Meat Quality Characteristics of Hair, Angora, Kilis and Honamli Turkish Indigenous Goat Breeds

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***Abstract*—** The study was conducted to comparison of meat quality characteristics in Longissimus dorsi (LD) muscle from kids born to Hair, Angora, Kilis and Honamli Turkish indigenous goat breeds. Male kids of Hair (n=6), Angora (n=6), Kilis (n=6) and Honamli (n=6) (pure breeds) were used as experimental animals. All kids were slaughtered at 3 months of weaning age and LD muscles sample were collected for determination some meat quality characteristics. There were no significant differences between kids in terms of total protein content in LD muscle, but water holding capacity, drip loss, frozen-thawing loss, cooking loss, pH, shear force, colour characteristics, dry matter, ash and intra-muscular fat content were shown differences ($p<0.05$) among breeds. It was concluded that meat quality characteristics of male kids born to Hair, Angora, Kilis and Honamli Turkish indigenous goat breeds exhibit differences.

***Keywords*—** kid, breeds, Longissimus dorsi, meat quality

I. Introduction

Meat quality has always been very important foods to the consumer due to its essential nutrients [1]. With rising income levels in developing countries, the consumption of animal origin protein, especially red meat consumption is increasing day-by-day [2]. Additionally, consumers prefer better quality meat such as lean, easy cooked and more delicious [3]. In order to produce high quality meat, meat quality characteristics and factors affecting them must be known by meat producers or farmers [4].

The nutrient content of the red meat from the domesticated animal species such as kid, lamb, beef or pork can be modified by various nutrition strategies during fattening period [4]. For example, the addition of various feed ingredients to the rations of animals to be used in meat production is the easiest and most effective method to be used for altering the meat composition. However, meat produced with various rationing practices is defined as functional foods and foods that have a very different nutritional profile than meat produced by traditional methods [5, 6]. Moreover, since this type of production system causes an additional economic cost on farmer, it leads to an increase in the price of the meat obtained.

The breeding of goat, which have a large share in the production of red meat around the world, is carried out under extensive conditions and there is almost no such additional or supplementary feeding practices [7, 8]. Pasture grazing is the most common practice for managing goat flocks worldwide [8]. Therefore, determination of quality and nutrient content of the meat in native goat breeds used in meat production may help offer alternative meat varieties to the consumers.

Turkey has about 10 million goats and 9 different breeds [9]. Therefore, the goats are an important source for meat production. Turkey has local goat breeds, which have a variety of geographic and climatic conditions. The most commonly raised native goat breeds in Turkey are Hair, Kilis, Angora and Honamli. These breeds constitutes approximately 92% of the goat population in Turkey [9]. Numerous studies have examined meat quality characteristics of sheep, cattle and pig, but there is little data from comparative studies for meat quality of kids born to Hair, Angora, Kilis and Honamli Turkish indigenous goat breed.

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

II. Material and Methods

A total of 24 kids of Hair (n=6), Kilis (n=6), Angora (n=6) and Honamli (n=6) breeds were used as experimental. All animals were obtained from the national sheep and goat breeding project in Tokat (Hair), Kilis (Kilis), Ankara (Angora) and Antalya (Homanlı) provinces of Turkey. All kids were slaughtered at 90 days of weaning age.

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 muscle taken from the left side of the carcasses to determine the meat quality traits. After homogenizing the meat samples dry matter, protein (N × 6.25), intramuscular fat and ash contents of LD muscle was analyzed according to the [10] procedures. The water holding capacity of LD muscle samples (approximately 25 g) were determined by the filter-paper press method [11] with some modifications. Approximately 50 g LD muscle samples were vacuum packed and stored −20℃ for one week to evaluate thawing loss values [12]. The sample packages were thawed under tap water, and then the thawing loss values were expressed as percent of water

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[12]. To determine the dripping loss values of LD muscle samples, approximately 50 g of each muscle were vacuum-packaged and stored at 4°C for 7 days. The dripping loss values (%) were measured on the 3th and 7th days of storage [13]. Cooking loss values of LD muscle samples were determined according to Sen et al. [13]. The muscle samples were put in plastic bags and cooked for 40 min in a water bath settled to 70°C. 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 Warner-Bratzler shear machine (Model 1132, Instron, Canton, MA, USA). The pH value of muscle samples was measured at 24 h after slaughter by using pH meter with a puncture electrode (Testo 205, Lenzkirch, Germany). CIE L*a*b* value measurements were taken by using a chrometer (Konica Minolta CR-300, Minolta Co., Ltd., Osaka, Japan) at 24 h after slaughter. The protein, ash and intra-muscular fat content was determined as a percentage of dry (samples were retained 12 h at 105°C) muscle samples weight [13]. Water holding capacity, drip loss, cooking loss and frozen-thawing loss was determined as a percentage of fresh muscle samples weight [13]. Mean pH, colour 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 statistical software. 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 $p<0.05$.

