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Fattening Performance and Carcass Characteristics of Yearling Damascus Male Goat**

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ABSTRACT

This study was conducted to determine the fattening performance and carcass characteristics of the Damascus goat. The animal material was 7 heads of male yearling Damascus goats (Shami) obtained from the Research and Training Farm of Agriculture Faculty of Hatay Mustafa Kemal University. They were kept in individual wooden boxes during the fattening period. Feed was given to the goats daily and recorded. At the end of the experiment, the averages Average Daily Gain and Feed Conversation Rate were calculated as 197.8 ± 8.10 g and 7.6 ± 0.32, respectively. The initial live weight and final live weight were found to be 20.74 ± 0.540 kg and 38.714 ± 0.699 kg, respectively. Slaughter weight, hot carcass weight, and hot carcass rates were determined as 35.7 ± 0.90 kg, 18.8 ± 0.70 kg, and 52.7 ± 1.69%, respectively. Bone percentage was calculated as 18.2 ± 0.62 %, muscle percentage as 55.6 ± 2.70 %, subcutaneous fat as 9.9 ± 1.93 % and intermuscular fat as 15.2 ± 1.05 %. Due to the daily gains and high carcass yield, Damascus goats can be used as meat production material. Considering the fattening period according to the market requirements increases the profitability and carcass quality.

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INTRODUCTION

Sheep and goat breeding differs according to the regions in terms of species, but goat breeding in our country is generally carried out in the mountainous regions and under extensive natural conditions. The people living in these places derive their financial income and source of food from goats. In many parts of the world, when people talk of red meat, they first think of beef and mutton. On the other hand, the goat is generally not considered a fattening animal but is mainly bred for milk production. The

production of red meat in Turkey is 1,201,397 tons and this meat was obtained from goats (1.38%), sheep (9.10% tons) and cattle (89.52%) (TURKSTAT, 2021).

Goat meat is traditionally preferred in a limited area, especially in the mountainous parts of the Mediterranean regions and Southeastern Anatolian in Turkey. On the other hand, in European countries where beef and mutton are mainly consumed, capretto and chevon meat are well known and popularly consumed. In the USA, kid meat has recently become one of the luxury consumer goods and finds its buyers at high prices (Devendra and Owen, 1983; Warmington and Kirton, 1990; Dhanda et al., 1999; Basinger, 2016; Hatipoğlu et al., 2016).

Many studies have been conducted on carcass traits and fattening performance of local and breeding sheep breeds. Especially recently, the importance of goat meat has been highlighted in several reviews (Adanacıoğlu, 2018; Koşum et al., 2020). While most studies on goat fattening performance and carcass traits have focused on the Hairy and Angora goats.

Agricultural progress and scientific researches on goat meat are beginning to make an important contribution to increasing red meat consumption in our country.

In this regard, some studies have been carried out in our country using molecular and genetic technologies and new genotypes have been developed. Based on these studies, Honamli goat in Western Anatolia, Norduz goat in Eastern Anatolia, Damascus and Hatay goat in Eastern Mediterranean Region have been developed in the last two decades. The productivity traits of these breeds have been investigated in many studies and the results have been published. (Keskin, 2000; Daşkıran and Cedden, 2004; Gül et al, 2009, 2010; Bingöl et al., 2012; Elmaz et al., 2012; Engindeniz et al, 2016 and 2018; Gül et al., 2020).

Various studies have been conducted on Damascus goats, which are bred in the Eastern Mediterranean region and are known as dairy goats, about milk and

reproductive performance (Keskin, 2000; Sarı et al., 2005; Güler et al., 2007; Keskin et al., 2016; Gül et al., 2018). However, there are not enough studies on fattening performance and carcass characteristics. This study aimed to investigate the fattening performance and carcass traits of Damascus male yearlings.

MATERIAL and METHOD

Animal material

This study was conducted in Hatay Mustafa Kemal University, Faculty of Agriculture Selam Research and Application Farm. The farm is located at an altitude of 80 m above sea level and longitude 36.22◦E and latitude 36.38◦N. A total of seven pure male yearling Damascus goats were used as animal material for the experiment.

