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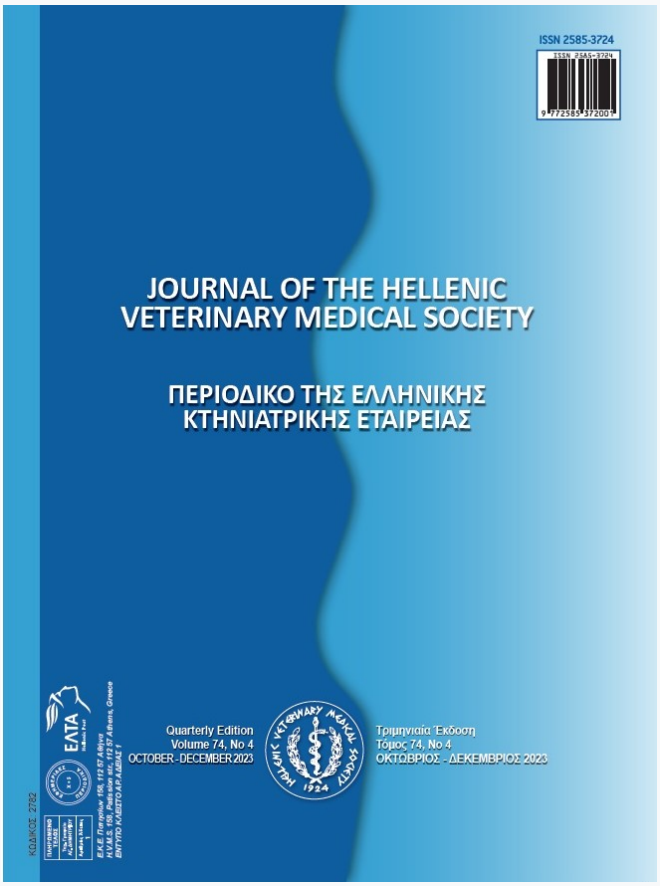

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Some Meat Quality Traits and Fatty Acid Composition of Saanen, Turkish Hair × Saanen (F_1) and Honamlı × Saanen (F_1) Crossbreed Kids

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ABSTRACT: The study was aimed to investigate the possibilities of obtaining slaughtered kids using indigenous breeds in Saanen flocks, which does not require breeding. The cross-sectional surface of the Musculus longissimus dorsi (MLD) muscle was used to evaluate some meat quality parameters. Evaluations were made after slaughtering and at 24th hour and on 7th day after the slaughtering. The average values of pH, pH 24, cooking loss, water holding capacity and shear force values obtained in research groups were 6.46, 5.02, 24.58%, 3.25% and 3.67 kg / cm2 in Honamlı x Saanen; In the same order, 6.46, 5.69, 25.66%, 5.59% and 4.52 kg / cm2 in Saanen and 6.62, 5.27, 22.69%, 2.55% and 4.25 kg / cm2, in the Turkish Hair x Saanen (F1) respectively. It was found in the study that L0 (brightness), a0 (redness) and b0 (yellowness) values were 47.50, 7.51 and 12.67 for Honamlı x Saanen crossbred kids, respectively. The same values were 48.34, 7.74, and 12.62 for Saanen kids and 47.73, 8.01, and 13.20 for Turkish Hair x Saanen crossbred kids, respectively. In the study, the amount of muscle fat in Turkish Hair x Saanen (F1) crossbred kids was found 2.85%. While there was no difference in oleic acid content among genotypes, the ω-6 fatty acids linoleic and arachidonic were detected in the Saanen kids with a maximum of 10.67% and 4.98%, respectively ($P< 0.05$). According to findings, It was found that Honamlı x Saanen (F1) cross kids have shown beter performance for many traits than others. Therefore, Saanen farms which has no need young breeding animal can use Honamlı bucks as patternal line for the butchered kid production. This application can be introduced to the sector.

Keywords: crossbreeding, fatty acid, goat, Honamlı, meat quality, Saanen, Turkish Hair

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INTRODUCTION

Goat breeding is important because it is one of the important sources of revenue for a sustainable economy in developing countries, as well as a relatively inexpensive source of food to satisfy rising food demand and accommodates rising and changing food demands in developed countries (Morand-Fehr et al. 2004; Aziz, 2010). Meat yields of goats, which are a vital source of livelihood for people living in rural areas, are particularly essential as much as their milk yields. It may be stated that the diverse grazing preferences of goats, their high adaptation to current environmental circumstances, as well as traditional habits and socio-economic structures of societies, all have a part in the preference for goat meat consumption (Casey, 1992).

Goat meat is distinguished from other meats by its unique flavour and aroma. Goats had less carcass fat and thinner carcass external fat than sheep fed under identical circumstances (Mahgoup and Lodge, 1998; Gül, 2004; Karaca, 2010; Goetsch et al., 2011). In the literature, it is reported that the intramuscular fatty acid ratio of beef is 3.8%, that of mutton is 4.9% (Enser et al., 1996), the amount of intramuscular fat is between 3.23-3.27% in beef, 1.02%-6.16% in mutton and 2.27% in goat meat, and goat meat is the best protein source for the cholesterolemic effect (Park et al., 1991; Banskalieva et al., 2000; Chambaz et al., 2003; Slósarz et al., 2011).

