Growth, slaughter and carcass characteristics of Alpine × Hair goat, Saanen × Hair goat and Hair goat male kids fed with concentrate in addition to grazing on rangeland

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The objective of this study was to compare the growth, slaughter and carcass characteristics of Alpine × Hair goat (first cross) (AH), Saanen × Hair goat (first cross) (SH), and Hair goat (H) male kids fed with concentrate in addition to grazing on the natural pasture. Seven kids per breed group (a total of 21 kids) at approximately 3.5 months of age were fed 300 g/day/animal concentrate in addition to grazing on rangeland for 70 days. The kids were kept in the natural pasture accompanied by a shepherd throughout the day, except pen rest to avoid the midday heat outside for 1–2 h. The concentrate was given after returning from grazing at the end of the day. All lambs were slaughtered at the end of the 70 days period. Least squares means of the final live weights of AH, SH and H kids were 32.7, 33.6 and 28.9 kg (P < 0.01), respectively. Total and daily live weight gains were 9.2, 9.8 and 6.7 kg (P < 0.05), and 0.13, 0.14 and 0.09 kg (P < 0.05) for the AH, SH and H kids, respectively. Cold carcass weight and dressing percentage of AH, SH and H groups were 12.9, 13.3 and 11.1 kg (P < 0.01), and 39.4, 40.5 and 38.5% (P < 0.05), respectively. Internal fat weight of AH, SH and H kids were 0.06, 0.06 and 0.03 kg (P < 0.05), respectively. M. Longissimus dorsi (MLD) area between the 12th and 13th ribs of AH, SH and H kid carcasses were 10.5, 11.5 and 8.9 cm² (P < 0.05), respectively. The liver (P < 0.01), kidney (P < 0.01) and internal fat (P < 0.05) percentages of the kid carcasses were significantly different among groups. In this study, the total and daily live weight gain, dressing percentage and several carcass characteristics were found to be different among genotype groups. Results suggest that Alpine and Saanen breeds could be used to improve the productivity of Hair goat kids fed with concentrate in addition to grazing on rangeland.

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1. Introduction

Goat breeding has an important place in Anatolian cultural and social life since olden times. Most goat populations in Turkey subsist harsh environments that adversely affect plant and animal production. Goat breeding are concentrated in inner-forest and forest-side villages in Anatolia, contributing mainly to the livelihood of goat breeders. Goat keeping contributes to employment and nutrition of households in these areas. The goat population in Turkey is composed mostly (97%) of the Hair goat (Anatolian Black). The Hair goat serves multiple purposes (mainly meat and milk). But, productivity of Hair goats is considered low. Hair goat herds are distributed over the rugged, mountainous, forest or dense bush areas which are mostly not suitable for crop production and other grazing animal species, especially in Mediterranean, South-East Anatolia and South-West Anatolia regions. Hair goats are primary ruminants in the rangelands of these regions and are one of the most important parts of traditional extensive

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systems. These goats are characterised by their adaptation to harsh environments and climatic, topographic and vegetative conditions of these regions. In other regions such as the Eastern Anatolia, large herds of goats are rare and generally a small number of goats are included as a component making up 5–10% of the sheep flocks. In those flocks, goats are a secondary component of the small ruminant production system.

The number of Hair goat in Turkey began a rapid decline in the early 1980s and continues today. The current number is estimated to be about 6.1 million as compared to 15.3 million in 1982 (DIE, 2000; TUK, 2012). Much of the decline has resulted from (1) efforts of Ministry of Forestry to destroy Hair goats by considering them as the primary enemy of forests, (2) social and economical problems in rural areas, (3) voluntary or involuntary migrations to urban areas, (4) traditional farming system that does not change for years, (5) the negative attitudes of breeders against the innovation and new techniques, (6) inadequate government support, (7) lack of cooperation among breeders, (8) young people’s reluctance to sustain the traditional goat farming, (9) lack of sufficient demand for goat products, (10) narrowing of the natural pasture lands, and (11) difficulties in finding shepherds (Gürsoy, 2006; Gökdal and Atay, 2011).

