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# Fattening performance and carcass characteristics of Turkish indigenous Hair and Honamlı goat male kids

**Ahmet Hamdi AKTAŞ[1,*], Bekir GÖK[1], Serkan ATEŞ[1,2], Mehmet Emin TEKİN[3], İbrahim HALICI[1], Hüseyin BAŞ[1], Hakan ERDURAN[1], Shinan KASSAM[2]**

[1]Department of Animal Science, Bahri Dağdaş International Agricultural Research Institute, Konya, Turkey
[2]International Center for Agricultural Research in the Dry Areas, Amman, Jordan
[3]Department of Biostatistics, Faculty of Veterinary Medicine, Selçuk University, Konya, Turkey

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**Abstract:** This study was undertaken to measure the effect of fattening duration (60, 80, and 100 days) on growth performance and carcass characteristics of male kids from indigenous Hair and Honamlı goat breeds reared under intensive fattening systems in Turkey. Fattening duration had a significant effect ($P < 0.001$) on the fattening performance and a number of carcass characteristics of kids. An interaction was detected between genotype and fattening duration for average daily gain (ADG). Hair goat kids grew at a faster rate than Honamlı kids in the 20–40 day and 40–60 day fattening periods, but they maintained relatively similar ADGs within other fattening periods. On average, over the course of the fattening trial, Honamlı kids grew at an average daily rate of 209 g/head, while Hair goat kids grew at a daily rate of 231 g/head. Dressing percentage and carcass lean and fat percentages of kids increased ($P < 0.05$–$0.001$) with slaughter age and weight for both genotypes, whereas the percentage of bone decreased ($P < 0.001$) with each successive fattening period. No genotypic differences were detected for a number of carcass characteristics at the time of slaughter, with the exception of relatively higher ($P < 0.01$) fat deposit rates within the kidney and pelvic areas for Hair kids.

**Key words:** Hair goat, Honamlı goat, mountain livelihoods, intensive fattening, carcass traits

## 1. Introduction

The Mediterranean mountains are home to some of the poorest segments of the Turkish population, where the availability of land and water resources for smallholder farmers is limited and marginal at best (1,2). Goat production is of significant importance to livelihoods within this mountain agroecosystem and has a crucial role in alleviating rural poverty, enhancing food security, and spurring economic development for agropastoral communities. Within this environment, goats are typically reared under traditional extensive systems, either within mountainous pastures or highland forests. Longstanding environmental concerns related to forest degradation have, however, led to regulatory restrictions on livestock production systems. This has had a significant impact on traditional nomadic goat production systems, with a decrease in the number of goats from 19 million in 1980 to 10.3 million in 2014 (3).

With approximately 30% of the goat population present within the Mediterranean region of Anatolia (4,5), small ruminant production, and specifically low-input goat farming, is a potential source of significant economic return. Indigenous to this mountainous region and of economic importance to small-scale family farms, Hair goats ('Kıl' in Turkish) are a predominant breed and constitute 90% of the goat population in Turkey (4). Despite their low genetic potential for production, Hair goats are characterized by relatively good resistance to diseases and parasites and the ability to withstand unfavorable climates, endure periods of drought, and tolerate poor quality of grazing (2). In contrast, Honamlı goats represent a relatively small proportion of the goat population, maintain a larger body size relative to other indigenous goat breeds, and are typically raised by nomads on the hillsides of the Taurus Mountains (4–6).

Substantial knowledge on the fattening performance of indigenous Hair goats within various feeding systems in Turkey is available. There is a need, however, for a better understanding of the potential for enhancing profitability in intensive fattening production systems given a shift away from traditionally extensive rearing systems. Conclusive evidence related to fattening performance of the Honamlı genotype has not been reported, despite preferences for this genotype within nomadic production

* Correspondence: ahaktas@hotmail.com

systems. With relatively greater withers height and body length, conventional wisdom suggests that Honamlı goats maintain faster growth rates relative to other indigenous goat breeds. It is presumed, therefore, that this genotype may be better suited to both semiintensive and intensive fattening systems (5,6). With the exception of mere observational notes, however, quantified data on the growth rates of Honamlı genotype kids within different feeding systems are not readily available. In order to address this deficiency, a series of on-station and on-farm research studies within the framework of the "National genetic improvement project for small ruminants at breeders' conditions" in Turkey were carried out in order to quantify the performance of indigenous goat breeds within extensive and intensive fattening systems.

This study was undertaken in order to compare the fattening performance and carcass characteristics of Hair and Honamlı goat male kids slaughtered at days 60, 80, and 100 of the feeding period.

## 2. Materials and methods

### 2.1. Location, animals, and experimental design

This study was carried out in 2012 in Konya Province of Turkey and kids of Hair and Honamlı goats were obtained from the flocks used for the "National genetic improvement project for small ruminants at breeders' conditions" by the Ministry of Food, Agriculture, and Livestock.

A total of 30 Honamlı and 30 Hair goat single male kids born between 1 and 10 March 2012, and whose weights were closest to the mean flock live weight (LW) at weaning (day 75), were purchased from 3 Honamlı goat breeders in Beyşehir district (37°40′ N, 31°44′ E, 1158 m a.s.l.) and from 3 Hair goat flocks in Taşkent district (36°55′ N, 32°29′ E, 1545 m a.s.l.). These 2 districts situated within the Taurus Mountains have a gateway climate (summers are short, cool, and arid; winters are cold and snowy) between the Mediterranean and Central Anatolian climates. The geographic structures of the Taşkent and Beyşehir regions are composed of mountains, high-altitude plateaus, and valleys, and there is a large freshwater lake in the Beyşehir region. Forests of these 2 regions consist of juniper, cedar, spruce, black pine, and oak trees.

Except for heavy snowfall days in winter, Honamlı and Hair goats were fed in extensive conditions (in pasture, shrubbery, and forested areas) throughout the year. They were only given a limited amount of supplemental feeds in late pregnancy and birth season (daily 300–500 g of straw mixed with vetch and chickpeas/bean and 300–400 g of concentrate feeds containing barley and cottonseed). Goats were sheltered in open-top shelters in the pasture season, but they were sheltered in roofed shelters made from simple materials in winter and birth season. Honamlı and Hair goat kids utilized within this study suckled their mothers twice a day prior to weaning. Between days 25 and 30 after birth, Honamlı kids were provided a daily average of 100 g of concentrate feed (lamb-kid grower feed), but no concentrate feed was given to Hair goat kids prior to weaning. The kids of both breeds grazed on pasture, shrubbery, and forested areas in close proximity to the stockyard as separate groups away from the goats after the age of 30–40 days.