It is of primary importance to increase both the meat quantity and quality of reared goats. Numerous factors affect the meat quality, which is also assessed in terms of conformity with globally well-accepted standard values and is becoming more and more important day by day, and thus the product's value. These factors are determined in two ways; intrinsic factors directly associated with the animal and the extrinsic factors to which the animal is exposed during the rearing and pre-slaughter period. While the intrinsic factors include breed, sex, slaughter weight, type of birth, time of birth, maternal age, and genetic interventions, the extrinsic factors are the animal's activity level, diet, fattening system, and practices before and during slaughter (Sanudo et al., 1998, Akçapınar and Özbeyaz, 1999). Breed is a clear source of variation in carcass morphology related to fat quantity or meat quality (Guerrero et al., 2013). Significant differences among different goat breeds were reported by numerous authors (Dhanda et al., 2003; Santos et al., 2007; Ozcan et al., 2010; Ekiz et al., 2010) in terms of meat quality traits. It is important to determine the effect of related factors in order to bring out the meat quality.

Honamlı goats which are called after the Honamlı nomads are generally reared in the forest-maquis areas of the Taurus Mountains in Mediterranean region in Turkey. Honamlı goat is a multipurpose breed but usually mentioned for its huge body and meat production (Saatcı and Elmaz, 2017).

One of the most significant problems in dairy goat breeding across the world is the impossibility to employ male kids born every year and female kids without breeding qualities for meat production. The study aimed to analyse comparatively some meat quality properties and fatty acid profiles of Honamlı goat, which was registered as a native breed in 2015, and Turkish Hair-Goats, which have excellent tropical adaptation, as well as F1 crossbred kids, bred by using Saanen goats.

MATERIALS AND METHODS

Sampling and Analytical Procedures

This study was conducted at Antalya province in Mediterranean Region of Turkey on a private livestock farm that raises Saanen goats. Three genotype groups [Saanen, Turkish Hair x Saanen (F1), and Honamlı x Saanen (F1)] were created within the scope of the study. All three groups of kids were kept in the same environment, under the same care and feeding conditions. Within this scope, the kids not only sucked their dams but also were fed with high-quality roughage and kid starter feed. Kids stayed with their mothers until the 25th day after birth and sucked them whenever they wanted. Dams had never been milked before that date. The kids were separated from their dams at noon after the twenty-fifth day and kept in a setting where they could access the feed. They were reunited with their damss in the morning. During this period, mothers were milked every evening. After being weaned, the kids in all three groups were fattened for 56 days (including a 15-day feed transition period on the 90th day). The animals were fed ad libitum with concentrated feed (Crude protein: 15.5%, Crude fat: 3.7%, Crude Cellulose: 8.9%, Crude ash: 5.9 %) and quality roughage during fattening (alfalfa bale and vetch bale). A fattening group for carcass analysis was not established since the female kids born from the Saanen group preserve their breeding qualities (Table 1).

The cross-sectional surface of the Musculus longissimus dorsi (MLD) muscle was used to evaluate

Table 1. Animal material of study

	Honamlı x Saanen (F_1)				Turkish Hair x Saanen (F_1)				Saanen	
Birth Type	Single		Twin		Single		Twin		Single	Twin
Sex	M	F	M	F	M	F	M	F	M	M
Animal Number	6	5	8	10	5	5	6	8	5	5
Totaly	**29**				**24**				**10**	

M: Male F: Female

the meat quality parameters (from the 9-10th costa). Evaluations were made after slaughtering and at 24th hour and on 7th day after the slaughtering. The pH of the meat was measured after slaughter and on a carcass that had been refrigerated at +4°C for 24 hours, by inserting the pH meter probe into a slit incised with a scalpel in the MLD area. In Meat Colour measurements, D65 was employed as the light source. Colour measurements were taken three times from a tick sections of 2 cm of meat meat samples matured on the 0th day, 24th hour, and 7th day after slaughter. By using a chromometer (Minolta CR 400 colourimeter, Minolta Camera Co., Osaka, Japan) to take three triplicates (for a total of nine measurements) from the fat-free section of the cross-sectional surface of the sample at each colour measurement hour, the average of the values was accepted as the colour parameter measurement value.

The "Modified Grau and Hamm" method of Beriain et al., (2000) was used to determine the water holding capacity (WHC). The samples were put in heat-resistant polyethene bags, the bags were vacuum packed to avoid any water intrusion, and kept in an 80°C water bath for 45 minutes to determine cooking loss (Honikel, 1998). The samples were taken from the water bath and cooled under running water at the end of this period. Cooking loss (%) was calculated as ratio of difference between pre-and post-cooking weights to the initial weight by taking the meat samples out of their bags, drying them with paper towels, and measuring their post-cooking weights (Ekiz et al., 2012). The shear force was determined using a Warner-Bratzler blade attached to a Zwick/roell (Instron Universal Testing Machine Model 3343, Norwood, MA, USA) device.

In order to determine the fatty acid profile, meat samples were packaged in plastic packages, and stored at -80°C until analyses at Scientific and Technical Application and Research Center of Burdur Mehmet Akif Ersoy University. Analyses were performed in two parallels. The crude fat amount of the samples was determined using a BUCHI AG E-816 HE model hot extraction device according to AOAC 991.36 (2005). The lipid extraction from the samples was performed based on modifications proposed by Christie (1993) and Jeronimo et al. (2009). The fatty acids of the lipid fraction were prepared according to IUPAC (1987).