Hair goat breeders have maintained their traditional goat production systems for many years. The traditional system is characterised by low input and output level, lack of preventive health practices and disease controls, lack of extra labour and inadequate housing conditions. Nutritional needs of animals are entirely met from natural pastures dominated by shrub and forest pastures (with little or almost no feed supplementation). Goat breeders devote a large part of their daily time to grazing their flocks. A significant part of the income is obtained from sale of male kids. The kids are sold at the age of 5–6 months in the middle and/or towards the end of the summer grazing period (Atay et al., 2010a). Production and sale of kids is not well organised among the goat breeders. There is no standard method for raising and fattening of kids to improve the quality and quantity of meat. The production is completely dominated by the traditional and natural conditions in this system. Especially for small holders in highland and forest areas, Hair goat is important in meeting their need for meat. But goat meat production has reduced in parallel to numerical decline of the populations. The disadvantages related to the traditional system have also contributed to the decrease in the number of goats in Turkey.

It can be said that goat meat is generally not a preferred source of protein in the regions where have a weak cultural, social and economic connection to goat breeding. However, scientific studies in recent years have showed that nutrient value and quality characteristics of young goat meat are not inferior to lamb and mutton (Webb et al., 2005; Brzostowski et al., 2008; Madruga and Bressan, 2011). The goat meat is said to be healthier thanks to lower in fat and cholesterol compared to beef (Yarali et al., 2010). It can be said that the paucity of demand for goat meat consumption is due to consumer habits in most region. But in the worldwide, consumption of goat meat has increased during the last 20 years (Madruga and Bressan, 2011). Goat meat is high in protein and low in fat, which makes it an attractive red meat alternative for consumers (Dhanda et al., 2003a).

Several studies have been conducted to characterise the growth, carcass and meat traits of Hair goat and/or its crosses under the intensive conditions (Şimşek and Bayraktar, 2007; Yılmaz et al., 2009; Atay et al., 2010b, 2011; Valçıntan et al., 2010). Therefore, more studies are needed to improve our knowledge of growth and carcass characteristics of Hair goat and its crosses with other breeds in different conditions. The aim of the present study was to compare the growth, slaughter and carcass characteristics of Alpine × Hair goat, Saanen × Hair goat and Hair goat male kids fed with concentrate addition to grazing on natural pasture in the rangeland. The present study was also aimed that to be a pioneer for the establishment of an appropriate model for goat meat production under rural condition.

2. Materials and methods

2.1. Location of the study, animals and data collections

In Turkey, there is a need for genetic improvement of the productivity and efficiency characters of Hair goat through genetic variations within-and among the other goat breeds. A project is carried out in order to improve both milk yield and productive performance of Hair goat through crossbreeding with milk goats, in forest and forest side villages of Çine district, Southern Aegean Region (Gökdal and Atay, 2010) since 2003. The present study conducted as a part of the project which goats from different genotypes (Hair goat and its crosses with Saanen or Alpine) were conducted to compare productivity in a crossbreeding program. The present study was carried out in a breeder flock in Kasıvel Village in scope of the project. The Kasıvel Village (latitude 37°65′E, longitude 28°13′N) is a forest side village altitude 700 m at the approximately 10 km from Çine district to Aydın city in Southern Aegean Region. After the pregnancy period after synchronised matings in the flock, kids were weighed in 24 h after birth and numbered with ear tags. Kids were kept continuously with their mothers during the first week and then only at nights. After 2–2.5 months of age, kids were begun to grazing together with its mothers in the rangeland. Subsequently, kids were weaned at approximately 3.5 months of age and separated from doe flock 7 days before feeding program. At the beginning of additional feeding experiment, a total of 21 kids was weighed and assigned to genotype groups (Alpine × Hair goat (first cross) (AH), Saanen × Hair goat (first cross) (SH) and Hair goat (H)). Thus, seven kids in each group were subjected to concentrate in addition to natural pasture in the rangeland for 70 days. The kids were kept in the rangeland accompanied by a shepherd throughout the day, except pen rest to avoid the midday heat outside for 1–2 h. This rangeland contains a significant woody component and comprises shrubland, woodland and maquis. Three hundred grams/animal concentrate were given after returning from grazing at the end of the day. Commercially available concentrate contained 88% dry matter, 12% crude protein, 9% crude ash, 12% crude fibre and 2750 ME kcal/kg. The animals were housed at “the Research and Practice Farm of the Project in Kasıvel Village” during the night. Live weights of the kids were determined every second week. Final weights of all animals were recorded after 12 h fasting and then after 24 h fasting prior to slaughter. All kids were slaughtered at the end of the 70 days period. After complete bleeding, the slaughtered animals were skinned. Hot carcass weight and weights of head, skin, feet, internal fat around the gastrointestinal tract and some visceral organs (heart and lungs, liver, spleen) were recorded. The carcasses were chilled for 24 h at +4 °C. At the end of this period, the cold carcass was weighed. Testes, kidney, kidney and pelvic fat and tail were excluded and weighed. The carcasses were split into two symmetrical parts with the aid of an automatic saw. The carcass length was measured on the left half of the carcasses. And then, the left half of the carcasses were divided in cuts (Fig. 1), according to the procedure of Colomer-Rochet et al. (1987) and weighed. The surface area of a cross section of the M. Longissimus dorsi (MLD) between the 12th and 13th rib was obtained by tracing it onto acetate
paper and measured using a planimeter. Dressing percentage was calculated as a ratio of slaughter weight and cold carcass weight. Proportional yields of different carcass parts, fats and organs were calculated as the ratio according to the procedure of Cengiz et al. (1989).

