T.R.
VAN YÜZÜNCÜ YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF ANIMAL SCIENCE

DETERMINATION OF GROWTH, FATTENING PERFORMANCE AND CARCASS CHARACTERISTICS OF AKKARAMAN AND ASSAF x AKKARAMAN (F_1) CROSSBRED LAMBS IN BREEDER CONDITIONS

Ph.D. THESIS

Ismail Ibrahim Ismail AL-BARWARI
Supervisor: Assoc. Prof. Dr. Ferda KARAKUŞ
Second Supervisor: Asst. Prof. Dr. Rabee Asmat Saadullah ORAMARI

VAN – 2024

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This thesis entitled "Determination of Growth, Fattening Performance and Carcass Characteristics of Akkaraman and Assaf x Akkaraman (F_1) Crossbred Lambs in Breeder Conditions" presented by Ismail Ibrahim Ismail AL-BARWARI under supervision of Assoc. Prof. Dr. Ferda KARAKUŞ and Dr. Rabee Asmat Saadullah ORAMARI in the department of Animal Science has been accepted as a Ph.D. thesis according to Legislations of Graduate Higher Education on 26/08/2024 with unanimity of votes members of jury.

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I declare that all the information in this thesis has been obtained and presented within the framework of ethical behavior and academic rules, and that in this thesis, which has been prepared in accordance with the thesis writing rules, all kinds of statements and information that do not belong to me have been fully cited.

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ABSTRACT

DETERMINATION OF GROWTH, FATTENING PERFORMANCE AND CARCASS CHARACTERISTICS OF AKKARAMAN AND ASSAF x AKKARAMAN (F_1) CROSSBRED LAMBS IN BREEDER CONDITIONS

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This study aimed to determine the growth, fattening performance and carcass characteristics of purebred and F_1 crossbred lambs obtained by crossing Assaf rams with Akkaraman ewes in breeder conditions. The animal material of the study consisted of 150 head Akkaraman ewes, 5 head Akkaraman rams aged (2-6 years old) and 2 head purebred Assaf rams (2-3 years old) and lambs obtained from their matings.

The live weights of Akkaraman and ASF x AK F_1 crossbred lambs at birth, 30, 60, 90, 120, 150 and 180 days were found as 3.87±0.08, 9.79±0.18, 14.98±0.27, 22.11±0.37, 25.17±0.40, 28.72±0.44 and 32.02±0.54; 3.79±0.10, 10.59±0.40, 16.82±0.54, 25.84±0.87, 30.44±0.90 and 35.67±0.91, respectively. The daily live weight gains of purebred and crossbred F_1 lambs between birth-180 days and 90-180 days were 0.156 and 0.177 kg ($p<0.001$), 0.123 and 0.155 kg ($p<0.001$), respectively. The survival rates of Akkaraman and ASF x AK F_1 crossbred lambs up to the 3rd month of weaning age were found to be 90.29% and 90.20%, respectively.

Testicular diameter, testicular length, scrotum circumference, scrotum length and testicular volume of Akkaraman and ASF x AK F_1 male lambs at 3rd month were 2.68±0.11 cm and 2.77±0. 14 cm, 5.21±0.19 cm and 5.80±0.26 cm, 14.40±0.71 cm and 17.37±0.80 cm ($p<0.01$), 7.75±0.39 cm and 12.40±0.73 cm ($p<0.01$), 51.00±6.45 cm^3 and 73.07±7.44 cm^3 ($p<0.01$). On the other hand, testicular diameter, testicular length, scrotum circumference, scrotum length and testicular volume measurements determined at 6th month were 3.60±0.18 cm and 4.35±0.12 cm ($p<0.05$), 7.10±0.37 and 8.15±0.32 cm, 19.29±0.90 cm and 20.73±0.96 cm, 12.66±0.64 cm and 16.64±0.78 cm ($p<0.01$), 120.37±16.40 cm^3 and 127.82±15.80 cm^3 in Akkaraman and ASF x AK F_1 crossbred lambs, respectively.

While the live weight of Akkaraman and ASS x AK F_1 crossbred lambs at the beginning of fattening was 23.89 kg and 23.77 kg, the live weight at the end of fattening was 41.02 kg and 44.03 kg ($p<0.01$), respectively. Purebred and crossbred lambs gained 17.14 kg and 20.26 kg ($p<0.01$) in total and 0.245 kg and 0.289 kg daily average weight gain, respectively. Feed consumption for 1 kg live weight gain of both genotypes was determined as 4.70 kg and 4.15 kg.

Among the slaughter and carcass traits, slaughter weight, cold carcass weight, untailed cold carcass weight, left half carcass weight, dressing percentage and the area of Musculus *longissimus dorsi* were found to be 39.22±1.62 kg and 44.34±0.53 kg ($p<0.05$), 19.60±0.70 kg and 21.40±0.26 kg ($p<0.05$), 15.86±0.61 kg and 19.22±0.24 kg ($p<0.01$), 7.20±0.24 kg and 9.41±0.34 kg ($p<0.001$), 50.04±0.67% and 48.28±0.65%, 12.49±0.73 cm^2 and 14.24±0.38 cm^2 respectively.

It was found that ASF x AK F_1 crossbred lambs obtained by crossbreeding Akkaraman ewes with purebred Assaf rams had better growth and fattening performance, testicular, slaughter and carcass characteristics than purebred Akkaraman lambs.

Keywords: Akkaraman, Assaf, Growth, Carcass characteristics, Crossbreeding, Fattening performance.

ÖZET

YETİŞTİRİCİ KOŞULLARINDA AKKARAMAN VE ASAF x AKKARAMAN (F_1) MELEZ KUZULARININ BÜYÜME, BESİ PERFORMANSI VE KARKAS ÖZELLİKLERİNİN BELİRLENMESİ

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Bu çalışmada, Asaf koçları ile Akkaraman koyunlarının yetiştirici koşullarında melezlenmesi ile elde edilen saf ve melez F_1 kuzuların büyüme, besi performansı ve karkas özelliklerinin belirlenmesi amaçlanmıştır. Araştırmanın hayvan materyalini 150 baş Akkaraman koyunu, 5 baş Akkaraman koçu (2-6 yaş) ve 2 baş saf Asaf koçu (2-3 yaş) ile bunların çiftleştirilmesinden elde edilen kuzular oluşturmuştur.

Akkaraman ve ASF x AK F_1 melezi kuzuların doğum, 30, 60, 90, 120, 150 ve 180. günlerdeki canlı ağırlıkları sırasıyla 3.87±0.08, 9.79±0.18, 14.98±0.27, 22.11±0.37, 25.17±0.40, 28.72±0.44 ve 32.02±0.54; 3.79±0.10, 10.59±0.40, 16.82±0.54, 25.84±0.87, 30.44±0.90 ve 35.67±0.91 olarak bulunmuştur. Saf ve melez F_1 kuzuların doğum-180. gün ve 90-180. günler arasındaki günlük canlı ağırlık artışları sırasıyla 0.156 ve 0.177 kg ($p<0.001$), 0.123 ve 0.155 kg ($p<0.001$) olmuştur. Akkaraman ve ASF x AK F_1 melezi kuzuların 3. ay sütten kesim yaşına kadar yaşama gücü oranları sırasıyla %90.29 ve %90.20 olarak bulunmuştur.

Akkaraman ve ASF x AK F_1 erkek kuzuların 3. aydaki testis çapı, testis uzunluğu, skrotum çevresi, skrotum uzunluğu ve testis hacmi sırasıyla 2.68±0.11 cm ve 2. 77±0. 14 cm, 5.21±0.19 cm ve 5.80±0.26 cm, 14.40±0.71 cm ve 17.37±0.80 cm ($p<0.01$), 7.75±0.39 cm ve 12.40±0.73 cm ($p<0.01$), 51.00±6.45 cm^3 ve 73.07±7.44 cm^3 ($p<0.01$). Buna karşılık 6. ayda belirlenen testis çapı, testis uzunluğu, skrotum çevresi, skrotum uzunluğu ve testis hacmi ölçüleri sırasıyla Akkaraman ve ASF x AK F_1 kuzularında 3.60±0.18 cm ve 4.35±0.12 cm ($p<0.05$), 7.10±0.37 ve 8.15±0.32 cm, 19.29±0.90 cm ve 20.73±0.96 cm, 12.66±0.64 cm ve 16.64±0.78 cm ($p<0.01$), 120.37±16.40 cm3 ve 127.82±15.80 cm3 olmuştur.