Statistical Analysis

The normality of data were tested with Kolmogorov-Smirnov test. The acceptability of defined sample size was also tested by the power and sample size tool by using the 19.1.1 version of MINITAB (2019) statistical package software. Transformed data were analysed by the analysis of variance (ANOVA) generalised linear model (GLM) procedure for the determination of effects on some meat quality traits. However, Tukey analysis was employed in controlling the significance of differences between subgroups ($P< 0.05$).

RESULTS

Table 2 shows the effect of genotype on pH, cooking loss, water holding capacity, and shear force, which are meat quality parameters, in the sample groups. While the pH values at the time of slaughter (pH0) for Honamlı x Saanen, Saanen and Turkish Hair x Saanen kids were 6.46, 6.46, and 6.62, respectively, the difference between the groups was not statistically significant. When the mean pH0 value of all groups was measured, it was found to be 6.47 for males, 6.59 for females, 6.43 for single births, and 6.58 for twins (Table 3). When analysing single and twin birth groups in terms of type of birth, the differences between the groups in terms of pH value (pHo) at the time of slaughter were found to be statistically significant ($P< 0.05$).

The pH24 values measured in the meats that were cooled and aged at +4°C for 24 hours after slaughter were found to be 5.02 for Honamlı x Saanen crossbred kids, 5.69 in Saanen kids, and 5.27 for Turkish Hair x Saanen kids. There were statistically significant differences between genotypes in pH24 values at the 24th hour ($P<0.05$). Also, the pH24 value was

Table 2. The effect of genotype onsome meat quality traits such as pH, cooking loss, water holding capacity, and shear force ($\bar{x} \pm S_{\bar{x}}$)

Genotype	Sex	Birth Type	N	pH_0	pH_{24}	Cooking loss (%)	Water holding capacity (%)	Shear force (kg/cm²)	P x̄
Honamlı x Saanen(F_1)	Male	Single	6	6.28±0.17	5.15±0.15	26.89±1.39	4.59±1.61	4.32±0.28	-
		Twin	8	6.42±0.18	5.07±0.07	23.90±1.54	2.92±0.50	3.42±0.36	-
	Female	Single	5	6.41±0.06	4.76±0.06	24.62±1.26	3.89±1.12	4.09±0.84	-
		Twin	10	6.63±0.11	5.04±0.12	23.71±1.70	2.41±0.40	3.25±0.27	-
Overall			29	6.46±0.07	5.02±0.05[c]	24.58±0.80	3.25±0.43	3.67±0.21	*
Saanen	Male	Single	5	6.48±0.32	5.81±0.01	28.45±1.37	7.31±3.94	5.49±0.13	-
		Twin	5	6.46±0.13	5.62±0.16	23.81±1.39	4.46±1.95	3.87±0.56	-
Overall			**10**	**6.46±0.13**	**5.69±0.09[a]**	**25.66±1.88**	**5.59±1.88**	**4.52±0.62**	*
Turkish Hair x Saanen(F_1)	Male	Single	5	6.48±0.18	5.25±0.10	24.08±2.43	2.69±0.52	5.18±0.47	-
		Twin	6	6.74±0.10	5.35±0.18	24.84±0.99	2.23±0.39	4.12±0.45	-
	Female	Single	5	6.57±0.10	5.36±0.09	23.46±1.62	2.95±0.46	4.35±0.66	-
		Twin	8	6.67±0.06	5.18±0.06	19.74±2.17	2.48±0.28	3.72±0.40	-
Overall			24	6.62±0.05	5.27±0.05[b]	22.69±1.01	2.55±0.19	4.25±0.25	*

[a,b,c] Values in the same column with different superscripts were statistically different (*: P < 0.05). -: nonsignificant (P > 0.05).

Table 3. pH, cooking loss, water holding capacity, and shear force values of all kids ($\bar{x} \pm S_{\bar{x}}$)

		N	pH_0	pH_{24}	Cooking loss (%)	Water holding capacity (%)	Shear force (kg/cm²)	P
Overall	Male	35	6.47±0.07	5.33±0.06	25.11±0.65[a]	3.82±0.63	4.26±0.24	*
	Female	28	6.59±0.04	5.08±0.06	22.69±0.97[b]	2.79±0.27	3.73±0.24	*
	Single	26	6.43±0.07[b]	5.23±0.07	25.44±0.78[a]	4.17±0.77	4.64±0.31[a]	*
	Twin	37	6.58±0.05[a]	5.21±0.06	23.11±0.78[b]	2.83±0.35	3.62±0.17[b]	*
	Totaly	**63**	**6.52±0.05**	**5.22±0.05**	**24.03±0.58**	**3.36±0.38**	**4.02±0.17**	

[a,b] Values in the same column with different superscripts were statistically different (*: P < 0.05).