All procedures related to the animals in this study were approved by Ethical Committee of Adnan Menderes University (ADU-HADYEK 2010/02–018).

2.2. Data analysis and statistics

Data analysis was performed using GLM procedure of SAS (1998) to determine fixed effects due to genotype. While comparing genotype groups, weaning weight were used as covariate for analysis of growth and carcass parameters. Significant differences between means were detected using Duncan’s multiple range tests.

3. Results and discussion

3.1. Growth characteristics

Growth curves of AH, SH and H male kids fed with concentrate in addition to grazing on natural pasture in the rangeland during the 70 days period are given in Fig. 2.

The SH kids had higher growth rates than the other genotypes. But, there was a little difference in growth rates between the AH and SH genotypes and their growth curves were almost parallel (Fig. 2). Growth of the H group was lower than those of the crossbred kids throughout the study (P < 0.01). The growth curves of H kids increased steadily until 42th day of the feeding study. Nevertheless, after the 42th day growth rate decreased in this group until the end of the study (Fig. 2). It can be attributed to the fact that the Hair goat breed is not capable of rapid growth and inadequate ability of feed efficiency. It is seen in the literature that the growth characteristics of Hair goat kids are also lower than that of Norduz goat (a local breed of Turkey) under intensive or semi-intensive conditions (Daşkiran et al., 2010).

Growth of the kids was also evaluated from least square means of total and daily weight gain of the groups (Table 1). Although the initial weight of the H group was lower than the crossbred groups, it can be seen that the differences in final weights among H and crossbred groups was higher than the initial (Table 1). Total and daily live weight gains were similar in AH and SH groups, but the values of these characters were found to be statistically different from that of the H kids (P < 0.05). These results are in agreement with Oman et al. (1999), Dhanda et al. (2003a,b), Kadim et al. (2003) and Tozlu (2006) who reported that genotype had a significant effect on daily live weight gain of kids. In a previous study (Atay et al., 2010b), the daily weight gains of the AH, SH and H kids under intensive fattening conditions have been reported to be similar. And the other researchers also reported that daily weight gain or growth of SH and H kids under intensive conditions did not
statistically differ (Karadağ, 2006; Şimşek and Bayraktar, 2007). In the present study, total and daily live weight gain of the H group were 6.7 and 0.09 kg, respectively. The H kids in the present study had higher values than those of same genotype under intensive fattening condition in previous studies (Yaşcantan et al., 2010; Atay et al., 2011). The growth rate of Hair goat kids obtained in the present study was comparable with the values reported for Oman local breeds under experimental farm conditions (Kadim et al., 2003). On the other hand, it has been reported in a study on the H kids under intensive fattening conditions that the total and daily live weight gain were found to be 8.4 and 0.12 kg, respectively (Atay et al., 2010b). In the same study (Atay et al., 2010b), the researchers reported that the average daily live weight gain of the AH and SH kids were 0.10 and 0.10 kg, respectively. These values are lower than the values determined in the present study for the same genotypes. Furthermore, total and daily live weight gain of the SH kids in the present study were higher than the values reported by other researchers (Karadağ, 2006; Şimşek and Bayraktar, 2007). However, it is difficult to make a direct comparison of the present results with the results of other studies. The differences could be attributed to several factors such as additional concentrate feeding, intensive fattening or only grazing, post-weaning depression of kids, maintenance conditions, ages of kids, pasture conditions and duration of the studies. The kid production systems in rural flocks of inner-forest and forest-side villages of Turkey are largely based on grazing on natural pastures in the rangeland. Generally, concentrate feed is not given to animals during the growth period. According to the results of the present study, additional feeding to grazing could be useful for provide a better growth rate and final weight of kids. Intensive fattening of kids is not a widespread practice in Turkey, except scientific experiments. However, according to the present results, concentrate feed given to animals at least in addition to the grazing can increase the growth rate of kids. There has not been made an economic analysis in this study. However, the observed live weight gain compared to the cost of the feed seems to be profitable.