Akkaraman ve ASF x AK F_1 melezi kuzuların sırasıyla besi başı canlı ağırlığı 23.89 kg ve 23.77 kg olurken, besi sonu canlı ağırlığı 41.02 kg ve 44.03 kg ($p<0.01$) bulunmuştur. Saf ve melez kuzular sırasıyla beside toplam 17.14 kg ve 20.26 kg ($p<0.01$) ve günlük ortalama 0.245 kg ve 0.289 kg ağırlık artışı sağlamıştır. Her iki genotipin 1 kg canlı ağırlık artışı için yem tüketimi 4.70 kg ve 4.15 kg olarak belirlenmiştir.

Kesim ve karkas özelliklerinden kesim ağırlığı, soğuk karkas ağırlığı, kuyruksuz soğuk karkas ağırlığı, sol yarı karkas ağırlığı, sargı yüzdesi ve Musculus *longissimus dorsi* alanı 39.22±1.62 kg ve 44.34±0.53 kg ($p<0.05$), 19.60±0.70 kg ve 21.40±0.26 kg ($p<0.05$), 15.86±0.61 kg ve 19.22±0.24 kg ($p<0.01$), 7.20±0.24 kg ve 9.41±0.34 kg ($p<0.001$), %50.04±0.67 ve %48.28±0.65, 12.49±0.73 cm^2 ve 14.24±0.38 cm^2 olarak bulunmuştur.

Akkaraman koyunlarının saf Asaf koçları ile melezlenmesinden elde edilen ASF x AK F_1 melezi kuzuların saf Akkaraman kuzulara göre daha iyi büyüme ve besi performansı, testis, kesim ve karkas özelliklerine sahip olduğu tespit edilmiştir.

Anahtar kelimeler: Akkaraman, Asaf, Büyüme, Besi gücü, Melezleme, Karkas özellikleri.

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SYMBOLS AND ABBREVIATIONS

Some symbols and abbreviations used in this thesis are presented below, along with their descriptions.

Symbols	**Description**
a.m.	Ante meridiem
C°	Centigrade
cm	Centimeter
cm²	Square centimeters
g	Gram
g/day	Grams per day
IU	International unit
kg	Kilogram
mg	Milligram
mg/kg	Milligram per kilogram
mm	Millimeter
p.m.	Post meridiem
%	Percentage

Abbreviations	**Description**
ASF x AK (F_1)	Assaf x Akkaraman (F_1)
BW	Body Weight
MLD	Musculus Longissimus Dorsi

1. INTRODUCTION

Sheep have been utilized by humans for thousands of years to provide meat, milk, fiber, energy, fuel, fertilizer, and pleasure. Sheep continue to provide a variety of products for a large proportion of the population, whether reared on family farms or in intensive commercial production (Rasali et al., 2006). Sheep production is recognized as an important economic activity to improve the livelihoods of rural farmers and increase their income levels. There are more than 1.000 different breeds of sheep in the world, accounting for 1.172 million sheep. Of these, more than 60 breeds, comprising about 293 million sheep, are fat-tailed. Twenty-five percent of all sheep worldwide are fat-tailed. It is known that fat-tailed sheep breeds store up to 20% of their carcass weight in the form of tail fat (Mohapatra and Shinde, 2018).

Sheep farming plays an important role in Türkiye's livestock sector. The number of sheep was 42.5 million heads in 2023 (TÜİK, 2023). Approximately 94% of Türkiye’s sheep population are indigenous breeds and 6% are cultivated breeds and crossbreeds. Local sheep breeds have different characteristics in terms of productivity and appearance as they adapt to the vegetation, climate and geographical situation of various regions. Fine-tailed sheep breeds are more prevalent in Aegean, Marmara, and Western Anatolia, whereas breeds of fat-tailed sheep predominate in Central, Eastern, and Southeastern Anatolia (Selvi and Üstüner, 2021).

The sheep population in Türkiye is composed mainly of fat-tailed and multi-purpose indigenous breeds with low producing capacity. Sheep breeding is generally carried out in family farms under extensive conditions, based on pasture and traditional methods. Since the 1920s, much research has been carried out in public research institutes and universities to improve the productivity of native sheep breeds, and new breeds have been tried (Selvi, 2021).

The two main ways to increase productivity in sheep breeding are improving environmental conditions and breeding the genotype. Increasing the genetic value of sheep gains importance as it is permanent and continuous. Breeding studies carried out in Türkiye have included both crossbreeding programs and attempts to improve local sheep breeds through purebred breeding and selection. As the genetic progress that can be achieved by purebred breeding and selection is limited, crossbreeding studies have

been emphasized in the breeding of sheep breeds. Further rotational and combination crosses have been made in these researches, resulting in the creation of many novel sheep breeds for milk, meat-wool and wool production (Sönmez et al., 2009).

Akkaraman breed has been used as ewe material in most of the sheep breeding studies. Akkaraman, which accounts for 44% of Türkiye's sheep population, is reared in Central and Eastern Anatolia, from Eskişehir and Kütahya in the west to Sivas in the east, excluding the coastal regions. Akkaraman sheep has a long, narrow body, a straight back, a long and narrow head, long and drooping ears, strong legs, and a body color that is often white with black patches on the head, nose, ears, and feet. They have coarse-mixed wool. Ewes are hornless, rams may have small or incompletely developed horns. The tail structure is S-shaped and fat-tailed. Akkaraman sheep are resistant to diseases and harsh conditions. They are easy to handle and have good maternal ability (TAPGEM, 2009).

Malya sheep, one of the genotypes obtained as a result of the sheep breeding studies, was obtained by crossbreeding German Meat Merino and Akkaraman and carries 35-40% Merino genotype. As a result of crossbreeding German Meat Merino x Akkaraman, Anatolian Merino with 75-80% Merino blood was developed. Konya Merino was obtained by mating German Meat Merino x Akkaraman crossbred ewes and rams at G_2 and G_3 level. Merino genotype is over 85%. Hasak sheep is a sire line created by triple crossbreeding of German Black Head, Hampshire and Akkaraman breeds (Fıçıcı, 2015).

With an average annual intake of 4.2 kg per person, sheep are one of the most important sources of red meat produced in Türkiye, particularly in regions with difficult climates. The majority of sheep breeds are raised for meat production (Aydin et al., 2024). World consumption of poultry, pork, beef and sheep meat is projected to increase by 15%, 11%, 10% and 15% respectively by 2032 (OECD-FAO, 2023). The results of crossbreeding studies carried out so far for lamb meat production in Türkiye are not sufficient. It is important to carry out studies to develop sire and dam lines suitable for lamb meat production using local breeds. The Turkish Sheep Breeding Development Project, implemented in the 1980s to increase lamb production in Türkiye, aimed to develop suitable dam and sire lines. According to this project, rams and sheep were imported and crossbreeding studies were carried out with local breeds (Mundan

and Özbeyaz, 2004). However, the number of breeds reaching breeders as a result of these studies is quite low. Therefore, per capita red meat consumption and economic red meat production are not at the desired levels (Selvi, 2021).

As sheep breeding studies are mainly concentrated in the central and western regions of Türkiye, breeders in this region can benefit from different genotypes with the desired productivity traits. On the other hand, sheep breeders in the geography where Van province is located do not have the same opportunities. All sheep genotypes are fat-tailed, combined yield-oriented and do not meet the breeder's expectations. For this reason, the existence of different sheep types that meet the needs of regional breeders is of great importance.

The most important prerequisite for successful sheep farming is to correctly determine the breeding method according to the geographical and economic conditions of the region to be farmed and to accurately select the breed of sheep suitable for the purpose. In the central and eastern Anatolia regions of Turkey, domestic sheep breeds with combined productivity adapted to harsh climatic and poor pasture conditions are successfully bred (Esen and Yıldız, 2000a). Although they are an important source of income to meet family needs despite their relatively low productivity characteristics, local breeds are the main reason for low production and productivity in profitable sheep farming. Therefore, in addition to improving environmental conditions, it is important to improve the genotype, considering the indispensable characteristics of local breeds, to develop new types of sheep that are highly productive and well-adapted to regional and local conditions.

Van province ranks first in Türkiye with a sheep population of 3.413.510 heads (TÜİK, 2022). Sheep breeding is the locomotive of the livestock sector in Van province, which is very favorable for sheep breeding in terms of natural and economic conditions, agricultural structure, and traditions. Sheep is also very important as it is an investment tool that can be converted into money when the breeder needs it. Considering the high potential of Van province, it is concluded that the resources cannot be used effectively and correctly because of the low contribution of sheep production. Solutions to fully utilize the potential of sheep should therefore be put into action right away.

