week to evaluate thawing loss values. The meat sample packages were thawed under tap water, and then the thawing loss values were expressed as a percentage of initial weight prior to freezing. To determine the drip loss percentage of the meat samples, approximately 50 g of each muscle were vacuum-packaged and stored at 4°C. The drip loss values were measured on the 3rd and 7th days of storage. The muscle samples were put in plastic bags and cooked for 40 min in a water bath with at 70°C constant temperature. Following the cooking step, the samples were cooled under tap water. The cooking loss values were calculated as % of weight loss. Shear force values of cooked samples (cut parallel to the muscle fibres with a cross section of 2 × 2 cm) were determined using a Texture Analyzer, (CT3, Brookfield Co., USA).

The pH value was determined using the meat pH meter with a puncture electrode (Testo 205, Lenzkirch, Germany) at 1 h and 24 h postmortem. Lightness (L*), redness (a*) and yellowness (b*) value of the meat samples were measurement of color by using a Chroma Meter (Konica Minolta CR-410, Minolta Co., Ltd., Osaka, Japan) at 1 h and 24 h postmortem. Chroma [C*, the square root of $(a^{*2} + b^{*2})$] and hue angle [H°, $\tan^{-1}(b^*/a^*)$] were also calculated according to Sen et al.[2] at 24 h post-mortem. Color difference (ΔD) was calculated using the following formula: $\Delta D = [(L_1^* - L_2^*)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2]^{1/2}$, where L_1^*, a_1^* and b_1^* represent color parameters measured at 1 h, and L_2^*, a_2^* and b_1^* represent color parameters measured at 24 h post-mortem[2].

The total protein, ash and intra-muscular fat content was determined as a percentage of dry (samples were retained 12 h at 105°C) meat samples weight. Water holding capacity, drip loss, cooking loss and frozen-thawing loss was determined as a percentage of fresh meat samples weight. Mean pH, color characteristics and shear force data from six measurements of each sample were used in the data analysis.

The statistical analysis was conducted on completely randomized design for traits. The statistical analyses were performed using SPSS 17.0 package program (SPSS, Chicago, IL, USA). Significant differences between means were tested by Duncan's multiple comparison tests. Results were computed as mean ± SE and statistical significance was determined at the level of $p<0.05$.

RESULTS

The pH values, drip loss, cooking loss, frozen-thawing loss, water holding capacity and shear force of LD and ST muscles from male kids born to Turkish indigenous goat breeds are given in Table 1.

The pH values of LD and ST muscles in Hair (except for LD muscle at 24 h postmortem) and Angora kids was higher ($p<0.05$) than Kilis and Honamli at 1 h and 24 h postmortem. Additionally, pH drop from 1 h to 24 h postmortem in LD and ST muscles were relatively higher in Kilis kids compared to other breeds ($p<0.05$). In the present study, there were significant differences among kids born to Angora, Hair, Honamli and Kilis breeds in terms of drip loss, cooking loos, frozen-thawing loss and water holding capacity ($p<0.05$). Angora kids had lower percentage of drip loss in LD muscle, but Kilis kids had higher percentage of drip loss in ST muscle on day 3 compared to other breeds ($p<0.05$). Kilis and Honamli kids had higher percentage of drip loss in LD muscle and also Kilis kids had higher percentage of drip loss in ST muscle on day 7 compared to other breeds ($p<0.05$). Percentage of cooking loss in Hair kids was higher

Table 1 - The pH, drip loss, cooking loss, frozen-thawing loss, water holding capacity and shear force values of Longissimus-dorsi (LD) and Semitendinosus (ST) muscles from male kids born to Turkish indigenous goat breeds.