The selected kids were transported to the Small Ruminant Unit of the Bahri Dağdaş International Agricultural Research Institute (37°51′ N, 32°33′ E, 1008 m a.s.l.) in Konya, drenched for parasite removal, and placed into a sheep pen within an area of 3 $m^2$ per kid. Both genotypes of goats were weighed and randomly assigned by genotype (Honamlı and Hair) and fattening period groups (60, 80, and 100 days) with each group containing 10 kids at the beginning of the experiment. However, fattening period groups were kept and fed together as one flock of kids in both genotype groups until slaughter dates. Following a 15-day adaptation period, kids were fed ad libitum concentrate (15.1% CP and 2640 kcal ME) in pellet form and ad libitum dry alfalfa hay diet (14.8% CP and 1980 kcal ME) in a group feeding trial for three periods of 60, 80, and 100 days. Kids were provided with rock salt and mineral licking blocks in the feeders, along with troughs supplying a continuous provision of clean drinking water. Ingredients and calculated nutrient composition of the concentrate diet is presented in Table 1.

### 2.2. Measurements

LWs of the kids were recorded at the beginning of the trial and at 20-day intervals thereafter, following a 12-h fasting period with a scale sensitive to 0.1 kg. The initial LWs of the kids were 17.5 ± 0.62 kg for Honamlı and 13.4 ± 0.62 for Hair goat kids. All kids were fed once daily, with nonconsumed feed collected from the feeders and weighed prior to morning feeding at 3-day intervals. Feed conversion ratio (FCR) was calculated by dividing average daily feed intake (ADFI) by average daily gain (ADG).

At the end of each fattening period (days 60, 80, and 100), 12 kids (6 from each genotype and 36 in total) whose weights were closest to the group LW mean were slaughtered. At each slaughtering point, final LWs of the kids sent for slaughter were recorded after a 12-h fasting period and the kids were slaughtered. Hot carcass weight and weights of head, skin, feet, internal fat around the gastrointestinal tract, and visceral organs (heart, liver, lungs, and spleen) were recorded. Testes, kidneys, kidney and pelvic fat, and tail were excluded and their weights were recorded separately. Carcasses were chilled for 24 h at 4 °C prior to weighing, with cold dressing percentage calculated as a ratio of slaughter weight to cold carcass weight. Carcass measurements (chest circumference, chest depth, chest width, body length, leg circumference, and leg

**Table 1.** Formulation and calculated nutrient composition of the ration.

| Item | g/kg |
|---|---|
| Ingredient | |
| Maize grain | 160 |
| Barley | 200 |
| Wheat | 150 |
| Wheat middlings | 185 |
| Cotton seed meal | 70 |
| Soybean meal, solvent, 0.49 | 50 |
| Distiller's dried grains with solubles | 100 |
| Molasses | 50 |
| Limestone | 26 |
| Salt | 8 |
| Vitamin-mineral premix* | 1 |
| Calculated nutrient composition (as fed) | |
| Dry matter | 890 |
| Metabolizable energy (kcal/kg) | 2640 |
| Crude protein | 151 |
| Calcium | 10.4 |
| Phosphorus | 5.1 |
| Crude fiber | 49.1 |

*The vitamin-mineral mix contained 15,000,000 IU of vitamin A, 3,000,000 IU of vitamin D3, 30,000 mg of vitamin E, 50,000 mg of Mn, 50,000 mg of Fe, 50,000 mg of Zn, 10,000 mg of Cu, 150 mg of Co, 800 mg of I, and 150 mg of Se per kg.

width) were subsequently analyzed after chilling. Carcasses were split down the dorsal midline with an automatic saw, with the left half of the carcass divided into cuts according to the procedure described by Colomer-Rocher et al. (7). 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 measuring using a planimeter. The rack of ribs (6th through 12th ribs) was removed from the left side of each carcass and separated into soft tissues (lean, subcutaneous, and intermuscular fat and waste ligament) and bone tissues. The tissues were measured and the results were expressed as percentages of rack weights.

### 2.3. Economic analyses

Total production costs included concentrate feed, alfalfa hay, and labor costs (35 US$/day for a flock of 300 goats). Concentrate feed and dry alfalfa costs were based on current market prices in 2012. Daily and total feeding costs per kid were calculated with prevailing market prices for concentrate feed (40 cents/kg) and alfalfa hay (0.26 cents/kg). Meat production per kid (kg/head) was calculated by multiplying ADG of kids (g/head/day) by the duration (60, 80, and 100 days) of the feeding experiment for both genotypes. Total meat production revenue was calculated on the basis of average market prices for goat meat (10 US$/kg) in Turkey over the period of study in 2012.

### 2.4. Data analysis and statistics

Data related to LWs and ADGs of kids were analyzed as a repeated measurement using a general linear model (GLM) procedure. The initial LWs prior to fattening were introduced as a covariance factor for all LW and ADG traits at all fattening periods. Carcass data were analyzed by employing a GLM approach. Slaughter times were analyzed independently of one another. Preslaughter weights at days 80 and 100 were introduced as a covariance factor for hot and cold carcass weights, dressing percentages, all offal items, and all percentage contributions of different cuts of the left half carcass given that the differences between genotypes were observed at significance levels of $P < 0.05$. Feed intakes and FCRs could not be analyzed statistically within this group feeding trial. Statistical analysis was performed with the Minitab program (8).

## 3. Results

### 3.1. Growth performance, feed intake, and feed efficiency

LW, ADG, ADFI, and FCR of the kids for the 100-day fattening period are given in Figure 1 and Table 2. Final mean LWs were 36.8 kg and 38.4 kg ($P < 0.05$) for Honamlı and Hair kids, respectively (Figure 1a). ADGs of the kids at days 0–60, 0–80, and 0–100 were 197, 204, and 221 g, respectively. On average, over the course of the fattening period, Honamlı kids grew at a rate of 209 g/head/day, while Hair goat kids grew at 231 g/head/day (Figure 1b). The difference in ADGs was not statistically significant. A genotype × fattening duration interaction ($P < 0.05$) was detected for the ADG of the kids (Figure 1b). The LWs of kids were similar at most measurement periods, with the exception of days 60 and 100, when Hair goat kids maintained greater LW gains relative to Honamlı goat kids (Figure 1a). The Hair goat kids also grew faster than Honamlı kids in the 20–40 day and 40–60 day fattening periods, while the kids of both genotypes had similar ADGs in the 0–20 day, 60–80 day, and 80–100 day fattening periods (Figure 1b).