### 3.2. Slaughter and carcass characteristics

Slaughter and carcass characteristics of the AH, SH and H male kids fed with concentrate in addition to grazing on natural pasture in the rangeland during 70 days period are presented in Table 2.

There were significant differences among genotype groups in slaughter weight, dressing percentage ($P<0.05$) and hot and cold carcass weights ($P<0.01$) (Table 2) with AH and SH having significantly higher values compared to H kids. Similar to the present results, Kadim et al. (2003) reported significant differences among three local goat breeds of Oman for dressing percentage based on full and empty body weight. Nevertheless, in some of previous studies (Şimşek and Bayraktar, 2007; Atay et al., 2010b; Yılmaz et al., 2009, 2010) reported that slaughter weight and dressing percentage did not significantly differ between Saanen × Hair and Hair goat kids under intensive fattening conditions. In the present study, the dressing percentage based on slaughter weight of kids ranged from 38.5 to 40.5%. In the previous studies (Kadim et al., 2003; Daşkuran et al., 2006a,b; Atay et al., 2010b; Yılmaz et al., 2009, 2010), the dressing percentage of kids had been reported to be around 37.1–49.2% in different goat breeds. In the present study, dressing percentage of the H kids was 38.5%. The H kids had lower values compared to the previous reports obtained for the same genotype under intensive fattening condition (Şimşek and Bayraktar, 2007; Atay et al., 2010b, 2011). Moreover, the observation that dressing percentages of the AH and SH kids were lower than obtained by Atay et al. (2010b) in the same genotypes under intensive fattening conditions, could be attributed to differences of age and rearing conditions. In addition, the dressing percentage may vary depending on head weight (the presence of horns) and skin weight (the presence and weight of hair), and the other variables (slaughter method and practice, relative to hot carcass weight, cold carcass weight, full body weight, empty body weight or slaughter weight) taken into account in the calculations of researchers.

As in many countries in the world, there are no regular and classified (in point of carcass parts and quality) sales of goat meat and goat offal items in city markets in Turkey. However, the yield of offal items of kids is important especially in rural areas, because of household consumption as a protein source. In the present study, genotype had a significant effect on head, internal fat ($P<0.05$), liver and testes weights ($P<0.01$) (Table 2). Head weights depend on the presence and size of horns. AH and SH kids had heavier testes than H kids. The H kids were deposited lowest internal fat than that of AH and SH kids. Similar to the present results, variation in deposition of internal fat in different breeds of goats had also been reported by Kadim et al. (2003). But, in a study done to determine the fattening performance and carcass characteristics of AH, SH and H kids under intensive fattening conditions (Atay et al., 2010b), it has been observed that internal fat percentages of all

<table>
<thead>
<tr>
<th>Traits</th>
<th>AH ($n=7$)</th>
<th>SH ($n=7$)</th>
<th>H ($n=7$)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial weight (kg)</td>
<td>23.4 ± 0.2</td>
<td>23.8 ± 0.3</td>
<td>22.2 ± 0.2</td>
<td>**</td>
</tr>
<tr>
<td>Final weight (kg)</td>
<td>32.7 ± 0.9</td>
<td>33.6 ± 1.0</td>
<td>28.9 ± 0.9</td>
<td>**</td>
</tr>
<tr>
<td>Total weight gain (kg)</td>
<td>9.2 ± 0.9</td>
<td>9.8 ± 0.9</td>
<td>6.7 ± 0.8</td>
<td>*</td>
</tr>
<tr>
<td>Daily weight gain (kg)</td>
<td>0.13 ± 0.01</td>
<td>0.14 ± 0.01</td>
<td>0.09 ± 0.01</td>
<td>*</td>
</tr>
</tbody>
</table>