Main income from sheep farming in Van is based on lamb (meat), milk and fleece production. Sheep are the main source of the fattening sector in Van. There is no

specific market and price for lamb in the region. Most of the meat sold as lamb in the market is from the lambs or male lambs. Since lambs' live weight at the age of 5-6 months is not considered sufficient for slaughter or marketing weight, lambs are usually kept on pasture until late autumn or fed for a short period and sent to the butcher at the age of lambs (Ülker and Demirel, 2005). This obviously results in losses due to late lamb slaughter.

Although there has been a decline over the years, Türkiye's high sheep breeding potential is increasing the demand for sheep meat domestically and internationally. The fact that sheep are favored in the region and throughout the country, especially in sacrificial offerings, clearly shows the dependence on this species. However, in the traditional breeding system, sheep production with low-yielding local breeds cannot meet the needs of either the breeder or the country's population. It is also a separate issue that there is a flight from sheep farming in today's conditions. Considering all these issues, it is very important to introduce a new type of sheep that will meet the needs of the breeders and attract the producers who go to the different livestock breeding branches in the province of Van, which has a very important position for sheep breeding.

Assaf sheep breed used as the sire line in this project is a semi-fat-tailed breed obtained from crossbreeding the improved Awassi sheep and the East Frisian breed. It was developed in Israel between the 1950s and 1960s. The lamb yield is also high, so it is grown for both lamb and milk production (Pollott ve Gootwine, 2004). The average live weight of Spanish Assaf rams and ewes was 110 kg and 75 kg respectively. Among the body measurements, chest and tail widths were 26.85 cm and 14.45 cm for rams and 13.01 cm and 12.35 cm for ewes (Legaz et al., 2011).

This study aimed to investigate the possibilities of using the Assaf breed to improve the progeny and meat yield characteristics of Akkaraman sheep, which is the most numerous of the indigenous Turkish sheep breeds. In addition to comparing growth rate, fattening performance, testicular and carcass characteristics of purebred and crossbred F_1 lambs obtained by crossing Assaf rams with Akkaraman ewes under rural farm conditions. This is a first step towards the development of a new breed adapted to regional conditions and with a high lamb growth rate.

2. LITERATURE REVIEW

2.1 Growth and Development

Growth and development describe the phase of change between the conception of the animal and its ultimate maturity and the various factors that influence the rate and quality of this development (Owen, 1976). Growth is typically quantified as an increase in body measurement in relation to a specific time frame (Butterfield, 1988) and considered it's an important trait in meat animals (Liu et al., 1991). While development is the changes in the shape and body proportion associated with growth. Additionally, growth is a multifaceted characteristic that is influenced by genetic and environmental factors, such as the season of birth, type of birth, year of birth, age of the dam, and sex of the animals, as well as their interaction (Ünal et al., 2006a; Sharif et al., 2022).

Sheep's Body Weight (BW) serves as a vital measure for producers, aiding in the enhancement of genetic management, nutritional strategies, and health care practices (Camacho-Pérez et al., 2022). According to Wang et al. (2021), there are two main approaches for estimating body weight: the first uses scales for direct measurements, while the second relies on indirect measurements of various body parts. For indirect weight estimation, various methodologies have been developed, including the use of mathematical regression models that estimate Body Weight (BW) based on morphological measurements (Kunene et al., 2009; Yilmaz et al., 2013). Birth weight is considered a key developmental trait in lambs and serves as an indicator of fetal growth (Esen and Yıldız, 2000a; Özbey and Akcan, 2003a). It significantly influences the live weight at weaning and post-weaning stages, impacting the lamb's future growth, the live weight of fattened lambs, and ultimately the carcass yield during post-weaning and butchery periods (Bozdepe et al., 1994; Karakuş, 2007).

The mean live weights of lambs at birth, weaning, and 6-month weights of different breeds of sheep kept in different countries are summarized in Table 2.1. This table appears that body weight of lambs at birth ranged between 3.20 kg in Karakaş lamb (Gökdal et al., 2004) and 6.01 kg in Assaf lamb (Aljamaeen et al., 2023). While the lighter weight at weaning (12.64 kg) was in Cukurova Assaf lambs (Ocak and Cankaya, 2013) and the heaviest (31.39 kg) in Akkaraman sheep in Türkiye (Güngör

and Ünal, 2020). Also, the minimum (28.43 kg) and maximum (52.30 kg) 6-month weights of lambs were noticed in Karadi sheep (Oramari, 2009) and in F_1 of Chios × Assaf (Eyal et al., 1986), respectively.

2.2 Factors Affecting Lamb Body Weights

2.2.1 Effect of Breed

Several researchers have documented the impact of genetic variations among sheep breeds on the body weight of lambs. Odabaşıoğlu et al. (1995) revealed that the effect of the genotypes (Akkaraman, Hampshire x Akkaraman F_1, and Corriedale x Akkaraman F_1) had appeared significant effect on lamb's body weight at 45 and 60 days ($p<0.001$ and $p<0.01$, respectively) but their effect on the weight of the lambs at birth, 15, 30, 75, and weaning (90 days) of age during the semi-intensive period were not significant.

Yakan et al. (2012) investigated the influence of Akkaraman, Awassi, and Kıvırcık lamb genotypes on growth traits, they found that the effect was not significant at birth, 15, 30, 45, 60, 75 days, and weaning (90 days of age), while the effect became significant at 120 and 180 days of age ($p<0.05$ and $p<0.01$, respectively). Additionally, Güngör and Ünal (2020) examined the effect of genotype and was mostly highly significant ($p<0.001$) on birth, 90 (weaning) and 180 days during the studying on sheep genotypes of Bafra, Akkaraman, Bafra x Akkaraman F_1 and Bafra x Akkaraman B_1.

In a study on the effect of Chios x Kıvırcık F_1 and Chios x Cine Caparı F_1 crossbred of single lamb's genotypes on growth, İlhan et al. (2020) observed that there was a non-significant effect of genotypes on body weight at birth, 30 and 60 days, while a significant ($p<0.05$) differences between first generation of crossbred lambs (Chios x Kıvırcık and Chios x Cine Caparı) with regard to the lamb body weight at 90 and 120 days of age. Moreover, the birth weight found to be affected significantly by breed in the study of Esen and Elmaci (2021) for Hampshire Down x Merino and Karacabey Merino lambs and were heavier significantly ($p<0.001$) than Bandirma lambs at birth (5.07 and 4.92 versus 4.08 kg, respectively). While the weaning body weight of Bandirma lambs became the highest (34.44 kg) and highly significant. On the contrary,

no significant differences were observed between Kıvırcık and Ramlic lambs in all body weights at different periods (Esen and Elmaci, 2021).

Table 2.1 Live weights at birth, weaning and 6-month-old (kg) of different sheep breeds

Breed	Country	Birth weight	Weaning weight	6- month weight	Reference
Chiose	Israel	3.89	14.67	43.90	Eyal et al. (1986)
Assaf		3.93	16.03	49.30	
Chiose x Assaf F_1		4.23	17.10	52.30	
Assaf x (Chiose x Assaf) F_1		3.98	16.03	46.70	
Landrage x Hamdani x Awassi	Iraq	4.22	15.64	-	Alkass et al. (1996)
Landrage x Hamdani x Karadi		4.14	16.51		
Awassi		3.65	17.47		
Karadi		3.61	17.77		
Karakaş	Türkiye	3.20	25.40	29.60	Gökdal et al. (2004)
(Ile de France x Akkaraman B_1) x Karakaş F_1		3.50	26.40	30.20	
Akkaraman		4.40	21.10	31.90	
Kıvırcık x Akkaraman F_2	Türkiye	4.30	20.30	29.40	Ünal et al., 2006a
Kıvırcık x Akkaraman B_1		4.10	19.60	30.30	
Chios x Akkaraman F_2		4.20	20.30	30.50	
Chios x Akkaraman B_1		4.10	19.90	30.10	
Karadi	Iraq	4.84	22.73	30.15	Hermiz and Mohammed (2009)
Karadi	Iraq	4.86	20.52	28.43	Oramari (2009)
Cukurova Assaf	Türkiye	4.05	12.64	-	Ocak and Cankaya, (2013)
Cukurova Meat Sheep		4.17	13.29		
Assaf	Israel	4.50	14.70	-	Rosov and Gootwine, (2013)
Suffolk x Assaf F_1		4.70	18.00		
Lacaune	Bulgaria	4.52	15.93	-	Panayotov et al. (2018)
Akkaraman	Türkiye	4.26	22.26	-	Sakar and Erişek (2019)
Bafra	Türkiye	3.65	23.51	33.62	Güngör and Ünal (2020)
Akkaraman		4.70	31.39	45.49	
Bafra x Akkaraman F_1		4.56	30.00	43.33	
Bafra × Akkaraman B_1		4.03	25.16	34.98	
Bulgarian Dairy Synthetic Population	Bulgaria	-	25.21	-	Kalaydzhiev (2021)
Bulgarian Dairy Synthetic Population x Lacaune		-	25.17	-	
Bulgarian Dairy Synthetic Population x Assaf		-	25.19	-	
Assaf	Jordan	6.01	20.40	-	Aljamaeen et al. (2023)

Furthermore, research on the impact of genotype on growth traits showed that the Assaf breed and Suffolk X Assaf first generation had no significant effect on birth

weight, while such effect had a significant ($p<0.001$) and ($p<0.05$) on weaning and post weaning body weights, respectively (Rosov and Gootwine, 2013). Finally, Ocak and Cankaya (2013) reported that the lambs from both Cukurova Assaf and Cukurova meat sheep genotypes had non-significant effect on all the period of live weight of lambs.