Traits	Muscles	Kilis	Honamli	Hair	Angora
pH					
1 h	LD	6.10 ± 0.11^{b}	6.14 ± 0.12^{b}	6.57 ± 0.13^{a}	6.99 ± 0.07^{a}
	ST	6.18 ± 0.06^{b}	6.16 ± 0.13^{b}	6.51 ± 0.14^{a}	6.56 ± 0.04^{a}
24 h	LD	5.46 ± 0.01^{b}	5.68 ± 0.14^{b}	6.15 ± 0.07^{ab}	6.64 ± 0.05^{a}
	ST	5.46 ± 0.01^{b}	5.62 ± 0.12^{b}	6.21 ± 0.07^{a}	6.23 ± 0.05^{a}
Drop	LD	0.64 ± 0.11^{a}	0.47 ± 0.04^{b}	0.42 ± 0.02^{b}	0.35 ± 0.07^{b}
	ST	0.72 ± 0.07^{a}	0.54 ± 0.07^{ab}	0.30 ± 0.20^{b}	0.33 ± 0.06^{b}
Drip loss (%)					
3 days	LD	11.17 ± 1.94^{a}	10.81 ± 2.40^{a}	10.91 ± 0.26^{a}	6.07 ± 0.41^{b}
	ST	20.16 ± 0.73^{a}	11.97 ± 0.82^{b}	10.07 ± 1.07^{bc}	7.77 ± 0.89^{c}
7 days	LD	19.82 ± 2.75^{a}	18.21 ± 1.34^{a}	13.71 ± 0.13^{b}	13.26 ± 0.86^{b}
	ST	38.90 ± 11.2^{a}	21.23 ± 1.83^{b}	17.89 ± 1.39^{bc}	16.17 ± 1.11^{bc}
Cooking loss (%)	LD	23.13 ± 1.40^{b}	29.29 ± 3.16^{ab}	34.61 ± 1.44^{a}	22.86 ± 1.49^{b}
	ST	30.44 ± 2.82^{b}	28.49 ± 4.02^{b}	36.84 ± 2.69^{a}	28.95 ± 2.36^{b}
Frozen-thawing loss (%)	LD	6.21 ± 0.74^{a}	5.23 ± 0.52^{a}	6.72 ± 0.39^{a}	3.77 ± 0.53^{b}
	ST	8.67 ± 0.34^{a}	6.34 ± 1.75^{ab}	4.89 ± 0.26^{b}	4.71 ± 0.31^{b}
Water holding capacity	LD	28.18 ± 0.31^{a}	29.20 ± 1.73^{a}	25.99 ± 0.97^{a}	13.38 ± 1.06^{b}
	ST	27.94 ± 0.73^{a}	30.12 ± 0.60^{a}	28.16 ± 1.14^{a}	18.23 ± 0.69^{b}
Shear force (kg/cm^2)	LD	9.92 ± 0.58^{a}	9.23 ± 0.95^{a}	9.62 ± 0.51^{a}	4.25 ± 0.21^{b}
	ST	15.02 ± 1.35^{a}	13.48 ± 2.57^{a}	12.12 ± 1.85^{a}	7.11 ± 0.89^{b}

$^{a, b, c}$ = The differences indicated by different letters on the same line are significant.

than those of other breeds (except for Honamli kids in LD muscle) in both muscles ($p<0.05$). Angora kids had lower percentage of frozen-thawing loss than those of other breeds in LD muscle ($p<0.05$). Frozen-thawing percentage of Angora kids in ST muscle were similar with Hair and Honamlı kids, but they had lower percentage of frozen-thawing loss than those of Kilis kids ($p<0.05$). Similarly, shear force and water holding capacity values of Angora kids was lower compared to other breeds in both muscles ($p<0.05$).

The color characteristics of LD and ST muscles from male kids born to Turkish indigenous goat breeds are given in Table 2.