5.23 in single- kids and 5.21 in twin-born kids; the same results were recorded at 5.33 for male kids and 5.08 for female kids (P> 0.05). The overall means of cooking loss for Honamlı x Saanen, Saanen, and Turkish Hair x Saanen crossbred kids were 24.58%, 25.66%, and 22.69%, respectively, in the study; the difference between genotypes was not statistically significant (P> 0.05). Again, the total mean cooking loss of male and female kids was 25.11% and 22.69%, respectively; the cooking loss was 25.44% for single kids and 23.11% for twin kids (P< 0.05). The water holding capacity was found to be 3.25%, 5.59%, and 2.55% for Honamlı x Saanen crossbred kids, Saanen kids, and Turkish Hair x Saanen crossbred kids in the study. Also, water holding capacity was 3.82%, 2.79%, 4.17%, and 2.8% for male kids, female kids, single kids, and twins, respectively (P> 0.05). When the shear force, another meat quality parameter identified in the study, was evaluated, it was found to be 3.67 kg/cm², 4.52 kg/cm², and 4.25 kg/cm², respectively for the genotypes. When all kids in the study were assessed (Table 3), the shear force was found to be 4.26 kg/cm² for male kids, female kids had a shear force of 3.73 kg/cm², single- kids had a shear force of 4.64 kg/cm², and twin kids had a shear value of 3.62 kg/cm². The effect of sex and birth type on the shear force was statistically significant (P< 0.05).

Table 4 shows the effect of genotype, sex, and birth type on the meat colour parameters examined in the study. It was found in the study that L0 (brightness), a0 (redness) and b0 (yellowness) values were 47.50, 7.51 and 12.67 for Honamlı x Saanen crossbred kids, respectively. The same values were 48.34, 7.74, and 12.62 for Saanen kids and 47.73, 8.01, and 13.20 for Turkish Hair x Saanen crossbred kids, respectively. When all of the kids in the study were assessed, it was found that the L0, a0, and b0 values were 48.44, 7.84, and 13.10, respectively for male kids; the same values were 46.77, 7.60, and 12.55 for female kids (P> 0.05). While the L0, a0, and b0 values were 48.08, 7.93, and 13.06, respectively for single kids, these values were 47.46, 7.59, and 12.71, respectively for twin kids. There were no statistically significant differences between single and twin kids in terms of L0, a0, and b0 values (P> 0.05). When the 24-hour meat colour parameters in the study were calculated, it was determined that the L24 value was 48.04, the a24 value was 7.64, and the b24 value was 12.88 for Honamlı x

Table 4. The effects of genotype, sex and birth type on meat colour parameters of kids ($\bar{x} \pm S_{\bar{x}}$)

	N	L_0	a^*_0	b^*_0	L_{24}	a^*_{24}	b^*_{24}	L_7	a^*_7	b^*_7	P
Genotpe											
Honamlı x Saanen(F_1)	29	47.50±0.51	7.51±0.37	12.67±0.25	48.04±0.51	7.64±0.41	12.88±0.30	41.37±0.51^b	6.97±0.39	10.62±0.34	*
Saanen	10	48.34±1.30	7.74±0.42	12.62±0.52	48.47±1.40	8.43±0.46	12.89±0.64	42.82±1.37^a	7.99±0.46	11.03±0.67	*
Turkish Hair x Saanen(F_1)	24	47.73±0.71	8.01±0.36	13.20±0.37	47.08±0.57	7.06±0.33	12.33±0.25	44.44±0.73^a	7.46±0.45	11.92±0.42	*
Sex											
Male	35	48.44±0.54	7.84±0.30	13.10±0.28	48.64±0.53	7.67±0.30	12.97±0.25	43.26±0.61	7.62±0.40	11.60±0.37	-
Female	28	46.77±0.57	7.60±0.35	12.55±0.26	46.55±0.48	7.38±0.41	12.26±0.29	42.10±0.67	6.91±0.26	10.61±0.29	-
Birth type											
Single	26	48.08±0.72	7.93±0.28	13.06±0.32	47.68±0.68	7.84±0.36	12.71±0.30	42.27±0.82	7.63±0.50	11.10±0.47	-
Twin	37	47.46±0.46	7.59±0.34	12.71±0.25	47.79±0.47	7.35±0.33	12.64±0.26	43.05±0.53	7.14±0.29	11.22±0.30	-
Overall	63	47.72±0.40	7.74±0.23	12.86±0.20	47.75±0.39	7.54±0.24	12.66±0.19	42.77±0.45	7.32±0.26	11.18±0.25	

^{a,b,c} Values in the same column with different superscripts were statistically different (*: P < 0.05). -: nonsignificant (P > 0.05).

Saanen kids. The indicated values were reported to be 48.47, 8.43, and 12.89, respectively for Saanen kids and 47.08, 7.06, and 12.33, respectively for Turkish Hair x Saanen crossbred kids. Also, while the L24 value was 48.64, the a24 value was 7.67, and the b24 value was 12.97 for male kids, the values were 46.55, 7.38, and 12.26 for female kids, respectively (P> 0.05).

The colour parameters (L24, a24, and b24) on 24th day were determined to be 47.68, 7.84 and 12.71 for single kids and 47.79, 7.35 and 12.64 for twin kids, respectively. Also, the L7 value was 41.37, the a7 value was 6.97 and the b7 value was 10.62 for Honamlı x Saanen crossbred kids, whereas the L7, a7, and b7 values for Saanen breeds were 42.82, 7.99, and 11.03, respectively. The same values for the Turkish Hair x Saanen crossbred kids were found to be 44.44, 7.46 and 11.92, respectively. The differences in L7 value among Saanen, Turkish Hair x Saanen crossbred kids, and Honamlı x Saanen crossbred kids were statistically significant (P< 0.05) in the study findings. When all of the kids in the study were assessed, the L7 value was 43.26, the a7 value was 7.62, and the b7 value was 11.60 for male kids; the same values were 42.10, 6.91, and 10.61 for female kids. Single kids had L7, a7, and b7 values of 42.27, 7.63, and 11.10, respectively, whereas twin kids had L7, a7, and b7 values of 43.05, 7.14, and 11.22 (P> 0.05).