2.2.2 Age of Dam

Numerous researchers discovered that the dam age significantly impacted the weights of the lambs at birth and during weaning. Ünal et al. (2006a) found that the effect of dam age had significant ($p<0.05$) effect on lamb's weight at birth, weaning (three months) and 6-months of age, lambs born from ewes with 4 years old had higher birth weight than those produced by 2 years old dams in Akkaraman, Kıvırcık x Akkaraman F_2, Kıvırcık x Akkaraman B_1, Chios x Akkaraman F_2, Chios x Akkaraman B_1 lamb genotypes. Such effect could be attributed to the large size of uterus, best intra-uterine environment, the size of dam and stage of maturation (Eltawil et al., 1970; Bhadula and Bhat, 1980).

Additionally, in the genotypes of Bafra, Akkaraman, Bafra x Akkaraman F_1, and Bafra x Akkaraman B_1, the age of the dam had a highly significant effect ($p<0.001$) on lamb birth weight and weaning (90 days); however, in the same study, there was no significant difference in the body weight of the lambs at six months of age (Güngör and Ünal, 2020).

Furthermore, it was demonstrated by Gökdal et al. (2004) that the age of the dam had a significant impact on the weight of the lambs at different stages. Significant differences ($p<0.05$) were found between the age of the dam at birth and the weight at weaning in both genotypes of lambs: Karakaş and (Ile de France x Akkaraman B_1) x Karakaş. The lambs with the best growth performance and highest birth weight were found in the lambs born to dams that were 2, 4, and 5 years old, while the lowest-born lambs were found in ewes that were 3 years old.

Yakan et al. (2012) investigated the effect of the dam's age on Akkaraman, Awassi, and Kıvırcık lamb genotypes, they found that the effect was significant at birth ($p<0.05$), but it was non-significant at 15, 30, 45, 60, 75 days, weaning (90 days), 120, and 180 days of age. Aljamaeen et al. (2023) in their study on Assaf lambs claimed that

the age of the dam was significantly affected birth weight ($p<0.05$), weaning weight ($p<0.01$) and lamb weight at marketing age ($p<0.05$). Alkass et al. (1996) reported that the effect of the dam was significant on both birth ($p<0.05$) and weaning weight ($p<0.01$) in pure Karadi, pure Awassi and Landrage x Hamdani x Awassi and Landrage x Hamdani x Karadi crossbred lambs and the highest birth and weaning weights were obtained from ewes aged 5 and 6 years. However, other researchers could not detect a significant effect of age of dam on birth, weaning and 6-month body weights of Karadi lambs (Hermiz and Mohammed, 2009; Oramari, 2009).

2.2.3 Sex of Lamb

Most authors were generally agreed that male lambs surpassed the female lambs in their birth weights significantly (Table 2.2). This difference might be due to the total weight of cotyledons (Rhind et al., 1980), to the function of the sex hormone (estrogens and androgens) (Owen, 1976), and to the growth hormones (Davis et al., 1977). Ünal et al. (2006a) reported that there were a highly significant effects ($p<0.001$) of sex of lams on all weights of lambs, male lambs had higher birth and weaning (90 days) weight (4.3 kg and 21.3 kg) than female lambs (4.1 kg and 19.2 kg) for genotypes of Akkaraman, Kıvırcık x Akkaraman F_2, Kıvırcık x Akkaraman B_1, Chios x Akkaraman F_2 and Chios x Akkaraman B_1.

Also, sex of lamb had a highly significant effect ($p<0.001$) on lamb body weights at birth, weaning (90 days) and 180 days for the genotypes of Bafra, Akkaraman, Bafra x Akkaraman F_1 and Bafra x Akkaraman B_1, and male lambs (4.39 kg, 29.50 kg, 42.62) were surpassed female lambs (4.09 kg, 25.23 kg, 35.39 kg) body weight at birth, weaning and 180 days, respectively (Güngör and Ünal, 2020). In addition, there were a significant ($p<0.05$) differences between both sexes of male lambs (3.62 kg, 27.5 kg, and 31.9 kg) and female (3.10 kg, 24.3 kg, 28.0 kg) live weight at birth, weaning (90 days) and 6 months, respectively for genotypes of purebred Karakaş and (Ile de France x Akkaraman B_1) x Karakaş crossbred (Gökdal et al., 2004).

Yakan et al. (2012) studied the effects of lambs' sex on the weights of Akkaraman, Awassi, and Kıvırcık genotypes, they found a highly significant effect ($p<0.001$) at birth, 60, 75, weaning (90 days), 120, and 180 days of age, male lambs

weighed 4.65 kg, 20.16 kg, 23.52 kg, 26.83 kg, 31.45 kg, and 38.96 kg at these respective ages, while female lambs weighed 4.19 kg, 18.11 kg, 20.78 kg, 23.46 kg, 27.44 kg, and 34.13 kg. At 45 days of age, male and female lambs of the same genotypes weighed 16.42 kg and 14.80 kg, respectively, showing a significant effect ($p<0.01$) of sex. While at 15 and 30 days of age, male lambs weighed 8.79 kg and 12.87 kg, and female lambs weighed 8.13 kg and 11.96 kg, the effect of sex was found to be significant ($p<0.05$).

Table 2.2 Effect of sex of lamb on birth weight (kg) in different breeds of sheep

Breed	Country	Male	Female	Significance	Reference
Landrage x Hamdani x Awassi Landrage x Hamdani x Karadi	Iraq	4.06	3.75	**	Alkass et al., 1996
Awassi Karadi					
Karakaş (Ile de France x Akkaraman B_1) x Karakaş F_1	Türkiye	3.62	3.10	*	Gökdal et al., 2004
Akkaraman Kıvırcık x Akkaraman F_2 Kıvırcık x Akkaraman B_1	Türkiye	4.30	4.10	***	Ünal et al., 2006a
Chios x Akkaraman F_2 Chios x Akkaraman B_1 Karadi	Iraq	4.63	4.33	*	Hermiz and Mohammed, 2009
Assaf Suffolk x Assaf F_1	Israel	4.80	4.50	*	Rosov and Gootwine, 2013
Cukurova Assaf Cukurova Meat Sheep	Türkiye	4.09	4.03	N. S.	Ocak and Cankaya, 2013
Lacaune	Bulgaria	4.60	4.40	N. S.	Panayotov et al., 2018
Akkaraman	Türkiye	4.09	4.09	N. S.	Sakar and Erişek, 2019
Bafra Akkaraman Bafra x Akkaraman F_1 Bafra x Akkaraman B_1	Türkiye	4.39	4.09	***	Güngör and Ünal, 2020
Assaf	Jordan	6.01	6.21	N. S.	Aljamaeen et al., 2023

N.S.: non-significant; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Moreover, sex of lamb had affected significantly ($p<0.05$) on birth, weaning and post weaning weight for both Assaf and F_1 genotype of Suffolk x Assaf (Rosov and Gootwine, 2013). The significant effect of sex on the birth and weaning weight of Awassi lambs was documented by Şireli et al. (2015). However, Ocak and Cankaya

(2013) reported that the sex of the lambs had a non-significant effect on birth and weaning weights (6 weeks of age) for Cukurova Assaf and Cukurova Meat Sheep. The birth weights of male and female lambs were 4.09 kg and 4.03 kg, respectively, while the weaning weights were 13.08 kg and 13.03 kg, respectively. Oramari (2009) reported that the male lambs were significantly heavier than females at birth (4.72 vs 4.35 kg) and at weaning (19.84 vs 18.45 kg) weights, while the difference between males and females in their weights at 6 month (27.30 vs 26.51 kg) was non-significant in Karadi lambs. On the other hand, and in contrast, few authors have indicated a non-significant effect of sex of lamb on body weights including Aljamaeen et al. (2023) in Assaf breed lambs and Sakar and Erişek (2019) in Akkaraman breed lambs (Table 2.2 and 2.3).