*Values in the same line with different superscripts were statistically different ($P<0.05$). 
* $P<0.05$, the differences among groups were statistically significant. 
** $P<0.01$, the differences among groups were statistically significant.
genotype groups were similar. The internal fat deposition may be explained by lower slaughter weight of H kids in the present study. Similar to the present results, Dhanda et al. (2003b) reported that the liveweight at slaughter was one of the contributing factors (others being age and carcass weight) for the internal fat deposition in kids. In the present study, although the differences were not significant, kidney and pelvic fat weight of the H kids tended to be lower than in the other groups. The average of deposited internal fat in the H kids was found to be 0.03 kg. After, Atay et al. (2011) reported that internal fat weight of Hair goat kids under intensive fattening conditions for 60 days was 0.13 kg. This difference may be explained mainly with feeding conditions. The weights of other offal items of the crossbred kids were generally tended to be higher than those of the H kids in the present study.

In the present study, except for MLD muscle area, there were no differences in carcass measurements among genotype groups (Table 2). The MLD muscle area which is indicator of valuable part of carcass meat was higher in the AH and SH groups than the H group (P < 0.05), in agreement with the findings of Atay et al. (2010b). In this study, MLD area of H kids was 8.9 cm². These results are also in agreement with those of Atay et al. (2011) who reported that MLD area of male Hair goat kids under intensive fattening conditions was 8.3 cm². But, values of the MLD muscle area and depth varied widely according to the slaughter weight, age, genotype and feeding or pasturing conditions (Dhanda et al., 2003b; Kadim et al., 2003; Koyuncu et al., 2007; Atay et al., 2010b; Yilmaz et al., 2010).

The wholesale cuts of the left half of the carcasses are also presented in Table 2. The carcass lengths of the kids did not statistically differ among the groups. The long leg weight, neck weight, flank weight (P < 0.05) and shoulder weight (P < 0.01) were statistically different in the carcasses of AH, SH and H kids. The higher weights of valuable parts of the carcass were the indirect result of higher growth rates in AH and SH groups than in the H group. The data on weights of wholesale cuts of the left half-carcass indicated that AH and SH yielded better carcasses with more developed long leg, neck, flank and shoulder compared to H kids. These findings are not consistent with those of Yilmaz et al. (2010) who found that weights of the valuable carcass parts of Saanen × Hair goat kids were similar with those of Hair goats under intensive conditions. But, different slaughter weights, mature size of breed used and different raising conditions were difficult to make a direct comparison with other studies. The higher weight of marketable parts of goat carcass is result of being with higher carcass weights of AH and SH kids than that of H kids. In this study, significant differences among genotypes were found for carcass characteristics. These results indicate that Alpine and Saanen breeds could be used to improve carcass quality of Hair goats.

The proportional yields of carcass cuts and organs are presented in Table 3.

### Table 2
Slaughter and carcass characteristics of Alpine × Hair goat (AH), Saanen × Hair goat (SH) and Hair goat (H) male kids fed with concentrate in addition to grazing on rangeland (X ± SD).