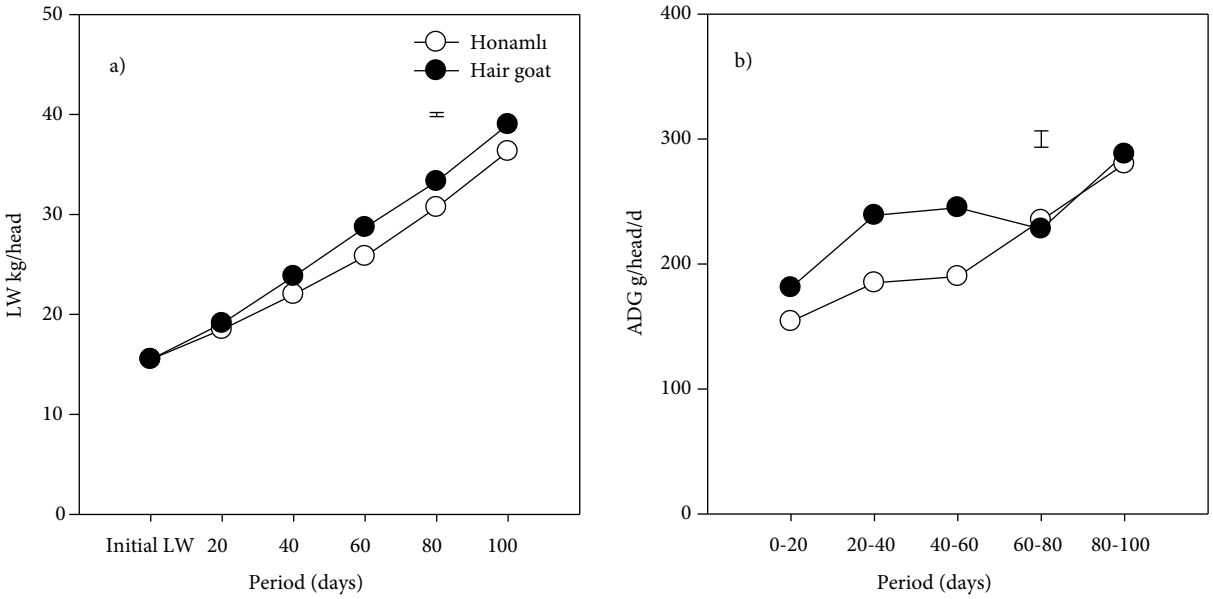


**Figure 1.** Live weights (a) and average daily weight gains (b) of kids at different periods of fattening. The initial live weight covariant was 15.5 ± 0.22 kg because differences in the initial weight were statistically significant ($P < 0.05$). Bars represent period × genotype interactions.

**Table 2.** Average daily feed intake and feed efficiency of kids at different periods.

| Periods | Average daily feed intake, g | | | | | | Feed conversion ratio | |
|---|---|---|---|---|---|---|---|---|
| | Honamlı kids | | | Hair kids | | | Honamlı kids | Hair kids |
| | Concentrate ration | Alfalfa hay | Total | Concentrate ration | Alfalfa hay | Total | | |
| 0–20 days | 162 | 579 | 741 | 235 | 488 | 723 | 4.8 | 4.0 |
| 20–40 days | 303 | 615 | 918 | 351 | 552 | 903 | 5.3 | 3.8 |
| 40–60 days | 544 | 622 | 1166 | 471 | 574 | 1045 | 6.1 | 4.3 |
| 60–80 days | 943 | 442 | 1385 | 805 | 463 | 1268 | 5.7 | 5.6 |
| 80–100 days | 1106 | 569 | 1675 | 1079 | 475 | 1554 | 5.9 | 5.4 |
| 0–60 days | 336 | 605 | 941 | 352 | 538 | 890 | 5.4 | 4.0 |
| 0–80 days | 488 | 564 | 1052 | 466 | 519 | 985 | 5.5 | 4.4 |
| 0–100 days | 612 | 565 | 1176 | 588 | 511 | 1099 | 5.6 | 4.7 |

Feed conversion ratio was calculated as average daily feed intake (g) / average daily gain (g).

### 3.2. Slaughter characteristics

Slaughter characteristics at days 60, 80, and 100 of the fattening period are provided in Table 3. No statistically significant differences between the genotypes were detected for any traits, with the exception of feet weight and proportions at days 60 and 80, which were relatively larger ($P < 0.05$) for Honamlı kids. Hot carcass dressing ranged from 44.3% to 49.3% and did not change with genotype ($P > 0.05$) or fattening period. Offal items, other than heart and lungs, had noticeable increases in their proportions and sizes in varying degrees as the fattening period progressed. The omental-mesenteric fat percentages increased from 0.9% at day 60 to 2.0% at day 100.