The tables show the crude fat amounts, and fatty acid profile analysis findings of meat samples from Honamlı x Saanen (F1), Turkish Hair x Saanen (F1), and Saanen kids (Tables 5-8). The maximum fat rate was found in Turkish Hair x Saanen (F1), while the minimum fat rate was recorded for Saanen kids, as shown in Table 5. Twin and female samples had higher fat rates than single-born males. Although the effect of birth type on meat fatty acid profile was statistically non-significant (P> 0.05), its effect on genotype and sex was significant (P< 0.05). The results of the study revealed that palmitic and stearic acids were

Table 5. The effects of genotype, sex and birth type onthe crude fat amounts ($\bar{x} \pm S_{\bar{x}}$)

	Dry matter %	Wet weight %
Genotype		
Honamlı xSaanen (F_1)	9.77± 0.47^{ab}	2.29±0.12^{ab}
Saanen	8.12±0.68^b	1.90±0.17^b
Turkish Hair x Saanen (F_1)	11.68± 0.99^a	2.86±0.29^a
P	*	*
Sex		
Male	9.18±0.56^b	2.20±0.17^b
Female	11.55±0.72^a	2.75±0.20^a
P	*	*
Birth Type		
Single	9.09±0.53^b	2.12±0.13^b
Twin	11.04±0.67^a	2.68±0.20^a
P	*	*

^{a,b,c} Values in the same column with different superscripts were statistically different (*: P < 0.05).

Table 6. The fatty acid composition of Honamlı x Saanen (F_1), Turkish Hair x Saanen (F_1) and Saanen kids ($\bar{x} \pm S_{\bar{x}}$)

Fatty acids	Fatty acid corbon number	Honamlı x Saanen (F1)	Turkish Hair x Saanen (F1)	Saanen	P
Caprilic acid	C8:0	0.03±0.01^{b}	0.01±0.00^{b}	0.05±0.01^{a}	*
Capric acid	C10:0	0.09±0.01	0.11±0.01	0.11±0.01	-
Lauric acid	C12:0	0.10±0.01	0.15±0.02	0.11±0.03	-
Miristic acid	C14:0	1.68±0.12	2.19±0.18	1.67±0.31	-
Pentadecanoic acid	C15:0	0.07±0.01^{b}	0.17±0.03^{a}	0.07±0.01^{b}	*
Pentadecenoic acid	C15:1 (10)	0.87±0.09^{ab}	0.59±0.09^{b}	1.21±0.29^{a}	*
Palmitic acid	C16:0	20.34±0.25^{b}	21.58±0.39^{a}	19.72±0.63^{b}	*
Hexadecenoic acid	C16:1 (7)	0.23±0.04	0.23±0.02	0.21±0.03	-
Palmitoleic acid	C16:1 (9)	1.32±0.06	1.37±0.06	1.18±0.08	-
Margaric acid	C17:0	0.24±0.02^{b}	0.31±0.01^{a}	0.21±0.03^{b}	*
Heptadecanoic acidisomer	C17:0	0.76±0.04^{ab}	0.86±0.03^{a}	0.67±0.06^{b}	*
Heptadecenoic acid	C17:1 (7)	1.11±0.06^{b}	0.96±0.06^{b}	1.37±0.13^{a}	*
Stearicacid	C18:0	14.92±0.35	15.56±0.41	14.93±0.59	-
Oleic acid	C18:1 (9)	37.68±0.93	38.11±0.72	36.88±1.45	-
Oleic acid isomer	C18:1 (10t/11te/12t)	2.70±0.13^{a}	2.71±0.16^{a}	1.86±0.26^{b}	*
Linoleic acid	C18:2 (9,12) ω-6	9.59±0.67^{ab}	8.22±0.56^{b}	10.67±0.99^{a}	*
Linoleic acid isomer	C18:2 (11t,15) ω-3	0.06±0.02	0.05±0.01	0.09±0.03	-
Gama Linolenicacid	C18:3 (6,9,12,) ω-6	0.06±0.03	0.06±0.01	0.03±0.01	-
Linolenic acid	C18:3 (9,12,15) ω-3	0.20±0.02^{ab}	0.17±0.03^{b}	0.26±0.03^{a}	*
Eicosadienoic acid	C20:2 (11,14) ω-6	0.04±0.01	0.05±0.01	0.06±0.02	-
Dihomogamalinolenicacid	C20:3 (8,11,14) ω-6	0.24±0.02^{b}	0.17±0.02^{b}	0.31±0.03^{a}	*
Eicosatrienoic acid	C20:3 (11,14,17) ω-3	0.23±0.02^{ab}	0.17±0.02^{b}	0.29±0.03^{a}	*
Arachidonic acid, AA	C20:4 (5,8,11,14) ω-6	4.11±0.42^{ab}	2.89±0.37^{b}	4.98±0.75^{a}	*
Eicosapentaenoic acid, EPA	C20:5 (5,8,11,14,17) ω-3	0.18±0.02	0.20±0.07	0.26±0.06	-
Docosahexaenoic acid, DHA	C22:6 (4,7,10,13,16,19) ω-3	0.37±0.07	0.20±0.05	0.34±0.18	-
Total fatty acid		97.22	97.09	97.54	
Unidentified		2.78	2.91	2.46	

^{a,b,c} Values in the same rows with different superscripts were statistically different (*: P < 0.05). -: nonsignificant (P > 0.05).