<table>
<thead>
<tr>
<th>Traits</th>
<th>AH (n = 7)</th>
<th>SH (n = 7)</th>
<th>H (n = 7)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carcass weight (kg), dressing (%) and drip loss (%)</td>
<td>32.7 ± 0.9</td>
<td>32.8 ± 1.0</td>
<td>28.8 ± 0.9</td>
<td>*</td>
</tr>
<tr>
<td>Slaughter weight</td>
<td>13.3 ± 0.4</td>
<td>13.6 ± 0.4</td>
<td>11.5 ± 0.4</td>
<td>**</td>
</tr>
<tr>
<td>Hot carcass weight</td>
<td>12.9 ± 0.4</td>
<td>13.3 ± 0.4</td>
<td>11.1 ± 0.3</td>
<td>**</td>
</tr>
<tr>
<td>Cold carcass weight</td>
<td>39.4 ± 0.4</td>
<td>40.5 ± 0.4</td>
<td>38.5 ± 0.4</td>
<td>*</td>
</tr>
<tr>
<td>Drip loss</td>
<td>2.9 ± 0.3</td>
<td>2.4 ± 0.3</td>
<td>2.9 ± 0.2</td>
<td>NS</td>
</tr>
<tr>
<td>Offal items (kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head weight</td>
<td>2.07a ± 0.07</td>
<td>2.09ab ± 0.08</td>
<td>1.79b ± 0.07</td>
<td>*</td>
</tr>
<tr>
<td>4 feet weight</td>
<td>0.88 ± 0.3</td>
<td>0.88 ± 0.03</td>
<td>0.80 ± 0.02</td>
<td>NS</td>
</tr>
<tr>
<td>Skin weight</td>
<td>2.39 ± 0.13</td>
<td>2.15 ± 0.14</td>
<td>2.23 ± 0.13</td>
<td>NS</td>
</tr>
<tr>
<td>Heart and lungs weight</td>
<td>0.67 ± 0.03</td>
<td>0.67 ± 0.03</td>
<td>0.61 ± 0.02</td>
<td>NS</td>
</tr>
<tr>
<td>Liver weight</td>
<td>0.60 ± 0.02</td>
<td>0.60 ± 0.03</td>
<td>0.45 ± 0.02</td>
<td>*</td>
</tr>
<tr>
<td>Kidney weight</td>
<td>0.10 ± 0.00</td>
<td>0.10 ± 0.00</td>
<td>0.10 ± 0.00</td>
<td>NS</td>
</tr>
<tr>
<td>Spleen weight</td>
<td>0.09 ± 0.00</td>
<td>0.07ab ± 0.00</td>
<td>0.07a ± 0.00</td>
<td>NS</td>
</tr>
<tr>
<td>Kidney and pelvic fat weight</td>
<td>0.07 ± 0.01</td>
<td>0.07 ± 0.01</td>
<td>0.04 ± 0.01</td>
<td>NS</td>
</tr>
<tr>
<td>Internal fat weight</td>
<td>0.06 ± 0.00</td>
<td>0.06 ± 0.00</td>
<td>0.03a ± 0.00</td>
<td>*</td>
</tr>
<tr>
<td>Testes weight</td>
<td>0.24 ± 0.01</td>
<td>0.21a ± 0.01</td>
<td>0.17a ± 0.01</td>
<td>*</td>
</tr>
<tr>
<td>Tail weight</td>
<td>0.04 ± 0.00</td>
<td>0.04 ± 0.00</td>
<td>0.04 ± 0.00</td>
<td>NS</td>
</tr>
<tr>
<td>Carcass measurements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carcass length (cm)</td>
<td>71.6 ± 1.2</td>
<td>70.3 ± 1.3</td>
<td>70.3 ± 1.2</td>
<td>NS</td>
</tr>
<tr>
<td>M. Longissimus dorsi area (cm²)</td>
<td>10.5 ± 0.5</td>
<td>11.5 ± 0.6</td>
<td>8.9 ± 0.5</td>
<td>*</td>
</tr>
<tr>
<td>M. Longissimus dorsi depth (cm)</td>
<td>2.9 ± 0.1</td>
<td>3.1 ± 0.1</td>
<td>2.6 ± 0.1</td>
<td>NS</td>
</tr>
<tr>
<td>Wholesale cuts of left half of carcass (kg)</td>
<td>2.09 ± 0.07</td>
<td>2.18 ± 0.07</td>
<td>1.84 ± 0.07</td>
<td>*</td>
</tr>
<tr>
<td>Long leg weight</td>
<td>1.32 ± 0.07</td>
<td>1.30 ± 0.08</td>
<td>1.10 ± 0.07</td>
<td>NS</td>
</tr>
<tr>
<td>Shoulder weight</td>
<td>1.44 ± 0.03</td>
<td>1.50 ± 0.04</td>
<td>1.28 ± 0.03</td>
<td>**</td>
</tr>
<tr>
<td>Neck weight</td>
<td>0.75 ± 0.03</td>
<td>0.71 ± 0.04</td>
<td>0.60 ± 0.03</td>
<td>*</td>
</tr>
<tr>
<td>Flank weight</td>
<td>0.75 ± 0.04</td>
<td>0.80 ± 0.05</td>
<td>0.61b ± 0.04</td>
<td>*</td>
</tr>
</tbody>
</table>

*Values in the same line with different superscripts were statistically different (P < 0.05). NS: nonsignificant.