In the present study, Angora kids had lower ($p<0.05$) lightness (L*) value than those of other breeds (except for Hair in LD muscle), but Kilis kids had higher ($p<0.05$) L* value than those of other breeds (except for Hair in LD muscle) in LD and ST muscles at 1 h and 24 h postmortem. Hair kids had higher ($p<0.05$) redness (a*) value than those of Kilis in both muscles at 1 h and 24 h postmortem. The yellowness (b*) value of Angora kids were lower ($p<0.05$) than those of other breeds (except for Hair) in LD muscle, but Hair kids had higher ($p<0.05$) b* value than those of other breeds (except for Honamli) in ST muscle at 1 h postmortem. Angora kids had lower ($p<0.05$) b* value than those of other breeds in both muscles at 24 h postmortem. Chroma (C*) value of Hair kids were higher ($p<0.05$) than those of other breeds (except for Honamli) in LD muscle at 24 h postmortem. Similarly, Hair and Honomli kids had higher ($p<0.05$) C* value than those of Kilis and Angora in ST muscle at 24 h postmortem. Angora kids had lower hue angle (H°) value than kids born to other breeds (except for Hair in ST muscle) in both muscles at 24 h postmortem. Meat color difference (ΔD) of Angora kid were lower ($p<0.05$) in LD muscle compared to other breeds (except for Honamli), but Kilis kids had higher ($p<0.05$) ΔD value in ST muscle compared to other breeds at 24 h postmortem.

The chemical composition of LD and ST muscles from male kids born to Turkish indigenous goat breeds are given in Table 3. There were significant differences among kids born to Turkish pure goat breeds in terms of chemical composition in LD and ST muscles. Hair and Angora kids had higher ($p<0.05$) percentage of dry matter than those of Kilis and Honamli in LD muscle at 24 h postmortem. Similarly, Hair kids had higher ($p<0.05$) percentage of dry matter than those of Kilis in ST muscle at 24 h postmortem. Honamli kids had higher ($p<0.05$) percentage of ash compared to kids born to other breeds in both muscles at 24 h postmortem. There were no significant differences among kids in terms of percentage of total protein in LD and ST muscles at 24 h postmortem. Angora kids had higher ($p<0.05$) intra-muscular fat content in both muscles compare to kids born to other breeds (except for Kilis in ST muscle) at 24 h postmortem.

DISCUSSION

Breed effects on meat quality traits defined in the present study may be due to differences in breed specific differences in growth or development and distribution of fat deposits among breeds studied.

Table 2 - Color characteristics of Longissimus-dorsi (LD) and Semitendinosus (ST) muscles from male kids born to Turkish indigenous goat breeds.

Traits	Muscles	Kilis	Honamli	Hair	Angora
Lightness (L*)					
1 h	LD	45.60 ± 0.59^{a}	44.69 ± 0.73^{a}	43.22 ± 0.76^{ab}	41.53 ± 0.71^{b}
	ST	47.13 ± 0.49^{a}	46.26 ± 0.97^{ab}	44.70 ± 0.29^{b}	44.65 ± 0.34^{b}
24 h	LD	49.49 ± .98^{a}	46.85 ± 0.50^{b}	47.05 ± 0.71^{ab}	42.24 ± 0.54^{c}
	ST	53.10 ± 0.56^{a}	48.86 ± 0.76^{b}	48.31 ± 0.52^{b}	46.56 ± 0.53^{b}
Redness (a*)					
1 h	LD	16.78 ± 0.37^{b}	17.89 ± 0.26^{ab}	18.34 ± 0.30^{a}	17.93 ± 0.57^{ab}
	ST	16.75 ± 0.26^{b}	18.05 ± 0.34^{ab}	19.08 ± 0.47^{a}	18.39 ± 0.89^{ab}
24 h	LD	18.73 ± 0.44^{b}	19.36 ± 0.28^{ab}	20.35 ± 0.35^{a}	19.48 ± 0.10^{ab}
	ST	17.54 ± 0.37^{b}	19.67 ± 0.34^{a}	20.00 ± 0.33^{a}	18.44 ± 0.2^{ab}
Yellowness (b*)					
1 h	LD	6.14 ± 0.14^{a}	6.03 ± 0.34^{a}	5.51 ± 0.18^{ab}	5.00 ± 0.17^{b}
	ST	5.25 ± 0.14^{b}	5.85 ± 0.17^{ab}	6.26 ± 0.45^{a}	5.19 ± 0.18^{b}
24 h	LD	10.46 ± 0.34^{a}	9.57 ± 0.30^{a}	10.07 ± 0.31^{a}	8.42 ± 0.31^{b}
	ST	8.15 ± 0.19^{a}	9.19 ± 0.25^{a}	8.03 ± 0.70^{a}	6.41 ± 0.38^{b}
Chroma value (C*)	LD	21.46 ± 0.42^{b}	21.60 ± 0.26^{ab}	22.71 ± 0.35^{a}	21.23 ± 0.42^{b}
	ST	19.35 ± 0.32^{b}	21.73 ± 0.25^{a}	21.59 ± 0.55^{a}	19.54 ± 0.25^{b}
Hue angle (H°)	LD	29.21 ± 0.74^{a}	26.32 ± 0.85^{b}	26.33 ± 0.76^{b}	23.35 ± 0.72^{c}
	ST	24.95 ± 0.79^{a}	28.08 ± 0.92^{a}	21.70 ± 1.46^{ab}	19.12 ± 1.05^{b}
Color difference (ΔD)	LD	6.32 ± 0.68^{a}	4.59 ± 0.73^{ab}	6.45 ± 0.17^{a}	4.26 ± 0.52^{b}
	ST	6.76 ± 0.83^{a}	4.68 ± 0.43^{b}	4.47 ± 0.47^{b}	3.18 ± 0.50^{b}