**Table 3.** Least squares means for the slaughter characteristics of kids at days 60, 80, and 100 of fattening period.

| Slaughter time* | Day 60 | | | Day 80 | | | Day 100 | | |
|---|---|---|---|---|---|---|---|---|---|
| Traits | Honamlı | Hair | | Honamlı | Hair | | Honamlı | Hair | |
| | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P |
| Number of slaughtered kids | 6 | 6 | | 6 | 6 | | 6 | 6 | |
| Preslaughter weight, kg | 25.9 ± 0.73 | 25.0 ± 0.73 | 0.381 | 33.6 ± 1.01 | 29.4 ± 1.01 | 0.016 | 38.8 ± 1.08 | 34.6 ± 1.08 | 0.021 |
| Preslaughter weight**, kg | | | | 31.5 ± 0.93 | 31.5 ± 0.93 | | 36.7 ± 0.96 | 36.7 ± 0.96 | |
| Hot carcass weight, kg | 11.5 ± 0.33 | 11.3 ± 0.33 | 0.699 | 14.9 ± 0.20 | 14.8 ± 0.20 | 0.957 | 18.1 ± 0.28 | 17.9 ± 0.28 | 0.683 |
| Hot dressing percentage, % | 44.3 ± 1.52 | 45.2 ± 1.52 | 0.068 | 47.2 ± 0.64 | 47.1 ± 0.64 | 0.910 | 49.3 ± 0.72 | 48.9 ± 0.72 | 0.691 |
| Offal items | | | | | | | | | |
| Omental and mesenteric fat, g | 237 ± 26.8 | 228 ± 26.8 | 0.820 | 256 ± 63.8 | 376 ± 63.8 | 0.273 | 709 ± 94.4 | 700 ± 94.4 | 0.952 |
| Omental and mesenteric fat, % | 0.9 ± 0.08 | 0.9 ± 0.08 | 0.928 | 0.8 ± 0.20 | 1.2 ± 0.20 | 0.284 | 2.0 ± 0.27 | 1.9 ± 0.27 | 0.931 |
| Skin weight, kg | 2.24 ± 0.106 | 2.06 ± 0.106 | 0.254 | 2.89 ± 0.102 | 2.84 ± 0.102 | 0.788 | 3.33 ± 0.173 | 3.63 ± 0.173 | 0.302 |
| Skin percentage, % | 8.6 ± 0.20 | 8.2 ± 0.20 | 0.210 | 9.2 ± 0.30 | 9.0 ± 0.30 | 0.763 | 9.1 ± 0.44 | 9.9 ± 0.44 | 0.284 |
| Feet weight, kg | 0.80 ± 0.055 | 0.63 ± 0.055 | 0.048 | 1.04 ± 0.040 | 0.87 ± 0.040 | 0.027 | 1.06 ± 0.032 | 1.05 ± 0.032 | 0.795 |
| Feet percentage, % | 3.1 ± 0.14 | 2.5 ± 0.14 | 0.017 | 3.3 ± 0.13 | 2.8 ± 0.13 | 0.028 | 2.9 ± 0.09 | 2.9 ± 0.09 | 0.755 |
| Head weight, kg | 1.39 ± 0.057 | 1.29 ± 0.057 | 0.252 | 1.80 ± 0.091 | 1.77 ± 0.091 | 0.859 | 2.11 ± 0.057 | 2.27 ± 0.057 | 0.099 |
| Head percentage,% | 5.4 ± 0.14 | 5.2 ± 0.14 | 0.340 | 5.7 ± 0.31 | 5.6 ± 0.31 | 0.844 | 5.8 ± 0.16 | 6.2 ± 0.16 | 0.106 |
| Heart and lungs weight, kg | 1.12 ± 0.076 | 1.03 ± 0.076 | 0.453 | 1.44 ± 0.044 | 1.42 ± 0.044 | 0.806 | 1.59 ± 0.053 | 1.69 ± 0.053 | 0.260 |
| Heart and lungs percentage, % | 4.3± 0.18 | 4.1 ± 0.18 | 0.548 | 4.6 ± 0.14 | 4.5 ± 0.14 | 0.805 | 4.3 ± 0.15 | 4.6 ± 0.15 | 0.255 |

LSM: Least squares mean, SE: standard error of mean, P: level of significance.
*: Slaughter times were analyzed independently of one another.
**: The preslaughter weights at days 80 and 100 were introduced as a covariance factor for hot carcass weight and dressing percentage and for all offal items because differences in slaughter weights were statistically significant ($P < 0.05$). The preslaughter weight covariates were 31.5 ± 0.93 kg for day 80 and 36.7 ± 0.96 kg for day 100.

### 3.3. Carcass characteristics and percentages of carcass joints

Carcass characteristics and proportions of carcass joints are presented in Table 4. No significant difference ($P > 0.05$) was found between Honamlı and Hair goat kids in terms of carcass characteristics and proportions of carcass joints, with the exception of kidney and pelvic fat percentage ($P < 0.05$) at days 60 and 80, which were higher for Hair goats relative to Honamlı goat kids. Hot carcass weights were not statistically different ($P > 0.05$) between Honamlı and Hair goat kids, with both maintaining a steady increase over the course of fattening. Proportions of kidney and pelvic fat were 1.08 and 1.17 when the kids were slaughtered at day 60 and increased to 2.11 and 2.32 at day 100 for Honamlı and Hair kids, respectively. Fat deposit rates around the kidney and pelvic areas were higher ($P < 0.05$) for Hair kids relative to Honamlı kids at days 60 and 80 but were not statistically different ($P > 0.05$) at day 100.

### 3.4. Carcass measurements

Carcass measurements are presented in Table 5. Carcass length at days 80 and 100, external and interior leg lengths at day 80, and leg circumference at day 100 were greater for Honamlı than Hair goat kids ($P < 0.05$, Table 5).

### 3.5. Dissected tissue proportions

The dissected rack joint tissue compositions of left half carcasses are provided in Table 6. No significant differences ($P > 0.05$) were detected between the genotypes for tissue proportions in rack parts and MLD areas at any slaughter period (Table 6).

### 3.6. Effect of fattening duration and genotype on slaughter traits, carcass characteristics, and tissue percentages of kids

Effect of fattening duration on a number of slaughter traits, carcass characteristics, tissue percentages, and MLD areas are presented in Table 7. Fattening duration had a significant effect ($P < 0.05–0.001$) on slaughter traits, carcass characteristics, and tissue percentages. Preslaughter weights ($P < 0.001$) and hot and cold carcass dressing percentages ($P < 0.001$) increased over successive fattening periods and slaughter weights.