Experimental group design

Seven pure male yearling Damascus goats were kept in individual wooden pens sized as 1.2 m x 1.2 m x 1.5 m, and live weight gain and daily feed consumption were determined daily. Fattening was carried out in an enclosed pen. Before the start of fattening, the animals were disinfected and the pens were calcified. All animals were also vaccinated with enterotoxemia vaccine and ADEMIN® (A, D, E vitamin mixture). A seven-day adaptation period was conducted before the fattening diet used in this experiment. The mixed feed prepared for the experiment was given to the animals ad-libitum in the buckets located in front of the pens. The drinking water was changed daily. To determine feed consumption, the feed given daily was weighed before a new feed was introduced each day. The experiment began in early February 2003 and lasted 13 weeks (91 days). Animals were weighed on three days at the same time with a full stomach to determine initial live weight. Later, all animals were weighed weekly (on the same day and at the same hour) with an empty stomach using a 100-g weighing scale.

Feeding management

The diet used in the study was mixed feed containing approximately 15.04% crude protein and 2451 kcal/kg ME and Alfalfa straw was added to the mixed feed in a proportion of 10 % (Table 1).

Table 1. Composition of the diets given to experimental animals

Ingredients	Amount (%)	Kcal/kg ME	Crude protein (%)
Barley	25	2500	10
Wheat bran	20	2100	14
Cotton seed meal	22	2300	32
Corn	30	3000	9
Salt-marble powder	2	---	---
Vitamin and mineral mixture	1	---	---
Found by calculation	100	2451	15.04

* 10% alfalfa straw was added to the mixed feed.

Determination of carcass and slaughter characteristics

At the end of the fattening period, four animals representing the average weight were slaughtered to determine some carcass characteristics. Approximately 12 hours before slaughter, the animals were fasted and later the carcass weight was determined. After the animals were slaughtered, the weight of the hot carcass, heart, lungs, liver, spleen, skin, 4 feet, and head were determined. The carcasses were chilled at 4 °C for 24 hours before weighing, and the percentage of cold rendering was calculated as the ratio of carcass weight to cold carcass weight. At the end of this period, cold carcass weights and cold carcass characteristics were recorded (Fisher and de Boer, 1994). Thereafter, carcasses were split in half using the "Standard methods and procedures for goat carcass evaluation, jointing and tissue separation" by Colomer-Rocher et al. (1987) (Figure 1).

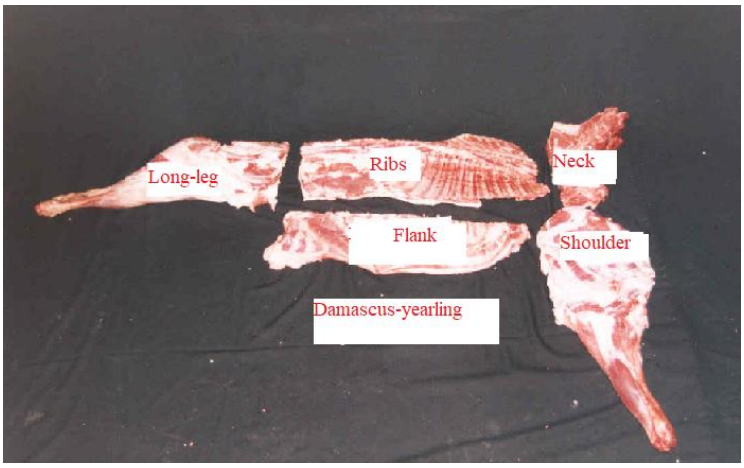

Figure 1. Damascus goat primal cuts

Each primal part separated into bone, muscle, subcutaneous and intermuscular fat tissues. A cross-section was made between the 12th and 13th ribs and the backfat thickness was measured with a ruler (Fisher and de Boer, 1994).

Statistical analyses

The findings obtained in the study were analysed by One-Sample T-test using the SPSS statistical package program (SPSS, 2012) according to the following model:

$Y_{ij}=\mu+\alpha_i+e_{ij}$

Where, Y_{ij} is an individual observation, μ is the overall mean, α_i is the effect of animal and e_{ij} is the experimental error.

RESULTS and DISCUSSION

Fattening performance

The weekly fattening performances of the yearlings are presented in Table 2. During fattening, an increase in body weight (BW) was observed in the goats. When examined from Average Daily Gain (ADG), ADG, which was low at times during the first three weeks of the study, increased in the 4th week and peaked in the 6th week (285.7 ± 31.08 g) and decreased again in the next 2 weeks. These fluctuations continued in the following weeks. Fluctuation in daily live weight gain was observed from the

beginning to the end of fattening and ADG was calculated to be 197.8 ± 8.10 g in the experimental groups. Hatefi et al (2015) reported a daily live weight gain of 119 g in Mahabadi kids; Aktaş et al (2015) reported 209 g in Honamlı kids and 231 g in Hairy kids were reported. Our results were higher than those of Hatefi et al. (2015) and agree with the reports of the other researchers. In addition, our BW results at the beginning and end of fattening are in agreement with the report of Keskin et al., (2003).