$^{a, b, c}$ = The differences indicated by different letters on the same line are significant.

In the present study, the pH values were significantly different among breeds, but pH ranges in all breeds are acceptable when previous studies are evaluated[8,11,12,13]. Hair and Angora kids had higher pH than Kilis and Honamli breeds at 1 h and 24 h postmortem in LD and ST muscles. Moreover, pH drop from 1 h to 24 h postmortem in LD and ST muscles of Kilis kids higher than almost in the studied other goat breeds. The pH values at 24 h postmortem in LD muscle, in Kilis and Honamli breeds, were found similar to those founds by previous studies[11,12,13] in the different native goat breeds. Formation of severe stress associated with noise, transport, handling and slaughter may cause weight loss and a high muscle pH after slaughter in young animals[14]. Possibly, Hair and Angora breeds may be more sensitive than Kilis and Honamli breeds and highest pH value of they might also reflect differences in their responses to the stress of transport, handling, and lairage.

The water retain ability of fresh meat during application of external handling such as heating, grinding, cutting or pressing is an important indicator for meat quality[2]. Moreover, the water retain ability influence holding of vitamin and minerals that affect meat sensory properties such as juiciness and flavor as well as the volume of water retained[2,12]. Meats with poor water retention are easily and quickly drier and

Table 3 - Chemical composition of Longissimus-dorsi (LD) and Semitendinosus (ST) muscles from male kids born to Turkish indigenous goat breeds (% on dry matter).

Traits	Muscles	Kilis	Honamli	Hair	Angora
Dry matter	LD	22.56 ± 0.35^{b}	23.01 ± 0.12^{b}	24.89 ± 0.52^{a}	24.54 ± 0.47^{a}
	ST	22.94 ± 0.14^{b}	23.36 ± 0.29^{ab}	24.34 ± 0.44^{a}	23.79 ± 0.34^{ab}
Ash	LD	1.95 ± 0.13^{b}	2.91 ± 0.31^{a}	2.23 ± 0.10^{b}	1.80 ± 0.20^{b}
	ST	1.89 ± 0.06^{b}	3.39 ± 0.44^{a}	2.24 ± 0.11^{b}	2.06 ± 0.30^{b}
Protein	LD	21.99 ± 0.19	21.95 ± 0.30	23.39 ± 0.62	22.59 ± 0.43
	ST	21.87 ± 0.17	21.85 ± 0.21	22.46 ± 0.31	21.60 ± 0.39
IMF	LD	1.51 ± 0.25^{b}	1.37 ± 0.25^{b}	1.29 ± 0.10^{b}	2.12 ± 0.33^{a}
	ST	2.12 ± 0.14^{ab}	1.75 ± 0.19^{b}	1.63 ± 0.16^{b}	2.28 ± 0.12^{a}

$^{a, b, c}$ = The differences indicated by different letters on the same line are significant. IMF = intra-muscular fat.