III. Result and Discussion

Meat quality parameters and chemical composition of LD muscle of male kids born to born to Hair, Angora, Kilis and Honamli Turkish indigenous goat breed are given in Table 1.

TABLE I: Meat quality parameters and chemical composition of Longissimus dorsi muscle of male kids born to born to Hair, Angora, Kilis and Honamli Turkish indigenous goat breed

Traits	Kilis	Honamli	Hair	Angora
pH	5.5±0.1^{b}	5.7±0.1^{b}	6.2±0.1^{ab}	6.6±0.1^{a}
Drip loss (%)				
3days	11.2±1.9^{a}	3.8±2.40^{c}	10.9±0.3^{a}	6.1±0.4^{b}
7days	19.8±2.8^{a}	18.2±1.3^{a}	13.7±0.1^{b}	13.3±0.9^{b}
Cooking loss (%)	23.1±1.4^{b}	29.3±3.2^{ab}	34.6±1.4^{a}	22.9±1.5^{b}
Water holding capacity (%)	28.2±0.3^{a}	29.2±1.7^{a}	26.0±1.0^{a}	13.4±1.1^{b}
Frozen-thawing loss (%)	6.2±0.7^{a}	5.2±0.5^{a}	6.7±0.4^{a}	3.8±0.5^{b}
Shear force (kg/cm^{2})	9.9±0.6^{a}	9.2±0.9^{a}	9.6±0.5^{a}	4.3±0.2^{b}
Colour				
L*	49.5±1.0^{a}	46.9±0.5^{b}	47.1±0.7^{ab}	42.2±0.5^{c}
a*	18.7±0.4^{b}	19.4±0.3^{ab}	20.4±0.4^{a}	19.5±0.1^{ab}
b*	10.5±0.2^{a}	9.6±0.3^{a}	10.1±0.3^{a}	8.4±0.3^{b}
Dry matter (%)	22.6±0.4^{b}	23.0±0.1^{b}	24.9±0.5^{a}	24.5±0.5^{a}
Ash	2.0±0.1^{b}	3.0±0.3^{a}	2.2±0.1^{b}	1.8±0.2^{b}
Protein	22.0±0.2	22.0±0.3	23.4±0.6	22.6±0.4
Intra-muscular fat	1.5±0.3^{b}	1.4±0.3^{b}	1.3±0.1^{b}	2.1±0.3^{a}

^{a,b,c} = The differences indicated by different letters on the same line are significant .
L* = lightness, a* = redness, b* = yellowness.

The significant variation was detected in pH values of LD muscles among the breeds ($p<0.05$). LD muscle pH value of Angora kids was higher ($p<0.05$) than those of other breeds, except for Hair kids. The pH value of fresh meat after rigor mortis phase has important effects on some meat quality characteristics including water holding capacity and texture. Therefore, determination of the pH value play pivotal role in assessment of meat quality and consumer prefer. Martínez-Cerezo et al. [14] reported that male lambs of some native Spanish sheep breeds (Rasa Aragonesa, Churra and Spanish Merino) had similar 24th h post-mortem pH values. Similarly, Sañudo et al. [15] reported that the meat pH values of suckling lambs born to Churra, Castellana, Manchega and Awassi crosses breeds were similar. However, some previous studies showed that there were significant differences in ultimate meat pH among sheep breeds [16, 17, 18] and goat breeds [19]. The variations in ultimate meat pH among breeds were generally explained by metabolic characteristics of muscle fibers in skeletal muscle mass such as glycolytic, oxidative and oxido-glycolytic activity [3, 6, 17] or by the pre-slaughter manipulations [19, 20]. In the present study, all kids were subject to similar pre-slaughter conditions. In addition, our pervious study by Sirin et al. [3] reported that there were no significant correlations between pH and muscle fiber characteristics. Differences in pH values of LD muscle among kids obtained from Turkish indigenous goat breeds may have resulted from the unique structure of the breeds. Devine et al. [21] reported that sensory tenderness score of meat decreases in

ultimate pH values between 5.8 and 6.0. In the present study, mean 24 h post-mortem pH values of LD muscle of kids born to Turkish goat breeds were within the acceptable range.