Table 2. Average live weight and average daily gain (ADG) during the experiment period (Mean ± SE)

Weeks	Weight (kg)	ADG (g)
Initial live weight	20.7 ± 0.54	----
1. week	21.6 ± 0.54	128.6 ± 5.27
2. week	22.6 ± 0.60	142.9 ± 26.79
3. week	23.7 ± 0.49	157.1 ± 21.53
4. week	25.3 ± 0.45	228.6 ± 22.82
5. week	26.7 ± 0.56	200.0 ± 31.64
6. week	28.7 ± 0.42	285.7 ± 31.08
7. week	30.0 ± 0.47	185.7 ± 21.14
8. week	31.3 ± 0.51	185.7 ± 14.86
9. week	32.8 ± 0.55	214.3 ± 26.79
10. week	34.2 ± 0.62	200.0 ± 25.84
11. week	35.8 ± 0.59	228.6 ± 37.89
12. week	37.7 ± 0.74	271.4 ± 21.57
13. week	38.7 ± 0.70	142.9 ± 28.03
Overall	---	197.8 ± 8.10

Feed consumption and feed conversation ratio (FCR)

The daily food consumption and conversation ratios of the animals are shown by week in Table 3.

It is an expected result that feeds consumption increases due to the increasing live weight of the animals. In the first 3 weeks of fattening, feed consumption was at a low level, so the feed conversion ratio was high. During this period, the daily live weight gain of goats was found to be the lowest level. From the fourth to the seventh week, an increase in feed intake and a decrease in FCR were recorded. FCR was at the normal level between the fourth and sixth week (maybe high in the 5th week). However, the

result showed that between the 7th and 11th week, FCR increased again with increased feed intake and decreased daily weight gain. Especially in the 13th week, FCR values were very high and reached a point that could reduce the profitability of fattening.

Table 3. Average daily feed consumption and conversion by week

Weeks	ADFC (g)	FCR
1	1261.4 ± 68.39	9.8 ± 0.73
2	1303.5 ± 92.28	9.1 ± 1.08
3	1371.7 ± 86.69	8.7 ± 1.05
4	1401.2 ± 87.35	6.1 ± 0.40
5	1416.2 ± 77.20	7.1 ± 0.66
6	1436.4 ± 55.89	5.0 ± 0.64
7	1431.4 ± 49.25	7.7 ± 0.40
8	1464.1 ± 28.94	7.9 ± 0.35
9	1500.4 ± 49.12	7.0 ± 0.55
10	1606.1 ± 44.56	8.0 ± 0.60
11	1769.0 ± 42.00	7.7 ± 1.20
12	1802.5 ± 41.65	6.6 ± 0.70
13	1876.7 ± 42.55	13.1 ± 1.80
Overall	1510.8 ± 26.01	7.6 ± 0.32

*ADFC, Average Daily Feed Consumption, FCR, Feed Conversation Ratio

This point can be accepted as an indicator of the necessity of completing the feed. The mean FCR value at the end of the study was at a level that can be considered normal (7.6 ± 0.32). Although some studies by researchers on this subject have shown lower values for FCR (Maia et al., 2012; Aktaş et al., 2015; Akbaş and Saatçi, 2016), there are also reports supporting our findings in this study (Zamiri et al., 2012; Nagamine and Sunagawa, 2017). The results of this study are also in agreement with the results of Ertuğrul, (1994) and Keskin et al. (2003) regarding FCR and feed consumption.

Slaughter and carcass characteristics

Dressing percentage is an important parameter in fattening studies, along with carcass weight. This parameter can differ between species as well as by breed within the same species. The best example of this is that breeds are meat and dairy types.

Some slaughter and carcass characteristics of Damascus male yearling are shown in Table 4. Accordingly, slaughter weight and hot carcass weight were 35.7 ± 0.90 kg and 18.8 ± 0.70 kg, respectively, and the dressing percentage was 52.7 ± 1.69% in Damascus goat yearlings. The weight of the cold carcass was 18.4 ± 0.69 kg and the dressing ratio of the cold carcass was 51.5 ± 1.70%.