weight loss increases during storage, transport and marketing. The water retain characteristics such as drip loss, cooking loss, frozen-thawing loss and water holding capacity in LD and ST muscles were clearly affected by breeds in the present study. Generally, the highest drip loss and cooking loss was determined in both muscles in Kilis and Hair breeds respectively, but lower water holding capacity was determined in Angora breed. Similarly, Madruga et al.[15] found significant differences among genotypes (Moxotó and Canindé) in terms of water holding capacity. However, our results for water holding capacity in both muscles were lower than results of Madruga et al.[15]. Differences among breeds in terms of cooking yield have also been reported by Schönfeldt et al.[16] and Dhanda et al.[7]. Johnson et al.[17], Dhanda et al.[7] and Sen et al.[18] have reported similar cooking losses, but Santos et al.[8] have reported lower cooking losses than the results of our study for goat meat. Differences in cooking losses among studies may be attributed to differences in age of kid, ultimate pH, cooking length, cooking temperatures and the muscles studied. Drip loss is an important indicator of meat quality[2]. Additionally, low drip loss in fresh meat indicates a high water holding capacity, greater juiciness, freshness, and a less-dry surface. The drip loss value is known to be negatively related to pH value in fresh meat but the magnitude of correlation differs between studies. Moreover, increased drip loss may be related to different factors, such as protein denaturation, sarcomere shortening and myosin denaturation[19]. Nayga et al.[20] reported that there were significant differences among goat breeds in terms of drip loss. In the present study, Kilis kids had relatively higher percentage of drip loss, while Angora kids had relatively lower percentage of drip loss values with high pH values. These observations are in agreement with the argument of Otto et al.[21], who reported high meat pH could actually be reduced drip loss. Lagerstedt et al.[22] reported that freezing decrease the meat quality and for this reason consumer prefer meat that has not been frozen. Thawing plays an important role in the processing of frozen meat due to the amount of leaking water during the thawing process, which is one of the criterias of the frozen meat quality[23]. In the present study, Angora kids had lower frozen-thawing loss with low water holding capacity. Therefore, it can be suggest that Angora meat more suitable for frozen during store compare to other Turkish native goat breed.

The evaluation of factors affecting meat tenderness is particularly important in goat meat because of its lower tenderness than sheep and beef[17]. Shear force values reported for goat meat vary considerably, depending on factors such as the treatment of the animals prior to slaughter and of the carcass post-mortem, the sampled muscle and method of sample preparation[24]. Hopkins et al.[25] indicated that shear force declines as intramuscular fat percentage increase. Moreover, previous studies reported that genotype had a significant effect on Warner-Bratzler shear force values in goat meat[8,12,26]. In the present study, tenderness were evaluated by the maximum shear force necessary to cut the meat perpendicular to the muscle fibers and it appears from present study that assessors identify differences in share force value among breeds and Angora kids had less tender meat obtained from LD and ST muscles than the other three breeds. This may be a consequence of their lower intra muscular fat contends in LD and ST muscles compared with the other breeds.

Muscle colour is extremely important in suckling kids' production whose carcasses should be pale or pink and one criterion by which consumers judge meat quality. The instrumental muscle colour values (L*, a* and b*) were significantly different among breeds at 1 h and 24 h postmortem and the meat colour from male kids born to Turkish indigenous goat breeds can be valued or classified as pale red. In the present study, L*, a* and b* colour values were affected by genotype, in agreement with Simela et al.[26] and Santos et al.[8], who studied indigenous South African and Portugal goat breeds, respectively. In the current study, the L* values in kids was lower than results of Sañudo et al.[13] in heavier animals, but a* and b* values were higher than results of same study. Redness reflects the presence of myoglobin and the availability of iron in muscles[13]. The Hair genotype displayed higher a* values (which vary in relation to haem pigment content) compare to other breeds in the present study. The main reason for this finding may probably the milk diet with low iron content received by the kids born to other breeds. These results were confirmed by results of previous studies the different level of haem pigment found among breeds[8]. Young offspring of small ruminants, especially non-weaned and fed with milk, have lightness meat. Consumers in Mediterranean countries associate meat from suckling kid as being tender, juicy, tasty and with a high price[11]. Angora genotype displayed lower L* and b* values compare to breeds, probably because these animals were fed substantially with milk, been weaned and slaughtered relatively early in the present study. Although L* can be positively correlated with myofibrilar structure and negatively with pH[27], it might have been more related to their evident paleness because of the limited amount of myoglobin[7]. Similarly, Şirin[28] reported that a positive correlation between type IIB muscle fiber number and L*, but negatively correlation with pH in LD muscle. Generally, in the both muscle of Kilis kids was higher in terms of L* values and lower in terms of a* value compare to the other kids' muscles in the present study. This could be related to its higher drip loss value and lower pH value at 24 h postmortem than those of the other kids. Similar to the findings in the present study, a significant effect of genotype on goat meat color has been reported by Madruga et al.[15] and Peña et al.[12]