Table 2.3 Effect of sex of lamb on weaning weight (kg) in different breeds of sheep

Breed	Country	Male	Female	Significance	Reference
Landrage x Hamdani x Awassi Landrage x Hamdani x Karadi Awassi Karadi	Iraq	17.16	16.54	**	Alkass et al. (1996)
Karakaş (Ile de France x Akkaraman B_1) x Karakaş F_1 Akkaraman	Türkiye	27.50	24.30	*	Gökdal et al. (2004)
Kıvırcık x Akkaraman F_2 Kıvırcık x Akkaraman B_1 Chios x Akkaraman F_2 Chios x Akkaraman B_1	Türkiye	21.30	19.20	***	Ünal et al. (2006a)
Karadi	Iraq	21.68	19.70	*	Hermiz and Mohammed (2009)
Cukurova Assaf Cukurova Meat Sheep	Israel	13.08	13.30	N. S.	Ocak and Cankaya (2013)
Awassi	Türkiye	22.85	21.29	*	Şireli et al. (2015)
Lacaune	Bulgaria	16.14	15.66	N. S.	Panayotov et al. (2018)
Akkaraman	Türkiye	21.84	21.89	N. S.	Sakar and Erişek (2019)
Bafra Akkaraman Bafra x Akkaraman F_1 Bafra x Akkaraman B_1	Türkiye	29.50	25.53	***	Güngör and Ünal (2020)
Assaf	Jordan	21.27	19.89	N. S.	Aljamaeen et al. (2023)

N.S.: non-significant; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

2.2.4 Type of Birth

Most of the authors reported a significant difference in birth and weaning weight of lambs attributed to the type of birth (Table 2.4 and 2.5). The minimum birth weight for single (4.15 kg) and twin (2.57 kg) born lambs were found for Karakaş and (Ile de France x Akkaraman B_1) x Karakaş F_1 lambs (Gökdal et al., 2004), while the maximum for single (6.43 kg) and twin (6.22 kg) born lambs were recorded for Assaf lambs (Aljamaeen et al., 2023). This significant effect could be due to the differences in the availability of the nutrient supplied during pregnancy (Aziz, 1986; Solomon et al., 2006). Also to decrease in the weight of cotyledons by 12% for each increase in fetal (Black, 1983). In addition, to the number of cotyledons (Rhind et al., 1980).

Aljamaeen et al. (2023) found that the type of birth was significantly ($p<0.05$) affected birth weight of Assaf breed lambs, single born lambs were heavier than twins or triplets born lambs (6.43, 6.24 and 5.64 kg), respectively, they also reported same significant of type of birth on lamb body weights, also single born lambs were heavier than multiples lambs at weaning age (21.80 and 19.36 kg) and at marketing age (33.09 and 30.74 kg), respectively. Also, Güngör and Ünal (2020) reported a highly significant effect ($p<0.001$) of birth type on lamb body weights, single born lambs (4.75 kg, 29.81 kg, and 40.79 kg) had heavier weight than twin (4.15 kg, 26.82 kg, and 38.68 kg) and triplet lambs (3.82 kg, 25.92 kg and 37.85 kg) at birth, weaning (90 days), and 180 days in Bafra, Akkaraman, Bafra x Akkaraman F_1 and Bafra x Akkaraman B_1 lamb genotypes, respectively.

In addition, Ünal et al. (2006a) found that the type of birth had significant effects ($p<0.001$) on all lamb body weights, single lambs (4.4 kg, 21.9 kg, 32.69 kg) had higher weights than twin born (4.0 kg, 18.8 kg, 28.21 kg) at birth, weaning and 180 days of age, respectively for the genotypes of Akkaraman, Kıvırcık x Akkaraman F_2, Kıvırcık x Akkaraman B_1, Chios x Akkaraman F_2 and Chios x Akkaraman B_1. Moreover, Sakar and Erişek (2019) found that the effect of type of birth on Akkaraman lambs was significant at birth ($p<0.001$) and at all other weights ($p<0.05$) (60, 90, and 120 days of ages). Single lambs (4.468 kg, 22.28 kg, 30.27 kg and 35.13 kg) were heavier than twin lambs (3.71 kg, 21.45 kg, 29.41 kg and 34.06 kg), respectively.

Furthermore, Gökdal et al. (2004) showed that birth type had a highly significant ($p<0.01$) effect on all growth traits in purebred Karakaş and (Ile de France x Akkaraman B_1) x Karakaş F_1 crossbred lambs. Singleton lambs (4.15 kg, 29.1 kg, 32.7 kg) were developed faster and heavier than twin lamb weights (2.57 kg, 22.7 kg, 27.2 kg) at birth, weaning and 6 months weights, respectively.

Table 2.4 Effect of type of birth-on-birth weight (kg) in different breeds of sheep

Breed	Country	Single	Twin	Significance	Reference
Landrage x Hamdani x Awassi Landrage x Hamdani x Karadi Awassi	Iraq	4.17	3.64	**	Alkass et al. (1996)
Karadi Karakaş (Ile de France x Akkaraman B_1) x Karakaş F_1	Türkiye	4.15	2.57	**	Gökdal et al. (2004)
Akkaraman Kıvırcık x Akkaraman F_2 Kıvırcık x Akkaraman B_1 Chios x Akkaraman F_2 Chios x Akkaraman B_1	Türkiye	4.40	4.00	***	Ünal et al. (2006a)
Karadi	Iraq	4.87	4.08	**	Hermiz and Mohammed (2009)
Cukurova Assaf Cukurova Meat Sheep	Israel	4.21	3.95	***	Ocak and Cankaya (2013)
Lacaune	Bulgaria	4.84	4.08	***	Panayotov et al. (2018)
Akkaraman	Türkiye	4.47	3.71	***	Sakar and Erişek (2019)
Bafra Akkaraman Bafra × Akkaraman F_1 Bafra × Akkaraman B_1	Türkiye	4.75	4.15	***	Güngör and Ünal (2020)
Assaf	Jordan	6.43	6.22	*	Aljamaeen et al. (2023)

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Yakan et al. (2012) studied the effects of type of birth on the weights of Akkaraman, Awassi, and Kıvırcık genotypes, they found a highly significant effect ($p<0.001$) on birth weight, with single-born lambs having higher weights than twin-born lambs (4.71 kg vs 3.64 kg, respectively). They also reported a significant effect ($p<0.01$) of the type of birth at 15, 30, 45, 60, 75, 90 (weaning), and 120 days of age, the weights of single-born lambs were 8.73 kg, 12.89 kg, 16.19 kg, 19.75 kg, 22.94 kg, 25.90 kg, and 30.34 kg, respectively. In comparison, the weights of twin-born lambs

were 7.73 kg, 11.10 kg, 14.06 kg, 17.45 kg, 20.01 kg, 22.96 kg, and 26.86 kg, respectively. The effect of birth type on the weight for the same genotypes was found to be significant ($p<0.05$) at 180 days of age, with the weights of single-born and twin-born lambs being 37.24 kg and 34.64 kg, respectively. In the study of Assaf and their crosses Suffolk × Assaf F_1 lambs, Rosov and Gootwine (2013) reported that the type of birth (single, twin, triplet, quadruplet and more) had affected significantly ($p<0.05$) on birth, weaning and post weaning weights.

Also, Ocak and Cankaya (2013) claimed that the birth type of lambs had significant ($p<0.001$) effect on the birth and weaning weight (6 weeks of age) of Cukurova Assaf and Cukurova meat sheep, and single birth weight were higher than twins lambs, single births body weight and weaning weight was 4.21 kg and 14.13 kg respectively, while twins body weight at birth and weaning (6 weeks of age) were 3.95 kg, and 12.37 kg respectively.

Table 2.5 Effect of type of birth on weaning weight (kg) in different breeds of sheep

Breed	Country	Single	Twin	Significance	Reference
Landrage x Hamdani x Awassi Landrage x Hamdani x Karadi Awassi Karadi	Iraq	17.13	16.57	*	Alkass et al. (1996)
Karakaş (Ile de France x Akkaraman B_1) x Karakaş F_1 Akkaraman	Türkiye	29.10	22.70	**	Gökdal et al. (2004)
Kıvırcık x Akkaraman F_2 Kıvırcık x Akkaraman B_1 Chios x Akkaraman F_2 Chios x Akkaraman B_1	Türkiye	21.90	18.60	***	Ünal et al. (2006a)
Karadi	Iraq	23.65	17.73	**	Hermiz and Mohammed (2009)
Cukurova Assaf Cukurova Meat Sheep	Israel	14.13	12.37	***	Ocak and Cankaya (2013)
Lacaune	Bulgaria	17.21	14.08	***	Panayotov et al. (2018)
Akkaraman	Türkiye	22.28	21.45	*	Sakar and Erişek (2019)
Bafra Akkaraman Bafra x Akkaraman F_1 Bafra x Akkaraman B_1	Türkiye	29.81	26.82	***	Güngör (2020)
Assaf	Jordan	21.80	19.36	*	Aljamaeen et al. (2023)

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

Finally, Oramari (2009) reported that a significantly ($p<0.01$) differences of type of birth on their birth and weaning weights of Karadi lambs, single born lambs surpassed twin lambs by 1.38 and 3.29 kg respectively, whereas the differences was not significant between singles and twins lamb in their weights at 6-month-old. Hermiz and Mohammed (2009) found a significantly affect ($p<0.01$) of type of birth on birth and weaning weight of Karadi breed lambs, single born lambs at birth (4.87 kg) and weaning weight (23.65 kg) were heavier than twins born lambs (4.08 and 17.73 kg), respectively.