### 3.7. Economic analysis

Economic data for both genotypes at the end of each of the fattening periods are provided in Table 8. Given that the only varying factors were feed consumption and associated live weight gain, economic analysis is only indicative. Profitability per kilogram remained constant

**Table 4.** Least squares means for the carcass characteristics and percentage contributions of different cuts of the left half carcass.

| Slaughter time* | Day 60 | | | Day 80 | | | Day 100 | | |
|---|---|---|---|---|---|---|---|---|---|
| Traits | Honamlı | Hair | | Honamlı | Hair | | Honamlı | Hair | |
| | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P |
| Cold carcass weight, kg | 11.2 ± 0.32 | 11.0 ± 0.32 | 0.746 | 15.4 ± 0.49 | 13.7 ± 0.49 | 0.033 | 18.7 ± 0.60 | 16.4 ± 0.60 | 0.020 |
| Cold carcass weight**, kg | | | | 14.4 ± 0.19 | 14.6 ± 0.19 | 0.511 | 17.6 ± 0.27 | 17.4 ± 0.27 | 0.680 |
| Cold dressing percentage, % | 43.2 ± 0.35 | 44.2 ± 0.35 | 0.064 | 45.8 ± 0.62 | 46.5 ± 0.62 | 0.536 | 48.0 ± 0.73 | 47.5 ± 0.73 | 0.689 |
| Shoulder percentage | 21.4 ± 0.25 | 21.8 ± 0.25 | 0.242 | 21.6 ± 0.44 | 21.5 ± 0.44 | 0.904 | 21.1 ± 0.27 | 21.2 ± 0.27 | 0.717 |
| Flank percentage | 10.9 ± 0.23 | 10.6 ± 0.23 | 0.513 | 10.2 ± 0.61 | 10.7 ± 0.61 | 0.665 | 10.9 ± 0.41 | 10.7 ± 0.41 | 0.624 |
| Long leg percentage | 33.5 ± 0.19 | 33.3 ± 0.19 | 0.559 | 33.9 ± 0.60 | 32.5 ± 0.60 | 0.194 | 31.7 ± 0.56 | 31.9 ± 0.56 | 0.719 |
| Neck percentage | 8.6 ± 0.31 | 8.1 ± 0.31 | 0.352 | 8.6 ± 0.36 | 8.4 ± 0.36 | 0.719 | 9.5 ± 0.37 | 9.2 ± 0.37 | 0.511 |
| Ribs percentage | 23.3 ± 0.29 | 23.5 ± 0.29 | 0.490 | 23.0 ± 0.37 | 23.9 ± 0.37 | 0.167 | 23.6 ± 0.71 | 23.5 ± 0.71 | 0.930 |
| Tail percentage | 0.40 ± 0.028 | 0.41 ± 0.028 | 0.818 | 0.38 ± 0.020 | 0.35 ± 0.020 | 0.406 | 0.35 ± 0.021 | 0.36 ± 0.021 | 0.731 |
| Kidney percentage | 1.14 ± 0.045 | 1.12 ± 0.045 | 0.716 | 1.01 ± 0.046 | 1.00 ± 0.046 | 0.809 | 0.74 ± 0.042 | 0.82 ± 0.042 | 0.188 |
| Kidney-pelvic fat percentage | 1.08 ± 0.023 | 1.17 ± 0.023 | 0.015 | 1.32 ± 0.076 | 1.74 ± 0.076 | 0.007 | 2.11 ± 0.305 | 2.32 ± 0.305 | 0.633 |

LSM: Least squares mean, SE: standard error of mean, P: level of significance.
*: Slaughter times were analyzed independently of one another.
**: The preslaughter weights at days 80 and 100 were introduced as covariance factors for cold carcass weight, dressing percentage, and all percentage contribution of different cuts because differences in slaughter weights were statistically significant ($P < 0.05$). The preslaughter weight covariates were 31.5 ± 0.93 kg for day 80 and 36.7 ± 0.96 kg for day 100.

**Table 5.** Least squares means for the carcass measurements of kids at different fattening durations, cm.

| Slaughter time* | Day 60 | | | Day 80 | | | Day 100 | | |
|---|---|---|---|---|---|---|---|---|---|
| Traits | Honamlı | Hair | | Honamlı | Hair | | Honamlı | Hair | |
| | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P |
| Chest circumference | 63.5 ± 0.89 | 63.9 ± 0.89 | 0.708 | 66.8 ± 0.70 | 65.3 ± 0.70 | 0.161 | 71.1 ± 0.95 | 68.7 ± 0.95 | 0.105 |
| Chest depth | 22.4 ± 0.35 | 22.5 ± 0.35 | 0.793 | 25.6 ± 0.26 | 24.8 ± 0.26 | 0.048 | 27.3 ± 0.41 | 26.1 ± 0.41 | 0.067 |
| Chest width | 14.1 ± 0.37 | 13.9 ± 0.37 | 0.736 | 13.9 ± 0.31 | 13.7 ± 0.31 | 0.627 | 15.7 ± 0.24 | 15.2 ± 0.24 | 0.183 |
| Rump width | 15.7 ± 0.34 | 15.9 ± 0.34 | 0.683 | 13.7 ± 0.35 | 13.6 ± 0.35 | 0.767 | 16.2 ± 0.20 | 16.1 ± 0.20 | 0.598 |
| Carcass length | 67.0 ± 0.64 | 67.4 ± 0.64 | 0.722 | 73.1 ± 0.57 | 70.8 ± 0.57 | 0.015 | 75.8 ± 1.07 | 71.7 ± 1.07 | 0.022 |
| Leg circumference | 37.7 ± 0.51 | 36.8 ± 0.51 | 0.250 | 44.8 ± 0.73 | 43.2 ± 0.73 | 0.169 | 46.9 ± 0.59 | 44.6 ± 0.59 | 0.018 |
| External leg length | 39.4 ± 0.48 | 38.6 ± 0.48 | 0.279 | 42.4 ± 0.48 | 39.9 ± 0.48 | 0.005 | 42.9 ± 0.72 | 41.2 ± 0.72 | 0.123 |
| Interior leg length | 32.9 ± 0.67 | 31.5 ± 0.67 | 0.173 | 32.8 ± 0.50 | 30.1 ± 0.50 | 0.003 | 32.6 ± 0.50 | 31.5 ± 0.50 | 0.148 |

LSM: Least squares mean, SE: standard error of mean, P: level of significance.
*: Slaughter times were analyzed independently of one another.