* P < 0.05, the differences among groups were statistically significant.

* P < 0.01, the differences among groups were statistically significant.
Except for the percentages of liver (P < 0.05), kidney (P < 0.01) and internal fat (P < 0.05), there were no significant differences in proportional yields of the AH, SH and H kids. The AH and SH kids deposited more internal fat compared to the H kids. Long leg, ribs and shoulder which make up the majority of carcass are considered commercially most valuable parts of carcass. However in this study, there were no significant differences among the groups in terms of proportion of these carcass parts. In contrast, Atay et al. (2010b) reported significant differences in the percentages of ribs, shoulder and neck of SH compared to H kids under intensive fattening conditions. But in the same study (Atay et al., 2010b), researchers reported non-significant differences in proportional yields between AH and H kids. Şimşek and Bayraktar (2007) also reported non significant differences between Saanen and Saanen × Hair goat (first cross) in proportional yields, except heart and lungs. Moreover, Yilmaz et al. (2010) reported non-significant differences related to the proportional yields of the valuable parts, organs and fats in the carcasses of Saanen × Hair goat (first cross) and Hair goat kids. In the present study, rates of the long leg, ribs and shoulder were in the range of 32.1–33.0%, 19.6–20.5% and 22.3–23.0%, respectively. These values of proportional yields are consistent with those of Yalcintas et al. (2010) and Atay et al. (2011) who studied on the Hair goats. In the present study, the proportional yields of the ribs of the kids are lower than found by Daşkıran et al. (2010) for Norduz kids (24.9–25.0%). But, the proportional yields of the long leg of the kids are higher than that of the Norduz kids (30.3–30.4%) (Daşkıran et al., 2010). In accordance with the results of the present study, a non-significant effect of genotype on the proportional yields of wholesale cuts of the carcass has been demonstrated by Dhanda et al. (2003a). The internal fat is highly variable and can be influenced by genotype, age, sex, nutrition, slaughter weight, physiological condition and physical activities (Solaiman et al., 2011). In the present study, the crossbred kids and Hair kids had different internal fat percentages relative to their hot carcass weights (P < 0.05).

There is a need for prevention of degradation of rangelands in rural areas caused by traditional goat production in Turkey. In addition, productivity of goats is low in this extensive system. An appropriate management system related to rearing, grazing and feeding should be improved for productivity and sustainability of the goat production. The present results showed that 300g/animal concentrate supplementation after the daily grazing period had desirable levels of growth and carcass productivity of the kids. The findings suggest that supplemental feeding should be made for achieving a good growth rate of kids and quality carcass production under rural conditions.

### 4. Conclusions

In developing countries, because of the low-productivity of indigenous breeds and inadequate environmental circumstances in traditional farming systems in rural areas, solutions must be aimed at genetic improvement (genetic selection and crossbreeding), developing new feeding strategies and the improvement of farming systems. One of the fundamental recommendations for the improvement in goat breeding in Turkey is crossbreeding of Hair goats with appropriate dairy goats (Kaymakçı and Engindeniz, 2010). However, there is a lack of well-planned goat breeding and improvement policies in rural regions of Turkey.

The present results showed that crossbreed groups (AH and SH) had desirable levels of growth and carcass characteristics under grazing conditions on rangeland. In this way concentrate feed addition to daily grazing seems to be useful to goat meat production. These findings suggest that crossbreeding Hair goat with Alpine or Saanen goats have equally important effects on achieving a good growth rate of kids and quality carcass production under rural
conditions with supplemental feeding. But, proportional yields, except for liver, internal fat and kidney percentages were not affected from genotype. Since the number of animals used in the study is relatively low, feeding with concentrate in addition to grazing on rangeland should be further evaluated using more animals. However, there is a need further investigations related to the effects of crossbreeding with dairy goats on different productive characteristics of Hair goats and on goat breeding sustainability under different conditions.

Conflict of interest

The author has not got a financial, personal or other relationship with other people or organisations within three years of beginning the submitted work that could inappropriately influence the paper entitled “Growth, slaughter and carcass characteristics of Alpine × Hair goat, Saanen × Hair goat and Hair goat male kids fed with concentrate in addition to grazing on rangeland”.

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