Water holding capacity, dripping loss and cooking loss, values are mainly physical meat quality traits and effective on productivity and quality of meat products [13]. Water holding capacity, dripping loss and cooking loss values are regarding with postmortem biochemical facts such as proteolysis, shrinkage of muscle proteins (actin and myosin) and destruction of cell wall [22]. These biochemical acts are effective for releasing of intercellular water. Also, high glycolytic metabolism in muscle is resulted in increases of water loss (namely high dripping loss, low Water holding capacity) of meat. The loss of water in meat has adversely effect on meat quality properties such as tenderness and juiciness [22]. In the present study, there were significant differences among kids born to Turkish indigenous goat breeds in terms of dripping loss and cooking loos values ($p<0.05$). Honamli kids had lower dripping loss values on day 3, but Angora kids had relatively lower dripping loss values on day 7 when compared to other breeds ($p<0.05$). Cooking loss value of Hair kids was higher than those of other breeds except for Homanli kids ($p<0.05$). Water holding capacity value of Angora kids was lower than those of other breeds ($p<0.05$). Thawing loss values of Angora kids was lower than those of other breeds ($p<0.05$). The cooking loss values of different indigenous sheep breed in Turkey ranged between 25.57% and 34.78% [20, 23, 24, 25]. In this study, cooking loss values of kids born to Hair, Angora, Kilis and Honamli Turkish indigenous goat breed were measured as 34.6%, 22.9%, 23.1% and 29.3%, respectively. These results indicated that meat kids of indigenous breed may not be disadvantage in terms of marketing.

In the present study, shear force values of Angora kids was lower than those of other breeds ($p<0.05$). Shear force values of kids was similar when compared with shear force values reported in Santos et al. [22], but Marichal et al. [26] lower shear force values in kids meat. The Warner-Bratzler shear force values of lamb meat beyond 5.5 kg are often be considered as objectionably tough both by a trained sensory panel and the consumers [27], however these values are based on a core size and shape different for that used in the present study. Because of the smaller size and lack of subcutaneous fat coverage, low weight carcasses of kids and lambs dissipate heat at a rapid rate during the immediate postmortem period. This rapid cooling rate of carcasses may cause cold shortening, a phenomenon, which results in lower tenderness of meat [28].

The colour of meat is of utmost important for consumer impression about the freshness of the product. Thus, the consumers generally prefer light red or pink colored meat [20, 29]. Muscle colour is extremely important in suckling kids' production whose carcasses should be pale or pink [19]. In the present study, the colour parameters L*, a* and b* were measured over cold carcasses (24 hours after slaughter) of LD muscle and significant differences were observed between kids born to Turkish sheep breeds. Although the lowest ($p<0.05$) L* and b* values was determined in Angora kids, Kilis kids had lower ($p<0.05$) a* value. For the lamb and kid meat, acceptable threshold values for L* and a* were reported to be 34-35 and below 19, respectively [19, 30, 31]. Purchasing decisions by customers for lamb and meat reported that the mean of L* and a* value are equal to or exceeds 34 and 9.50 respectively, thus, customer will consider meat colour acceptable [31, 32]. Also, under intensive fattening conditions, L*, a* and b* values of sheep breeds in Turkey measured at 24 h of postmortem were in the ranges of 37.91-42.72, 16.08-21.26 and 5.60-8.45 respectively [20, 23, 24, 25]. In the present study, L*, a* and b* values of 24 h post mortem were in the ranges of 49.5-42.2, 20.4-18.7 and 10.5-8.4, respectively. The L*, a* and b* values value was near the acceptable threshold value.

The chemical composition of meat is one of the best predictor of carcass meat composition [33]. Generally, chemical composition of kid meat was determined to be approximately 75% water and 25% dry matter. The component of the dry matter is 20% protein, 3%-5% intramuscular fat, 1% carbohydrates and 1% vitamin/mineral [34]. There were significant differences among lambs born to different Turkish pure breeds in terms of chemical composition of LD muscle, except for protein content ($p<0.05$). Honamli and Kilis kids had lower percentage of dry matter ($p<0.05$), but Honamli had higher ash values than those of other breeds ($p<0.05$). It was seen that Angora kids had highest percentage of intra-muscular fat in comparison with the other breeds ($p<0.05$). In the present study, dry matter (24.9-22.6%), protein (22.0-23.4%), intramuscular fat (1.15-3.72%) and ash (2.1-1.3%) contents of LD muscle samples of male kids born to Turkish indigenous goat breeds were considered as acceptable for fresh kid meat on sale.

IV. Conclusion

As conclusion, the findings show that goat breed had significant effects on chemical composition and meat quality parameters including pH, drip loss, cooking loss, water holding capacity, frozen-thawing loss, shear force and meat colour values. From the point of consuming healthy meat, Kilis, Honamli and Hair kids could be suggested due to its low intramuscular fat. In addition dripping loss has an important effect on quality of fresh meat and meat products, it was determined that dripping loss value of Honamli and Angora kids had relatively lower than Hair and Kilis kids.

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