**Table 6.** Least squares means for the proportions of dissected tissues of rack joint and m. longissimus dorsi (MDL) area.

| Slaughter time* | Day 60 | | | Day 80 | | | Day 100 | | |
|---|---|---|---|---|---|---|---|---|---|
| Traits | Honamlı | Hair | | Honamlı | Hair | | Honamlı | Hair | |
| | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P | LSM ± SE | LSM ± SE | P |
| Rack joint weight, g | 574 ± 37.2 | 600 ± 37.2 | 0.637 | 729 ± 36.3 | 642 ± 36.3 | 0.121 | 785 ± 37.2 | 709 ± 37.2 | 0.637 |
| Lean percentage | 55.2 ± 1.32 | 53.7 ± 1.32 | 0.445 | 56.7 ± 1.09 | 56.0 ± 1.09 | 0.630 | 57.9 ± 1.00 | 56.8 ± 1.00 | 0.465 |
| Bone percentage | 34.0 ± 1.44 | 34.9 ± 1.44 | 0.667 | 29.7 ± 1.17 | 31.9 ± 1.17 | 0.211 | 28.0 ± 0.97 | 29.6 ± 0.97 | 0.282 |
| Subcutaneous fat percentage | 3.1 ± 0.16 | 3.2 ± 0.16 | 0.485 | 4.0 ± 0.25 | 3.6 ± 0.25 | 0.273 | 4.2 ± 0.26 | 3.9 ± 0.26 | 0.533 |
| Intermuscular fat percentage | 5.8 ± 0.35 | 6.1 ± 0.35 | 0.517 | 7.7 ± 0.39 | 6.7 ± 0.39 | 0.115 | 8.1 ± 0.48 | 7.9 ± 0.48 | 0.821 |
| Total fat percentage | 8.8 ± 0.48 | 9.3 ± 0.48 | 0.482 | 11.7 ± 0.63 | 10.4 ± 0.63 | 0.155 | 12.4 ± 0.68 | 11.8 ± 0.68 | 0.602 |
| Waste percentage | 1.9 ± 0.04 | 2.0 ± 0.04 | 0.138 | 1.9 ± 0.06 | 1.8 ± 0.06 | 0.385 | 1.9 ± 0.08 | 1.8 ± 0.08 | 0.440 |
| Muscle/bone ratio | 1.7 ± 0.11 | 1.6 ± 0.11 | 0.551 | 1.9 ± 0.11 | 1.8 ± 0.11 | 0.288 | 2.1 ± 0.10 | 1.9 ± 0.10 | 0.296 |
| Muscle/fat ratio | 6.3 ± 0.36 | 5.9 ± 0.36 | 0.393 | 4.9 ± 0.33 | 5.5 ± 0.33 | 0.252 | 4.7 ± 0.32 | 4.9 ± 0.32 | 0.617 |
| MLD area, $cm^2$ | 9.23 ± 0.477 | 9.48 ± 0.477 | 0.720 | 10.15 ±0.313 | 9.75 ± 0.313 | 0.450 | 11.80 ± 0.669 | 11.05 ± 0.669 | 0.501 |

LSM: Least squares mean, SE: standard error of mean, P: level of significance.
*: Slaughter times were analyzed independently of one another.

**Table 7.** Least squares means for the effect of fattening duration on some slaughter traits, carcass characteristics, and tissue percentages.

| Slaughter time | Day 60 | Day 80 | Day 100 | |
|---|---|---|---|---|
| Traits | LSM ± SE | LSM ± SE | LSM ± SE | P |
| Number of slaughtered kids | 12 | 12 | 12 | |
| Preslaughter weight, kg | $25.4 \pm 0.83^{c}$ | $31.5 \pm 0.83^{b}$ | $36.7 \pm 0.83^{a}$ | 0.001 |
| Hot dressing percentage, % | $44.8 \pm 0.36^{c}$ | $47.2 \pm 0.36^{b}$ | $49.1 \pm 0.36^{a}$ | 0.001 |
| Omental and mesenteric fat, % | $0.9 \pm 0.12^{b}$ | $1.0 \pm 0.12^{b}$ | $1.9 \pm 0.12^{a}$ | 0.001 |
| Cold dressing percentage, % | $43.7 \pm 0.36^{c}$ | $46.2 \pm 0.36^{b}$ | $47.7 \pm 0.36^{a}$ | 0.001 |
| Kidney-pelvic fat percentage, % | $1.1 \pm 0.14^{b}$ | $1.5 \pm 0.14^{b}$ | $2.2 \pm 0.14^{a}$ | 0.001 |
| Lean percentage, % | $54.5 \pm 0.79^{b}$ | $56.3 \pm 0.79^{ab}$ | $57.3 \pm 0.79^{a}$ | 0.048 |
| Bone percentage, % | $34.5 \pm 0.85^{a}$ | $30.8 \pm 0.85^{b}$ | $28.8 \pm 0.85^{b}$ | 0.001 |
| Subcutaneous fat percentage, % | $3.2 \pm 0.16^{b}$ | $3.8 \pm 0.16^{a}$ | $4.1 \pm 0.16^{a}$ | 0.001 |
| Intermuscular fat percentage, % | $5.9 \pm 0.29^{b}$ | $7.2 \pm 0.29^{a}$ | $8.0 \pm 0.29^{a}$ | 0.001 |
| Total fat percentage, % | $9.1 \pm 0.43^{b}$ | $11.0 \pm 0.43^{a}$ | $12.1 \pm 0.43^{a}$ | 0.001 |
| Muscle/bone ratio | $1.6 \pm 0.08^{b}$ | $1.9 \pm 0.08^{ab}$ | $2.0 \pm 0.08^{a}$ | 0.003 |
| Muscle/fat ratio | $6.1 \pm 0.24^{a}$ | $5.2 \pm 0.24^{b}$ | $4.8 \pm 0.24^{b}$ | 0.002 |
| MLD area, $cm^2$ | $9.4 \pm 0.39^{b}$ | $10.0 \pm 0.39^{b}$ | $11.4 \pm 0.39^{a}$ | 0.002 |

LSM: Least squares means, SE: standard error of means, P: level of significance.
$^{a,b,c}$: Values shown with different letters in the same row differ significantly ($P < 0.05$).