2.2.5 Dam Weight at Lambing

The size and weight of ewe was a major factor that influencing growth of the lambs for both pre and postnatally period. The weight of heavier dam is associated to the large size of uterus, which provide more nutrient materials and have a large space for embryo growth and development during pregnancy period than the weight of lighter dam (Owen, 1976; Bhadula and Bhat, 1980). Therefore, many researchers reported a significant correlation between the dam's weight and the birth weight at lambing in different breeds of sheep, and the regression coefficient of birth weight of lamb on the weight of its dam at lambing was significant and positive (Hermiz, 1995; Alkass et al., 1996; Al-Anbari, 1998; Al-Tarayrah and Tabbaa, 1999; Demirel et al., 2004, Mohammed, 2008; Oramari, 2009). While other investigators found that the effect of dam weight at lambing on their lamb birth weights were non-significant (Khan and Bhat, 1981; Kutaibani, 1981).

Most authors showed a significant positive regression coefficient of lamb weaning weights on dam weight at lambing (Al-Ashwal, 2003; Al-Jalili, et al., 2006; Mohammed, 2008; Oramari, 2009). Such effects could be due to the relationship between the weights of dam and their milk yield, which in turn affect lambs' weight at weaning (Kutaibani, 1981). While other authors found that the dam weight at lambing had no significant effect on weaning weight (Hermiz, 1988; Jawasreh and Khasawneh, 2007). Whereas Al-Anbari (1998) found a significant ($P<0.01$) and positive regression coefficient (0.101 kg/kg) of lambs' body weight at 6-month-old on their dams weight at

lambing during his study on Local Awassi, Turkish Awassi, Assaf, and their crosses in Iraq.

Otherwise, Al-Barzinjy (2003), Mohammed (2008) and Oramari (2009) showed a non-significant effect of dam weight at lambing on body weight of their lambs at 6-month-old, which could be since lambs at this age depend on themselves in feeding (Alkass et al., 1993).

2.2.6 Effect of Earlier Weights on Later Weights

Several authors reported a significant and positive regression coefficient of weaning weight on the birth weight of lambs (Hermiz and Assak, 1995; Rastogi, 2001; Al-Barzinjy, 2003; Cemal et al., 2005; Al-Jalili et al., 2006, Gokdal et al., 2006 and Oramari, 2009). In addition, two studies of Karadi sheep, Mohammed (2008) and Oramari (2009) reported a significant effect of birth weight and the regression coefficient of birth weight on weaning were estimated to be 1.33 kg/kg and 1.591 kg/kg, respectively. On the other hand, Hermiz (1988) and Demirel et al. (2004) found a non-significant regression of weaning weight on birth weight of lambs. Moreover, Fogarty (1995), Hermiz and Assak (1995), Al-Anbari (1998), Al-Ashwal (2003), Mohammed (2008) and Oramari (2009) reported a significant regression of weight at 6-month-old on their weaning weights of lambs.

2.3 Live Weight Gains Between Various Periods in Lambs

There are several methods for calculating an animal's qualification for meat. One of these methods involves calculating the animal's average daily weight gain, which is the animal's weight increase divided by the number of days it is fed. For farmers, average daily gain indicates how quickly an animal grows; the quicker it is ready for the market, the lower the production costs can be. Animal cleanliness, diet, feed ratio, environment, and genetic makeup can all have an impact on average daily increase. Likewise, a number of writers discovered genetic diversity in growth between breeds (Dickerson et al., 1972; Crouse et al., 1981; Godfrey and Weis, 2005).

2.3.1 Factors Affecting Live Weight Gains Between Various Periods in Lambs

2.3.1.1 Effect of Breed

Sakar and Erişek (2019) observed a tendency for the daily live weight gain to decrease as the months progressed of Akkaraman lambs and recorded average daily live weight gains from birth to the 60 (weaning age), 90, and 120 days and were 297.5, 287.5, and 255.7 g/day, respectively.

Alarslan (2018) studied the average daily weight gain of Kıvırcık lambs at various intervals: from birth to 90 days, birth to 150 days, birth to 180 days, 90 to 180 days, and 150 to 180 days. The gains were 204.72, 202.71, 188.26, 171.04, and 116.01 g/day, respectively. He observed a linear decrease in live weight gain as time progressed during his study on Kıvırcık lambs.

Breed significantly affected ($p<0.05$) all growth periods of Assaf and American Suffolk × Assaf F_1 crossbred lambs, and the daily live weight gains was determined from birth to 35 days (weaning age) and from birth to 150 days were 294 and 335, 343 and 356 g/day, respectively, in addition, the American Suffolk x Assaf F_1 crossbred lambs had higher average daily gains than Assaf lambs (Rosov and Gootwine, 2013).

In Türkiye, it was noticed that the average daily weight gains during the period from birth to weaning (90 days) of Ile de France x Akkaraman crossbred lambs (289.1 g/day) surpassed significantly ($p<0.01$) Menemen purebred lambs (253.8 g/day) (Kandemir, 2013).

Altın et al. (2003) reported that the breed effect was significant ($p<0.01$) on the live weight gains of Kıvırcık lambs, Chios x Kıvırcık F_1 and Kıvırcık x Karya F_1 crossbred lambs from birth to 47 days and from 89 to 103 days, while such effect between other period was non-significant.

Eyal et al. (1986) noticed that the genotype effect on daily live weight gains of lambs was significant ($p<0.05$). Chios lambs grew significantly slower and were lighter than Assaf, Chios x Assaf F_1, and Assaf x (Chios x Assaf) F_1 crossbred lambs at weaning and at 150 days of age, while Assaf and crossbred lambs did not differ significantly from one another.

However, non-significant effect of the breed on daily live weight gain of lambs reported by many authors (Esen and Yıldız, 2000a; Özbey and Akcan, 2003a; Gokdal et al., 2004; Aslan, 2013; Ocak and Cankaya, 2013).

According to Köseman et al. (2023), Bafra lambs' daily live weight gain (Chios x Karayaka) averaged 174.49 g/day from birth to 30 days, 213.54 g/day from 30 to 60 days, 240.94 g/day from 60 to weaning (90 days), and 182.60 g/day from 90 to 120 days. Bingöl and Aygün (2014) recorded daily live weight gains of Karakaş lambs for period of birth-90 (weaning age), birth-180, and 90-180 days and were 133.82, 146.25, and 166.16 g/day, respectively. Ağdacı (2013), in his study to investigate the growth characteristics of Pırlak lambs from birth to weaning (132 days), recorded 164 g/day as the daily live weight gain of this breed.

Ceyhan et al. (2010) and (2013) reported the daily live weight gain and were 286.88 g/day and 179.81 g/day during the period from birth to weaning (90 day) of Ramlıç and Gökçeada lambs, respectively.

In Van area, Öztürk and Odabaşıoğlu (2011) determined the average daily live weight gains in Hamdani lambs during the periods of birth-30, 30-60, 60-weaning (90 days), and birth – weaning (90 days) and were 201.34, 207.73, 165.98, and 191.49 g/day, respectively. Finally, Kaymakçı et al. (2006) recorded daily average live weight gain and was 140 g/day during the period from weaning (average 60 day) to 120 days of age of Menemen lambs.

2.3.1.2 Effect of Age of Dam

Alarslan (2018) found a significant effect of age of dam on daily live weight gain of Kıvırcık lambs for the period between birth and 90 days only, while such affect was non-significant on live weight gain between the other periods.

Also, Öztürk and Odabaşıoğlu (2011) reported that age of dam affects significantly daily live weight gain of Hamdani lambs between day 30-60 only, and the lambs born from ewes with 2-2.5 years old had higher average daily live weight gain, while this effect was found to be non-significant on daily live weight gain between birth-30, 60-weaning, and birth-weaning (90 days).