Table 7. Fatty acid type content of Honamlı x Saanen (F_1), Turkish Hair x Saanen (F_1) and Saanen kids ($\bar{x} \pm S_{\bar{x}}$)

Fatty Acids	Honamlı x Saanen (F_1)	Turkish Hair x Saanen (F_1)	Saanen	P
SFA	38.22±0.47^{b}	40.94±0.7^{9}a	37.55±1.17^{b}	*
USFA	58.98±0.59^{a}	56.13±0.81^{b}	60.01±1.21^{a}	*
MUFA	43.90±0.87	43.96±0.65	42.72±1.30	-
PUFA	15.08±1.14^{ab}	12.17±0.98^{b}	17.29±1.84^{a}	*
ω-6	14.04±1.06^{ab}	11.39±0.91^{b}	16.06±1.68^{a}	*
ω-3	1.04±0.11^{ab}	0.78±0.11^{b}	1.24±0.26^{a}	*

^{a,b} Values in the same rows with different superscripts were statistically different (*: P < 0.05). -: nonsignificant (P > 0.05). SFA: Saturated fatty acid; UFA: Unsaturated fatty acid; MUFA: Monounsaturated fatty acid; PUFA: Polyunsaturated fatty acid; Σω-6: Omega 6; Σω-3: Omega 3.

Table 8. Fatty acid type content of female and malekids ($\bar{x} \pm S_{\bar{x}}$)

Fatty acids	Female	Male	P
SFA	40,00±0,67	38,47±0,58	-
USFA	57,20±0,77	58,75±0,61	-
MUFA	45,23±0,61	42,55±0,72	*
PUFA	11,98±0,79	16,20±1,07	*
ω-6	11,25±0,76	15,02±0,98	*
ω-3	0,72±0,07	1,18±0,12	*

^{a,b} Values in the same rows with different superscripts were statistically different (*: P < 0.05). -: nonsignificant (P > 0.05). SFA: Saturated fatty acid; UFA: Unsaturated fatty acid; MUFA: Monounsaturated fatty acid; PUFA: Polyunsaturated fatty acid; Σω-6: Omega 6; Σω-3: Omega 3.

the predominantly saturated fatty acids in the muscle tissue of all three genotypes (Table 5). Honamlı x Saanen (F1) and Saanen kids had significantly lower saturated fatty acid ratios (SFA) than the Turkish Hair x Saanen (F1) genotype (Table 6). Although there was no statistical difference in stearic acid rates of the groups, the high quantity of palmitic acid in the samples of Turkish Hair x Saanen (F1) kids elevated the SFA rate (Table 6). The samples of Hair x Saanen (F1) kids had the highest SFA rate (40.94%), while the samples of Saanen kids had the highest unsaturated fatty acid ratio (USFA) (60.01%). While there was no difference in monounsaturated fatty acid (MUFA) content between the genotypes, the samples of Saanen kids had the highest levels of polyunsaturated fatty acid (PUFA), ω-6 and ω-3 fatty acids (17.29 %, 16.06 %, and 1.24 %, respectively. The muscle samples from females had an SFA content of around 4% ($P> 0.05$) and a MUFA content of 6.3% ($P<0.05$) higher than muscle samples from males. The muscle samples of males had greater levels of USFA, PUFA ω-6 and ω-3 fatty acids than the muscle samples of females by 2.71% ($P> 0.05$), 35.23%, 35.51%, and 63.9%, respectively ($P< 0.05$).

DISCUSSION

This study evaluated the effects of genotype, birth type, and sex on pH, water holding capacity, cooking loss, shear force, and colour values in meats from Saanen, Turkish Hair x Saanen (F1), and Honamlı x Saanen (F1) crossbred kids. The pH values at the time of slaughter were found to remain same in terms of breed or sex ($P> 0.05$). Similarly, the studies by Oral Toplu et al., (2013) on Turkish Hair goat kids and by Santos et al., (2008) on Portuguese domestic goat breeds, also reported that the pH values at the time of slaughter did not differ by sex. Teixeira et al., (2011) found that the pH value at the time of slaughter was higher in Cabrito Transmontano male kids compared to female kids. In the study, it was determined that the pH0 values of twins were higher than the pH0 values of single kids in terms of birth type. In the literature, there has been no study evaluated the pH values at the time of slaughter by taking birth type into account. Therefore, the data from this study could serve as a reference for future studies.

When the present study's data were analysed, it was determined that the pH values at the 24th hour indicated a statistical difference among the breeds ($P< 0.05$). The highest pH24 value (5.69) was obtained in the Saanen breed, whereas the Honamlı x Saanen crossbred kids had the lowest pH24 value (5.02). The study by Atay (2016) on Alpine x Turkish Hair Goat, Saanen x Turkish Hair Goat crossbred and Turkish Hair Goat kids reported that the pH24 value differed by the breeds, and obtained consistent results with the present study. However, Peña et al., (2009) and Snezana et al., (2014) reported that pH24 values did not show any statistical difference between the breeds. There are insufficient studies on this subject, and the literature has inconsistent findings. The most important criterion in determining meat quality is pH change, which serves as the basis for the establishment of other quality parameters. When the overall means in the study were analysed, it was determined that the findings of pH values were at an acceptable level in kids (Hedrick, 1994). Water holding capacity refers to the ability of a muscle to hold water under different circumstances. In this study, although the water-holding capacity values, which are significant in the assessment of juiciness and aroma, ranged from 2.23 to 7.31% between the breeds, the differences between the groups (genotype, type of birth and sex) were not statistically significant ($P> 0.05$). The data are consistent with the water holding capacity values that were determined by Atay (2016). Even though the cooking loss values reported in the present study ranged from 19.74 % to 28.45 %, no statistical difference was found between the genotypes. The study by Atay (2016) indicated that mean cooking loss among genotypes was statistically significant, however, Peña et al., (2009) reported that cooking loss was not affected by the breed factor.