**Table 8**. Profitability analysis.

| | Honamlı kids | | | Hair kids | | |
|---|---|---|---|---|---|---|
| | 60 days | 80 days | 100 days | 60 days | 80 days | 100 days |
| Average intake of concentrates (g/head/day) | 336.00 | 488.00 | 612.00 | 352.00 | 466.00 | 588.00 |
| Average intake of alfalfa hay (g/head/day) | 605.00 | 564.00 | 565.00 | 538.00 | 519.00 | 511.00 |
| Daily feeding cost/kid (US$/day)* | 0.29 | 0.34 | 0.39 | 0.28 | 0.32 | 0.37 |
| Total feeding cost/kid (US$) | 17.50 | 27.30 | 39.10 | 16.80 | 25.70 | 36.80 |
| Total labor costs/kid** | 11.20 | 14.90 | 18.70 | 11.20 | 14.90 | 18.70 |
| Total costs | 28.70 | 42.20 | 57.80 | 28.00 | 40.60 | 55.50 |
| Average LW gain (g/head/day) | 173.00 | 190.00 | 209.00 | 221.00 | 223.00 | 236.00 |
| Total LW production (kg/head) | 10.38 | 15.20 | 20.90 | 13.26 | 17.84 | 23.60 |
| Total revenue*** | 103.80 | 152.00 | 209.00 | 132.60 | 178.40 | 236.00 |
| Profit from cumulative LW gain | 75.10 | 110.00 | 152.00 | 104.00 | 138.00 | 181.00 |
| Profit per kg of cumulative LW gain | 7.23 | 7.23 | 7.27 | 7.84 | 7.73 | 7.67 |

*Feeding costs: concentrated feed in the market = 40 cents/kg, alfalfa hay = 0.26 cents/kg.
**Labor costs: 35 US$/day for a flock of 300 goats.
***Value of kid meat: 10 US$/kg.

for the Honamlı genotype over the duration of fattening but decreased for Hair kids over successive fattening periods.

## 4. Discussion

### 4.1. Growth performance, feed intake, and feed efficiency

Within this study, Hair goat kids grew faster than Honamlı kids in the 20–40 day and 40–60 day fattening periods while the kids of both genotypes had similar ADGs in the 0–20 day, 60–80 day, and 80–100 day fattening periods (Figure 1b). One item of particular note is that faster growth rates for Hair goat kids within early fattening periods may reflect compensatory growth, as initial LWs were lower than those of Honamlı kids at the same age. This is possibly due to poor feeding conditions prior to purchase from local breeders in the Taşkent district where the Hair goat kids were purchased. Severe winter conditions in Taşkent in 2012, which limited pasture grazing options for local goat flocks, may have exacerbated issues of access to feed and forage for the Hair kids purchased.

There are no publicly available data related to live weight gains of Honamlı goat kids under any type of production system to compare with the results of the present study. Findings of the current study, therefore, provide the first knowledge publicly available that can be used as indicators for fattening performance of Honamlı goat kids. Overall, the ADGs of kids over 100 days of fattening period obtained within the current study compare favorably with the 82–160 g/head/day for Hair goat kids reported by several other authors (9–11). ADGs within the present study are comparable with the findings of Karaca (12), who reported an ADG of 203 g/head/day with Akkeçi male kids, and those of Kaić et al. (13), who reported an ADG of 204 g/head/day with male Boer kids, but lower than the ADG of 258 g/head/day with Boer × Balcalı crossbreeds (14) under intensive feeding systems. Despite the fact that similar growth rates of Hair goats and Boer kids may be surprising, comparable performances of indigenous breeds of goats and sheep to improve small ruminant breeds even in high-input feeding systems have been reported by some authors (15,16).

Relative to previous studies, higher live weight gains reported in this study would appear to reflect the high dry matter intakes of kids and is likely the result of the ad libitum offer of dry alfalfa and concentrated feed. It is well established that an increasing level of feed allowance results in higher feed intake, better opportunities for selection, and consequently a higher nutritive value of consumed diets (17). The average feed intake, in particular the intake of dry alfalfa (538 g/head/day) in the present study, is generally greater than the intake of the kids (average of 100-200 g/head/day roughage) reported in the previous studies mentioned above. The high performance of Hair kids within the present study is also reflective of better

feed conversion efficiencies for both genotypes relative to FCRs of Hair goat kids with 6.4–7.8 under intensive fattening as reported by Yalçıntan et al. (10) and Atay et al. (11). However, for Akkeçi male kids whose FCR was in the range of 3.26–3.60 (12), the results were superior to the findings of the present study. Despite increasing the ADG of the kids with the advancing fattening periods, the FCR of the kids increased as well, which may reflect better performances of the kids in shorter feeding periods. However, the profitability of the fattening did not seem to change with the fattening periods (Table 8).

ADFIs for Honamlı kids increased from 741 g/head/day (0–20 days) to 1675 g/head/day (80–100 days) and from 723 g/head/day (0–20 days) to 1554 g/head/day (80–100 days) for Hair goat kids. An increase in feed intake was a result of higher intake of concentrated feed, while the consumption of dry alfalfa remained relatively similar for both genotypes over the course of the entire feeding period (Table 2). While no statistical analyses were undertaken on the ADFI and FCR due to group feeding, Hair kids appeared to possess better FCR relative to Honamlı kids during the 0–60 day period of fattening. This is possibly a reflection of compensatory growth for Hair goat kids. A general relationship of feed efficiency to fattening period or age is that feed efficiency becomes poorer with increasing age and successive fattening periods (18). An increasing trend in ADFI, with a tendency for increasing feed-to-gain ratio over successive fattening periods, is likely an indicator of better performance in shorter fattening periods, with extended fattening periods generally required in order to rear the animals to target slaughter weights (18). An interesting feature of the results was that feed efficiency was the lowest when roughage-to-concentrate ratio was at its peak during the 0–60 day fattening period and relative to the 60–100 day period. This result does not fully concur with the findings of Oliveira et al. (19), who reported that increasing the roughage-to-concentrate ratio led to poorer feed efficiency in lactating goats.

**4.2. Slaughter characteristics**

Previous fattening studies with Hair goat (9,11) and Norduz goat kids (20) suggested that hot dressing percentage and omental-mesenteric fat proportions were 42.4%–49.0% and 1.2%–1.9%, respectively. Results obtained from this study are consistent with the range of values obtained in the previous studies cited above.

**4.3. Carcass characteristic and percentages of carcass joints**

The findings of this study concur with results from previous studies that reported genotypic effects on cold dressing and carcass joint proportions under intensive fattening conditions in Turkey for Saanen, Maltese, Gökçeada, Hair goat, and crossbred kids of Hair goat (9,11,21,22). More specifically, and in line with the findings of this study, no genotypic differences were reported in cold dressing and carcass joint proportions within the literature cited.