Table 4. Slaughter characteristics (Mean± SE)

Slaughter characteristics	Measurements
Slaughter weight (kg)	35.7 ± 0.90
Hot carcass weight (kg)	18.8 ± 0.70
Hot dressing percentage (%)	52.7 ± 1.69
Cold carcass weight (kg)	18.4 ± 0.69
Cold dressing percentage (%)	51.4 ± 1.70
Lung weight (g)	425.5 ± 26.03
Liver weight (g)	670.5 ± 49.05
Heart weight (g)	233.5 ± 18.40
Spleen weight (g)	58.5 ± 4.50
Skin weight (g)	3107.5 ± 141.45
Head weight (g)	2062.5 ± 24.32
Four leg weight (g)	1135.0 ± 34.77
Testis weight (g)	273.0 ± 13.90
Kidney weight (g)	100.0 ± 4.90
Kidney+Pelvic fat (g)	626.5 ± 155.87

Bayraktaroğlu et al. (1988) reported that the dressing ratio in Saanen x Kilis goat crosses was 50.27%; Koyuncu et al. (2007) reported 51.14% in Hair goats; Akbaş and Saatçi (2016) reported 53.41% in Honamlı goats, 52.22% in Hair goats, and 52.70% in Honamlı x Hair crossbreeds. On the other hand, some other researchers have shown that carcass percentage varied from 42.7% to 55.4% depending on the sex, fattening period, age at slaughter and breed of goats (Webb et al., 2005; Abdullah and Musallam, 2007; Zamiri et al., 2012, Nagamine and Sunagawa, 2017, Anneke et al., 2019). Our results are consistent with researchers in the field. Also, the weights of some non-carcass traits such as head, skin, four feet and internal organs are similar to the result of Bayraktaroğlu et al. (1988), Kebede et al. (2008), Mai et al. (2012); Aktaş et al. (2015).

Table 5 indicated the average carcass measurements of the goat.

Table 5. Carcass measurements of the cold carcass (mean±se)

Traits	Measurements
Carcass length (cm)	68.8 ± 0.52
Half Carcass length (cm)	65.6 ± 0.50
Long leg length (cm)	26.2 ± 1.59
Long leg width (cm)	20.5 ± 0.36
Long leg circumference (cm)	58.5 ± 0.74
Chest width (cm)	27.5 ± 0.40
Backfat thickness (mm)	1.4 ± 0.24

Table 5 shows that the whole carcass length, half carcass length, and long-leg length were 68.8 ± 0.52 cm, 65.6 ± 0.50 cm, 26.2 ± 1.59 cm respectively. The long-leg width and circumference were 20.5 ± 0.36 cm and 58.5 ± 0.74 cm, respectively. Backfat thickness, which is also an important parameter, was 1.4 ± 0.24 mm. Akbaş and Saatçi (2016) reported that the carcass length was 74.29 cm in Honamlı goats, 69.57 cm in Hair goats and 70.64 cm in Honamlı x Hair crossbreeds. Koyuncu et al. (2007) showed that Long leg length was 28.4 cm, Long leg width was 11.1 cm, Breast width was 15.48 cm and carcass length was 61.77 cm. Akbaş and Saatçi (2016) also reported that the back-fat thickness was 0.57 mm in Honamlı goats, 0.70 mm in Hair goats, 0.67 mm in Honamlı x Hair goats. Our findings in this study are almost similar to those reports and those of other researchers (Kor, 1991; Koyuncu et al., 2007; Aktaş et al., 2015). The differences between these studies are sourced by some factors such as fattening period, slaughter age and breed.

At the end of the fattening period, the carcasses were divided into primal cuts like shoulder, ribs, flank, long-leg neck. Each part was also separated into different tissues like muscle, bone, inter-muscular and subcutaneous fat. The results were presented as percentages of side weight (Table 6).

Table 6. Total carcass composition (Mean ± SE)

Tissues	Measurements
Bone (%)	18.2 ± 0.62
Muscle (%)	55.6 ± 2.70
Subcutaneous fat (%)	9.9 ± 1.93
Intermuscular fat (%)	15.2 ± 1.05
Losses (%)	0.6 ± 0.80
Evaporation (%)	0.5 ± 0.20

The results presented in Table 6 show that the bone ratio in the total carcass was 18.2 ± 0.62% and the muscle ratio was 55.6 ± 2.70%. An important point that draws attention to the carcass composition is the high proportions of subcutaneous and intermuscular fat. When these two proportions of adipose tissue were taken into account, they reached a level of 25.1%, which is almost half of the muscle proportion and exceeds the bone proportion. Especially for goat carcasses, the biggest complaint from consumers is that goat meat is dry. Based on this study, the texture called marbling may have occurred when looking at the percentage of intermuscular fat. When evaluating subcutaneous fat, it can be speculated that excessive fat will reduce the quality of the meat and consumers will not prefer a carcass with this texture. The tissue composition of goat carcasses by carcass part is shown in Table 7.