Chroma (C*), which represents color saturation or purity, and hue angle (H°), defined as color wheel, with red-purple at angle 0° and 360°, yellow at 90°, bluish-green at 180° and blue at 270°, were calculated from a* and b* parameters in the present study. Marichal et al.[27] reported that muscle color characteristics and carcass weight have significant effect on muscle C* and H° values. Moreover, Teixeira et al.[29] suggested that a decrease in H° value and an increase in C* value are related with a carcass weight increase. In the present study carcass weight of kids born to Hair, Angora, Kilis and Honamli breeds were similar (data not shown), but C* and H° values was, between goat breeds, higher in the both muscles from Angora, with Kilis in terms of C* value. Although C* value is influenced less by the chemical state (oxidative process) of the myoglobin than H° value of meat[12], the difference in Chroma (C*) and hue angle values of the muscles among breeds can be attributed to enzymatic reducing system or the sensitivity to oxidative change. Unfortunately, these parameters were not investigated in the present study.

The chemical composition of carcass meat is one of the best predictors of nutrient component and meat quality[1]. Marichal et al.[27] reported that moisture ranged from 77.2 to 78.5%, total protein from 18.1 to 20.7%, intramuscular fat from 0.9 to 1.3% and ash from 1.1 to 1.2% of meat from kids with different live weights. In the present study, the dry matter (22.56%-24.89%), total protein (21.60%-23.39%), intramuscular fat (1.29%-2.28%), and ash (1.80%-3.39%) contents of LD and ST muscle samples of male kids born to Turkish indigenous goat breeds were considered as acceptable for fresh kids meat on sale. Meat chemical analysis revealed that breed had significant effect on dry matter, intramuscular fat and ash content, in the proximate composition analysis of kids born to four Turkish native goat breeds. Oman et al.[30] reported that Angora goats had lighter live and hot carcass weights than other studied goat breeds and crossbreeds (Spanish, Boer × Spanish and Spanish × Angora) when slaughtered at a given age. Moreover, in the study of Oman et al.[30] primal carcasses cuts of Angora breeds were always the fattest or among the fattest compare to other studied goat breeds and crossbreeds. In the current study intramuscular fat content in LD and ST muscles of Angora kids were higher than the studied other goat breeds. These observations are in agreement with the argument of Oman et al.[30]. Wood[31] reported that 2 to 3% of intramuscular fat is needed to ensure the organoleptic qualities of meat; therefore, Angora kids potentially presented a better intramuscular fat distribution. Dry matter percentages reported by Marichal et al.[27] were similar with our results for kids slaughtered at same live weights. Additionally, total protein and ash percentages in the present study were similar to reports of Marichal et al.[27] and Kesava et al.[32] for goat kid meat.

In conclusion, the results obtained from present study indicate that there is a breed effect on meat quality characteristics and chemical composition at weaning. Differences among Turkish indigenous goat breeds in terms of meat quality characteristics may help to promote alternative kid meat or meat products for the consumers. The obtained results are key elements in functional meat production as a key input. Additionally, meat quality parameters of all breeds were commercially acceptable for consumer and market preferences especially for Mediterranean regions.

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