A number of studies have reported that cold dressing percentage of kids range between 37.1% and 47.6% for Hair goat and other native goat breeds (9,11,23,24). In the current study, the cold dressing percentage based on slaughter weight of Honamlı and Hair goat kids ranged from 43.2% to 48.0% at slaughter days of 60, 80, and 100. Similar cold dressing percentages were also reported by Şimşek and Bayraktar (9), Atay et al. (11), and Gürsoy et al. (23), while Daskiran et al. (20), Yilmaz et al. (21), and Gökdal (24) reported lower values. Proportions of carcass parts were generally similar to the results of previous studies at similar carcass weights (9,11,20–25). With the exception of proportions of shoulders and ribs, which were higher than in the findings reported by Şimşek and Bayraktar (9) and Gürsoy et al. (23), findings of the current study on long leg percentages were relatively lower. Proportions of kidney and pelvic fat are comparable to the values (0.9% and 2.6%) reported in previous studies at similar slaughter weights (9,11,20,21,23). Variation in the values reported on carcass characteristics within the literature is likely attributable to differences in genotype (rates of growth, fat deposition rates), age, slaughter weight, feeding system, and duration.

**4.4. Carcass measurements**

Results related to carcass measurements are similar to the findings of previous studies that reported that Honamlı goats maintained larger body sizes with greater withers height and body length than other indigenous goat breeds (5,6). Carcass measurements of Hair goat kids recorded in this study were higher than the values reported by Yilmaz et al. (21) and were generally similar to the findings of Şimşek and Bayraktar (9), with the exception of leg circumference, which was found to be relatively higher in our study.

**4.5. Dissected tissue proportions**

With respect to dissected tissue compositions for kids of various genotypes in a number of different studies, reported proportions ranged from 46.6% to 63.1% for muscle, 22.0% to 38.9% for bone, and 8.0% to 18.0% for total fat (18,20–22,25–27). Proportions of lean tissue (53.7%–56.8%) obtained in this study were similar to findings reported by Yalçıntan et al. (22) and Toplu et al. (25) for Hair kids, but lower than values reported by Yilmaz et al. (21) and higher than the proportions reported by Daskiran et al. (20) with Norduz kids. Proportions of lean tissue were lower than those reported in some other studies (18,26).

Total bone percentages (28.0%–34.9%) within this study were higher than the values of Peña et al. (26) and Yalçıntan et al. (22), but were similar to the results reported in a number of other studies (18,21,25,27).

Proportions of fat tissue (8.8%–12.4%) observed were lower than the results reported by Peña et al. (26) and Solaiman et al. (27), higher than the values obtained by Yilmaz et al. (21), and similar to the results reported by Marichal et al. (18), Daskiran et al. (20), Yalçıntan et al. (22), and Toplu et al. (25).

Genotype had no significant effect ($P > 0.05$) on MLD areas in this study. In a number of studies conducted with various goat genotypes, the MLD areas were reported to range from 7.0 $cm^2$ to 15.9 $cm^2$ (11,20,23,24,27). The findings of the present study were similar to those of Atay et al. (11), Solaiman et al. (27), and Gökdal (24) but were higher than the results of Daskiran et al. (20) and lower than the measurements of Gürsoy et al. (23).

### 4.6. Effect of fattening duration and genotype on slaughter traits, carcass characteristics, and tissue percentages of kids

In the present study, preslaughter weights and hot and cold carcass dressing percentages increased ($P < 0.001$) over successive fattening periods and slaughter weights. Similar results were obtained from other studies (25,28), where the dressing carcass percentage of kids increased with slaughter age or weight for different goat breeds. In the current study, the lean percentages ($P < 0.05$, Table 7) and fat accumulations (omental and mesenteric, kidney and pelvic, subcutaneous and intermuscular) increased ($P < 0.001$) with advancing fattening period and increasing slaughter weights while the bone percentage decreased ($P < 0.001$, Table 7). Similar findings on the increasing proportion of carcass fat tissue and declining percentage of bone with increasing slaughter age or weight of kids were also reported by several researchers (18,25,26,29). MLD areas in the present study also increased with fattening duration and slaughter weight (Table 7) and this result is similar to that of Alkass et al. (30).

### 4.7. Economic analysis

Given that the only varying factors were consumption of feed and associated live weight gain, economic analysis is only indicative. Profitability per kilogram remained constant for the Honamlı genotype over the duration of fattening, but decreased for Hair kids over successive fattening periods. The latter point is reflective of increasing consumption of feed concentrates for the Hair genotype, an observation that is likely reflective of compensatory growth. The increasing rate of cost in feed consumption for this genotype exceeded the rate of market value in live weight gain. While this resulted in lower profitability, on a per kilogram basis, total profitability was still rising over the duration of fattening. Sufficient (weekly) data were not available to conduct a traditional economic analysis in order to determine the economically profitable point at which to slaughter. This is an area of potential interest for future study, given the indication that the Honamlı genotype does not grow at a faster rate than the Hair genotype and has little comparative advantage in terms of fattening performance.

### 4.8. Conclusions

Despite the fact that intensive kid fattening is not a widespread practice in Turkey, results from this study reveal that the kids of indigenous Honamlı and Hair goats have a high potential for meat production within intensive fattening systems. Both Honamlı and Hair goat kids had noteworthy growth rates exceeding 200 g/head/day in an intensive fattening system. The LW and ADG of kids increased with the advancing fattening period. The results of this study indicate that the genetic potentials related to growth of the indigenous Honamlı and Hair goat kids are high and their fattening performance, feed efficiency, and a number of slaughtering and carcass quality traits are quite satisfactory when compared with the results of previous fattening studies with indigenous kids. No significant differences were detected between Honamlı and Hair kids in terms of fattening performances and a number of carcass characteristics at different periods within an intensive feeding system. However, the feed utilization efficiency of Honamlı kids was poorer than that of Hair kids.

The results of this study indicate that intensive feeding systems may improve kid growth performance when Honamlı and Hair goat male kids are fed intensively for a period of 60–80 days prior to marketing in order to increase carcass weight. Further fattening periods, however, led to higher fat accumulation, thereby resulting in lower meat quality. Further research is therefore needed in order to understand the growth performances of Hair and Honamlı goats under various farming systems.

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