Moreover, Ceyhan et al. (2010) in their study on Ramlıç lambs from birth to weaning (90 days) noticed a significant effect of age of dam on daily live weight gain, lambs born from dam with 3-year-old had greater daily live weight gain than lambs born from other ages (1, 2, 4, and 5-year-old dams).

Furthermore, Özbey and Akcan (2003a) reported that the age of dam was significant effect ($p<0.05$) on the daily live weight gain of purebred Morkaraman, Chios x Morkaraman F_1 and Kıvırcık x Morkaraman F_1 crossbred lambs from birth to weaning (105 days).

Whereas many investigators such as Esen and Yıldız (2000a), Altın et al. (2003), Gokdal et al. (2004), Ağdacı (2013), Ceyhan et al. (2013), Kandemir (2013), Bingöl and Aygün (2014) reported that age of dam at lambing had no significant effect on daily live weight gain of lambs in different breeds of sheep.

2.3.1.3 Effect of Sex

Many investigators reported that sex of lamb affected daily live weight gains significantly, and the males was higher daily live weight gains than females lamb (Altın et al., 2003; Özbey and Akcan, 2003a; Gokdal et al., 2004; Kaymakçı et al., 2006; Ceyhan et al., 2010; Ceyhan et al., 2013; Ağdacı, 2013; Kandemir, 2013; Rosov and Gootwine, 2013). Also, Köseman et al. (2023) working on Bafra lambs and reported that male lambs had significantly ($p<0.01$) higher daily live weight gain than female lambs between period 60 and 90 days only, whereas this effect was non-significant between birth-30 days, 30-60 days, and 90-120 days.

Alarslan (2018) on their study on Kıvırcık lambs, reported that the effect of sex was significant on live weight gain between birth-150 days, birth-180 days and 90-180 days, while such effect was non-significant on live weight gain between birth-90 days and 150-180 days.

On the other hand, other researchers found a non-significant effect of sex of lamb on daily live weight gains in many breeds of sheep (Esen and Yıldız, 2000a; Öztürk and Odabaşıoğlu, 2011; Aslan, 2013; Ocak and Cankaya, 2013; Bingöl and Aygün, 2014; Sakar and Erişek, 2019).

2.3.1.4 Effect of Type of Birth

Several authors observed that single born lambs surpassed twins significantly in their daily live weight gains at different periods of lamb age (Özbey and Akcan, 2003a; Gokdal et al., 2004; Kaymakçı et al., 2006; Ağdacı, 2013; Aslan, 2013; Ceyhan et al., 2013; Kandemir, 2013).

Köseman et al. (2023) stated that type of birth affects daily live weight gain of Bafra lambs significantly between birth-30 and 60-90 days (weaning age), while this effect on daily live weight gain was found to be non-significant between period of 30-60 and 90-120 days of age of lambs.

Öztürk and Odabaşıoğlu (2011) in their study on Hamdani lambs found that the type of birth had significant on daily live weight gains between day 30 and 60, while this effect was no significant on daily live weight gain between birth - 30, 60 – weaning (90 days), and birth - weaning (90 days).

Also, Altın et al. (2003) reported a significant effect of type of birth on daily live weight gain of Kıvırcık, Chios x Kıvırcık F_1, and Kıvırcık x Karya F_1 crossbred lambs during the period between 47 to 61 days only.

Significant differences in daily live weight gain of Kıvırcık lambs due to their type of birth was reported by Alarslan (2018) between birth-150 days, whereas a non-significant effect was recorded of type of birth on live weight gain between 90-180 days and 150-180 days.

However, other researchers revealed a non-significant effect of type of birth on daily live weight gains of different breeds of sheep and for various periods of lambs age (Esen and Yıldız, 2000a; Ceyhan et al., 2010; Ocak and Cankaya, 2013; Bingöl and Aygün, 2014; Sakar and Erişek, 2019).

2.3.1.5 Effect of Dam Weight

Ağdacı (2013) found that the daily live weight growth of Pırlak lambs from birth to weaning (132 days) was significantly influenced ($p<0.01$) by the dam's weight. The lambs born from ewes weighing ≥55 kg were found to be heavier than the lambs produced from ewes weighing less than 55 kg.

2.4 Live Weight Gains During Fattening

Khadre and Karabacak (2018) observed the average daily live weight gains during fattening period (70 days) and was 314 g/day for Akkaraman lambs and 284 g/day for Awassi lambs, and the Akkaraman lambs had significantly higher ($p<0.05$) daily live weight gain than Awassi lambs.

In Iraq, Oramari et al. (2014) reported an average daily live weight gains between initial (22 kg) and final (30 kg) live weight were 348 g/day in Hamdani lambs and 307 g/day in Awassi lambs, and the Hamdani lambs exhibited a significantly ($p<0.01$) higher daily gain compared to Awassi lambs.

Also, Ozturk and Odabaşıoğlu (2011) in their study on male Hamdani lambs which born as singles, weaned at 90 days of age and fattened for 70 days, and the average daily live weight gains during fattening period were 210 g/day.

Rodriguez et al. (2011) found that the average daily live weight gains of purebred Assaf and Merino x Assaf F_1 crossbred single-born male lambs which weaned at six weeks of age were 224 g/day in purebred Assaf lambs and 299 g/day in Merino × Assaf F_1 crossbred lambs and the differences was significant ($p<0.001$), with higher average daily weight gains observed in Merino × Assaf F_1 crossbred lambs.

In addition, Özbey and Akcan (2003b) found that the mean value of daily live weight gain during fattening period was 232.91 g/day for purebred Morkaraman lambs, 231.73 g/day for Chios x Morkaraman F_1 crossbred lambs, and 245.62 g/day for Kıvırcık x Morkaraman F_1 crossbred lambs, while the differences among groups were non-significant.

Esen and Özbey (2001b) in their study to investigate fattening performance, slaughter, and carcass characteristics of Chios x Akkaraman F_1 and Chios x (Chios x Akkaraman) B_1 crossbred lambs of single-born male lambs, and weaned at 90 days of age during fattening for 84 days, they recorded an average daily live weight gains and were 238.04 and 232.07 g/day, respectively, but the differences among genotype groups was no significant.

Moreover, Esen and Yıldız (2000b) reported a non-significant difference among genotype groups and the average daily live weight gain in purebred Akkaraman and Chios x Akkaraman F_1 crossbred single-born male lambs was 245.53 g/day and 218.87

g/day, respectively. Furthermore, Aygün et al. (1998) recorded that the average daily live weight gains of male Karakaş lambs during fattening period (90 days) were 228.80, 242.51, and 198.10 g/day at different weaning times (45, 60, and 75 days), respectively and the differences among these groups were non-significant.

2.5 Body Measurement of Lambs

It is challenging to pinpoint the exact role that each genetic and non-genetic element plays in the complex interaction that results in an animal's phenotypic traits. These factors typically function simultaneously. Aside from body weight (at birth, weaning, and marketing), growth rate, reproductive efficiency, and carcass characteristics, the most significant attributes defining the meat yield of farm animals are their morphological qualities (Şen et al., 2021).

Morphological traits are therefore a useful tool for characterizing breed standards and their capacities for development (Cam et al., 2010; Al-Atiyat et al., 2021). Therefore, before creating plans for a breeding program meant to increase the production of the breed, it is crucial to describe the morphological traits of the breed (Yilmaz et al., 2007).

It is important to note that morphological traits vary depending on a variety of circumstances, including breed, age, sex, birth type, and month of birth (Bimerow et al., 2011; Abd-Allah et al., 2018).

2.5.1 Factors Affecting Lamb Body Measurements

2.5.1.1 Effect of Breed

Aljamaeen et al. (2023) conducted research to characterize the morphology of Assaf lambs and how it relates to body weight at different ages as well as certain behavioral traits. The means for withers height, body length, chest girth, and chest depth were 42.04, 35.04, 42.01, and 12.89 cm, respectively, at birth. At weaning age (about 60 days), the same body measurement traits were 55.36, 52.65, 65.73, and 21.43 cm,

respectively, and at marketing age (about 120 days), the same traits were 61.46, 61.07, 79.30, and 25.10 cm, respectively.

Furthermore, Esen and Elmaci (2021) conducted a study involving Kıvırcık, Bandirma, Karacabey Merino, Hampshire Down x Merino crossbreed, and Ramlic sheep breeds, found a significant effect of breed (sheep genotypes) on withers height, body length ($p<0.001$) and chest girth ($p<0.01$) of lambs at weaning (90 days age) and significant ($p<0.001$) effect on all lamb body measurements of studied traits at post weaning (135 days of age).