Table 7. Percentages of various tissues (%) in carcass parts (mean± se)

Parts	Neck	Shoulder	Ribs	Flank	Long-leg
Total	9.9±1.02	21.5±0.20	24.3±0.80	13.7±0.30	30.6±0.93
Bone	19.2 ±1.25	17.8 ±0.45	20.2 ±1.07	16.6 ±1.22	17.0 ±0.57
Muscle	52.4 ± 0.03	60.8 ±1.80	54.0 ±1.97	43.0 ±3.09	60.7 ±1.48
Subcutaneous fat	12.5 ±7.42	5.3 ±0.80	9.2 ±1.70	13.9 ±3.64	10.5 ±0.93
Intermuscular fat	14.2 ±2.06	15.3 ±1.43	15.1 ±1.09	25.6 ±0.91	10.6 ±1.01
Losses	1.4 ±0.20	0.2 ±0.11	1.0 ±0.28	0.0 ±0.0	0.7 ±0.25
Evaporation	0.3±0.97	0.6±0.11	0.5±0.83	0.9±0.38	0.5±0.91

The results presented in Table 7 show that the highest bone rate was obtained from the ribs and the lowest from the flank part. The highest percentage of muscle was in the shoulder (60.8±1.80%) and the lowest in the flank (43.0±3.09%). The highest percentage

of subcutaneous and intermuscular fat was in the flank portion. The lowest rates in both tissues were located in the shoulder and neck regions, respectively.

According to Koyuncu et al. (2007) as animals age, the proportion of muscle growth increases consistently, while the proportion of bone tissue decreases and the proportion of fat deposition increases. Kebede et al., (2008) reported significant differences in muscle and fat ratio among the Arsi-Bale goats. Moreover, the carcass composition was composed of a range of 65.69-75.97% lean (muscle), 3.67-14.8% fat and 16.75-20.57% bone. Aktaş et al. (2015) reported that the percentage of muscle ranged from 53.7-56.8%, the percentage of bone was 28.0-34.9%, and the percentage of adipose tissue was 8.8-12.4% in Hair and Honamlı goats. The proportions of carcass tissue reported by the different researchers, in different breeds ranged from 22.0% to 38.9% for bone, 46.6% to 63.1% for muscle and 8.0% to 18.0% for total fat (Marichal et al., 2003; Koyuncu et al., 2007; Daşkıran et al., 2010, Zamiri et al., 2012; Yalçıntan et al., 2012; Toplu et., al. 2013; Aktaş et al., 2015). Researchers' reports showed that the percentage of muscle, bone and fat tissue in the carcass is generally influenced by many factors, such as fattening type, sex, castration, age at slaughter and weight in sheep, goats and cattle (Brandstetter et al., 2000; Webb et al., 2005; Johnson et al., 2005; Segato et al., 2005; Haddad et al., 2006; Warren et al., 2008; Marti et al., 2014; Sales, 2014). Our findings in the present study were in harmony with the findings of researchers from different studies.

CONCLUSION and RECOMMENDATIONS

Turkey ranks first among many European countries in the number of sheep and goats. Accordingly, in sheep and goat farming, as in other sectors, it is necessary to catch up with European standards, especially in terms of meat quality and grading for small ruminant production. Regardless of the product, animal husbandry and yield type in our country, fattening studies and meat quality using our local breeds should be

studied and promoted. Damascus goats are raised in the East Mediterranean region of our country and are well known as dairy goat breeds. The high ADG values and carcass yields are shown in this study indicate that this breed could also be used in meat production. Considering the fattening period following market requirements will increase profitability and carcass quality.

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Conflict of Interest Statement

The authors have declared that there are no competing interests.

Researchers' Contribution Rate Statement Summary

SG and OB contributed to the project idea, design and execution of the study. SG conducted the laboratory analyses. SG and OB supervised the experiment and SG wrote the manuscript.

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