The shear force ranged from 3.25 kg/cm^2 to 5.49 kg/cm^2 in this study. Likewise, Atay (2016) found no differences in shear force between breeds, but reported similar means in Alpine x Turkish Hair crossbreds, as well as high shear force in Saanen x Turkish Hair crossbreds and Turkish Hair goat kids, in keeping with our findings. In their study, Peña et al., (2009), reported that the mean shear force in Criollo Cordobes and Anglo-nubian kids was higher than the ones obtained in the present study, and the difference between breeds was statistically significant. When the overall shear force means in the present study were analysed, it was determined that both the factors, sex and birth type, affected the shear force statistically ($P< 0.05$). In this regard, it was observed that male kids had higher mean values than female kids, and single kids had higher mean values than twins. In the literature review, Todaro et al., (2004), Santos et al., (2008), and Oral Toplu et al., (2013) reported that sex

did not affect the shear force, which contradicted the findings of the present study.

Meat colour is a powerful marketing feature for the preference for meat. Customers frequently decide whether or not to eat the meat by examining its colour. They take the colour of meat into consideration when deciding on its freshness and flavour (West et al., 2001). The slaughter time colour parameters from Honamlı x Saanen, Saanen and Turkish Hair x Saanen crossbred kids in this study are consistent with the data of Santos et al., (2008)'s study. The L0, a0 and b0 values were not affected by genotype, birth type and sex in the related study, which is compatible with the present study. In their study, Teixeira et al., (2011) reported that the sex difference in colour parameters at the slaughter time did not affect the colour values. The parameter values at the 24th hour in the present study are compatible with those of Oral Toplu et al., (2013), Atay (2016) and Sañudo et al., (2012), but lower than the values of Todaro et al., (2004). The effect of sex on colour parameters at the 24th hour (L24, a24, b24) was not found to be statistically significant in the present study. Likewise, Santos et al., (2008), Teixeira et al., (2011) Oral Toplu et al., (2013), and Todaro et al., (2004) also reported that colour parameters on the 24th hour were not affected by sex in their studies for different breeds. These values were not also affected by the birth type in the present study. On the other hand, in the study on Nebrodi goats by Todaro et al., (2004), they reported that birth type had a statistically significant effect on L24 value and twin kids had a higher L* value.

Environmental and genetic factors have a significant effect on meat colour parameters, which may differ significantly between breeds and diverse populations within the same breed. Therefore, it is an acceptable circumstance that the data from different studies varied. Colour parameter variations were identified in kid meats of different breeds aged at +4 °C for 7 days in the present study, and statistically significant differences in the L* value were observed. According to the data, the L* value on the 7th day was determined to be close to each other in Saanen and Turkish Hair x Saanen crossbred kids, but lower than Honamlı x Saanen crossbred kids. When the literature was reviewed, studies that assessed the variation in colour parameters of aged meat of kids were observed to be qualitatively and quantitatively insufficient. The findings of the present study will serve as a basis for further research on the colour of aged kid meat. However, since the colour qualities of the aged kid meat are directly related to the consumer's preference, the assessment of L7 is considered to be an important parameter. In this assessment, this value was low in Honamlı x Saanen (F1) crossbred, which may negatively affect consumer preference due to low brightness.

The water holding capacity and cooking loss for the genotype, birth type, and sex in the study were found to be compatible with the literature. The effect of genotype, sex, and birth type on the crude fat ratio in meat was determined to be significant ($P< 0.05$) by statistical analysis, Turkish Hair x Saanen (F1) kids had the highest fat rate and Saanen kids had the lowest fat rate. The study by Özcan et al., (2015) on Turkish Saanen, Malta and Gökçeada kids revealed the fat rates of 8.67 %, 8.72 %, and 7.52 %, respectively. The fat rate of Saanen kids was determined as 8.12% in the present study, which was similar to the results of the study by Özcan et al., (2015). Muscle fat ratios over age-weight were found to be quite low in Honamlı x Saanen (F1), Hair x Saanen (F1), and Saanen kids in the present study, 2.29 %, 2.86 %, and 1.9 %, respectively; this is considered to contribute to the preference to consume goat meat as a source of protein and healthy fatty acids.

The study revealed that fatty acids, which were found in high amounts in muscle tissue, were oleic, palmitic and stearic acids respectively. Even though there was no difference in oleic acid rates among genotypes, Saanen kids had the highest linoleic and arachidonic acid values, with 10.67 % and 4.98 %, respectively. In their study, Özcan et al.,(2015) reported that linoleic, arachidonic, and oleic acid values were 5.16%, 0.73%, and 48.21% in the Turkish Saanen genotype, respectively, while Yalcintan et al., (2018) reported 7.48 %, 1.15 %, and 51.08 % in Turkish Saanen male kids, respectively. The average amount of oleic acid found in the Saanen genotype (excluding the oleic acid isomer) was 36.88 % in the present study. The findings of the present study showed that oleic acid levels were lower than those reported by Özcan et al., (2015) and Yalcintan et al., (2018), whereas linoleic and arachidonic acid levels were much higher. This difference was thought to be attributable to differences in the feed composition consumed by the animals. Also, the lower amounts of linoleic and arachidonic acid in muscle samples from Honamlı x Saanen (F1) and Turkish Hair x Saanen (F1) kids compared to Saanen kids in the present study can be attributed to differences in metabolic activity associated with fatty acid biosynthesis (Gurr et al., 2002).

The study by Oral Toplu et al., (2013) on Turkish Hair goat kids reported that they discovered that oleic acid, palmitic acid, and stearic acid were the most prevalent fatty acids in the fatty acid profile of M. longissimus dorsi tissue and they were 36.3-42.4%, 26.7-30.3%, and 14.9-17.9%, respectively. Yalcintan et al., (2018) found in their study with Turkish Hair goat male kids that these values were 48.64%, 18.13%, and 8.59%, respectively, and the study by Ekiz et al., (2014) on Turkish Hair x Saanen (F1) kids reported that these values were 39.31%, 20.20%, and 17.54%, respectively. These values of Turkish Hair x Saanen (F1) kids were 38.11%, 21.58%, and 15.56% in the present study, and Ekiz et al., (2014) reported similar results.

The effect of birth type on the fatty acid profile was determined to be insignificant (P> 0.05) in the study. The studies have reported that the mean MUFA content of bovine muscle (longissimus dorsi) is 41%, its PUFA content is 9.12%, its linoleic fatty acid content was 6.53%, and its SFA content was 43.29%. These values are reported to be 42.94%, 5.97%, 4.01%, and 44.1% for sheep muscle (longissimus dorsi), respectively (Banskalieva et al., 2000). However, there was no statistical difference between the genotypes in terms of MUFA content in the present study, and this value was determined to be 43.53 % on average. The Turkish Hair x Saanen (F1) genotype samples had the lowest PUFA and linoleic acid values (12.17% and 7.56%, respectively). While the highest SFA content was found to be 40.94% in the samples from Turkish Hair x Saanen (F1) kids, the lowest SFA content was 37.55% in the samples from Saanen kids. The data indicated that although the crude fat ratio of the meat samples of the goat genotypes included in the study was relatively lower than that of beef and sheep meat, it had a fatty acid profile that contains higher PUFAs, which are significant in terms of biological availability. It was found that the ratios of the PUFA, ω-6, and ω-3 fatty acid content of Honamlı x Saanen (F1) genotype samples were similar to those from Saanen genotype. It was determined that Honamlı x Saanen (F1) and Saanen kids had significantly lower saturated fatty acid (SFA) ratios compared to the Turkish Hair x Saanen (F1) genotype. The highest values of polyunsaturated fatty acid (PUFA), ω-6 and ω-3 fatty acids were found in Saanen and Honamlı x Saanen (F1) kids. It is reported that PUFA/SFA and ω-6/ω-3 ratios should be 0.45< and <4:1, respectively, to reach an opinion on the nutritional value of meat (Yalcintan et al. 2018). In the present study, the ω-6/ω-3 ratio in all genotypes was found to be 13.7 on average, which was significantly over the recommended 4:1 value. Goat meat is reported to be the best protein source for cholesterolemic effect. Although the crude fat ratio of the meat samples of the goat genotypes in the present study was relatively lower than that of beef and mutton, they had a fatty acid profile that contains higher PUFAs, which are significant in terms of biological availability.

CONCLUSION

There is a major problem with the utilization area of male kids in dairy goat breeding. Since these dairy animals, which are subjected to selection for milk, have low meat production, male and non-breeding female kids cannot be utilized to produce meat. To address this problem, it is possible to shift to meat-oriented breeding during particular periods by employing certain procedures that do not jeopardize the existence of breeding animals in dairy goat businesses. When compared to meat quality studies in cattle and pig species, studies on goat meat quality appear to be insufficient. Therefore, meat quality studies would be needed, particularly for countries, such as Turkey, which has considerable sheep and goat breeding, as well as a rise in the consumption of kid meat. In this sense, in order to make concrete recommendations about goat meat, it would be appropriate to increase studies, particularly to investigate crossbreeding with local breeds in small cattle farms which have a surplus of breeding stock. The study indicated that such crossbreeding had no negative result on meat quality. Furthermore, in circumstances when there is a surplus of breeders in the farms that rear the Saanen breed, crossbreeding with local breeds reaches the sales pH level from the 24th hour and has a lower pH level than full-blooded Saanen kids, prolonging the meat's shelf life. Also, given that the lack of literature reports on aged kid meat, the findings of this study are believed to constitute a basis for colour studies.

It is believed that the utilization of local breeds as the sire line in the study would contribute to diversified production, production of kid meat during particular periods, the determination of the meat quality of the kid carcasses, as well as defining them with the fatty acids they contain and presenting them to the public are important in terms of introduction of a unique alternative to traditional dairy goat breeding.

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STATEMENT OF ANIMAL RIGHTS

Study has been approved by Burdur Mehmet Akif Ersoy University Local Ethical Committee on Animal expirements (29.08.2014, meeting number: 14, resolution number: 89).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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