To investigate the effect of the genotypes group of Bafra, Akkaraman, Bafra × Akkaraman F_1 and Bafra × Akkaraman B_1 on the lambs body measurement in Türkiye, Güngör and Ünal (2020) found that the withers height were 56.76, 61.75, 60.98 and 61.73 cm, respectively; body length were 55.76, 55.18, 56.91 and 57.43 cm, respectively, chest girth were 63.05, 71.88, 60.89 and 61.92 cm, respectively, and chest depth was 22.14, 24.35, 23.89 and 22.36 cm, respectively, and the effect of genotypes group was found to be significant on withers height, chest girth, chest depth ($p<0.001$), and body length ($p<0.01$) at 90 days of age (weaning age), while the average means of wither height for the same genotypes of lambs were 64.01, 70.85, 68.99 and 64.63 cm, respectively; body length were 63.58, 64, 41, 65, 35 and 64.09 cm, respectively; chest girth were 75.18, 84.32, 84.04, and 76.48 cm, respectively; chest depth were 25.58, 27.92, 27.81 and 25.85 cm, respectively and the effect of these genotypes were reported to be significant on the wither height, chest girth and chest depth ($p<0.001$), and body length ($p<0.05$) at 180 days of age.

Moreover, Akdag and Karakuş (2020), in their study on Norduz lambs, noticed that the average means of withers height, body length, chest girth, chest depth and chest width were 60.32, 56.29, 75.81, 23.47, and 14.73 cm, respectively.

Sarı et al. (2014) conducted a study on body measurement traits such as withers height, body length, chest girth, and chest depth for 77 heads of Hemşin lambs at 30-day intervals from birth to 180 days of age, reported overall means of withers height as 39.08, 46.47, 53.06, 56.58, 58.57, 60.25, and 62.06 cm, respectively; body length as 39.87, 47.48, 54.40, 58.70, 61.99, 64.45, and 66.36 cm, respectively; chest girth as 43.73, 53.75, 62.77, 67.81, 73.68, 80.69, and 86.72 cm, respectively; and chest depth as 15.88, 18.41, 20.72, 22.49, 23.29, 24.31, and 25.32 cm, respectively.

In Türkiye, Aslan (2013) demonstrated a non-significant effect of lamb genotypes on withers height, body length and chest girth in day 150 of crossbred lambs old, and the withers height measurements was found as 56.69 and 55.81 cm; body length was 41.69 and 40.23 cm. Chest girth was 94.53 and 95.39 cm for the crossbred lambs of (Charollais x Romanov x Akkaraman) and (Charollais x Romanov x Morkaraman), respectively.

Some body measurements at 30, 60, 90, 120, 150 (weaning age) and 180 days for 100 Kıvırcık lambs were investigated by Alarslan (2018) and reported least square means for the withers height, body length, chest girth, chest depth and chest width and were 44.25, 41.71, 48.61, 14.59 and 10.91 cm, respectively for 30 days of age; 49.74, 47.97, 56.33, 17.37 and 12.57 cm, respectively for 60 days of age; 55.48, 54.95, 66.57, 21.44 and 14.53 cm, respectively for 90 days of age; 59.06, 59.44, 74.36, 23.69 and 16.55 cm, respectively for 120 days of age; 62.06, 62.60, 78.81, 25.27 and 18.27 cm, respectively for 150 days (weaning age) and 64.76, 64, 94, 81.03, 26.05 and 19.32 cm, respectively for 180 days of age.

Gül (2012) noticed that the differences between lamb genotypes were found to be significant effect on the chest girth ($p<0.05$) at 30 days of age, on body length ($p<0.001$) and wither height ($p<0.05$) at 60 days of age and withers height and body length ($p<0.001$) at 90 days (weaning age), whereas non-significant differences were determined in terms of withers height and body length at 30 days of age, chest girth at 60 days of age and 90 days (weaning age) during his study on Akkaraman and Tuj lambs under farm conditions.

Işık (2010) studied to determine the reproduction, livability and growth traits of Bafra sheep (Chios x Karayaka B_1). Body measurement traits such as withers height, body length, chest girth and chest depth of Bafra lambs at birth, 30, 60, 90 (weaning age), 120, 150 and 180 days were defined. At birth the body measurement traits for 145 Bafra lambs were recorded as 34.21, 29.24, 33.85 and 11.52 cm for withers height, body length, chest girth and chest depth, respectively. Also, at 30 days of age the same body measurement traits for 128 lambs were 40.85, 39.41, 43.31 and 16.35 cm, respectively. At 60 days of age the same body measurement for 118 lambs were 45.51, 44.17, 49.77 and 18.54 cm, respectively. At 90 days (weaning age) the same body measurement traits for 104 lambs were 46.61, 48.44, 55.28 and 19.11 cm, respectively. At 120 of age the

same body measurement traits for 92 lambs were 48.44, 50.56, 60.30 and 20.12 cm, respectively. At 150 days of age the same body measurement traits for 75 lambs were 52.41, 55.40, 64.75 and 21.91 cm, respectively. At 180 days of age the same body measurement traits for 50 lambs were 54.04, 57.89, 68.75 and 23.45 cm, respectively.

Karakuş (2007) during her study on body measurement traits such as withers height, body length, chest girth, chest depth, chest width and leg circumference for 41 purebred Karakaş and 52 (Ile de France x Akkaraman B_1) x Karakaş F_1 crossbreed lambs at 3 months (weaning age) and reported an average means and were 51.28 and 52.48 cm for withers height; 49.11 and 52.79 cm for body length; 63.18 and 66.96 cm for chest girth; 20.85 and 21.11 cm for chest depth; 13.33 and 15.15 cm for chest width and 54.55 and 57.35 cm for leg circumference, respectively, and the differences between lamb genotypes were reported to be significant ($p<0.01$) effect on the body length, chest girth, chest width and leg circumference; while no significant differences were determined in terms of withers height and chest depth. Whereas, at 6 months of age for 39 purebred Karakaş lambs and 52 (Ile de France x Akkaraman B_1) x Karakaş F_1 crossbred lambs the average means of withers height was 59.49 and 60.93 cm, body length was 56.65 and 61.26 cm, chest girth was 76.62 and 80.92 cm, chest depth was 25.03 and 26.09 cm, chest width was 16.80 and 19.23 cm and leg circumference was 64.08 and 69.02 cm, respectively and the differences between lamb genotypes were found to be significant ($p<0.01$) effect on all body measurement traits under study.

Further, by crossing sheep breeds of Kıvırcık x Akkaraman and Chios x Akkaraman in steppe conditions, Ünal et al. (2006a) investigated several production traits of crossbred genotypes developed for lamb production. Body measurement traits such as withers height, body length and chest girth at 3 months (weaning age) and 6 months of age for Akkaraman, Kıvırcık x Akkaraman F_2, Kıvırcık x Akkaraman B_1, Chios x Akkaraman F_2 and Chios x Akkaraman B_1 crossbred lambs were determined. At 3 months (weaning age), the withers height was 55.4, 54.8, 53.2, 55.6 and 57 cm, respectively, body length was 58.5, 56.8, 55.9, 57.3 and 58.8 cm, respectively, chest girth was 67.8, 64.2, 64, 63 and 63.7 cm, respectively, at the period of 3 months (weaning age) lamb genotypes had no significant effect on all body measurement traits examined. At the 6 months of age, in the same genotypes the withers height was found as 63.3, 63.8, 61.1, 64.7 and 65.2 cm, respectively, body length was 67.8, 64.8, 63.6,

67.6 and 67.9 cm, respectively, chest girth was 78.1, 76.7, 77.2, 76.5 and 76.3 cm, respectively. At 6 months of age the differences between lamb genotypes were found to be significant ($p<0.05$) in terms of withers height and body length, while had no significant effect in term of chest girth ($p>0.05$).

Kul and Akcan (2002) reported that the lamb genotypes had significant effect ($p<0.05$) on all body measurement traits of Awassi and East Friesian x Awassi F_1 crossbred lambs at 3 months old, and the average means of withers height, body length, chest girth (circumference), chest depth, chest width were 48, 45.18, 63.36, 20.45 and 15.82 cm for Awassi lambs, respectively, while these average means were 50.27, 48.36, 62.73, 21.45 and 15.73 cm for crossbred lambs of East-Friesian x Awassi F_1, respectively.

The growth, survival rate, and body measurements of Chios x Akkaraman F1 and Chios x (Chios x Akkaraman) B1 crossbred lambs were examined by Esen and Özbey (2001a). The data were obtained from 9 Chios x Akkaraman F_1 and 12 Chios x (Chios x Akkaraman) B_1 crossbred female lambs in to determine body measurements at 3 and 6 months of age. Withers height, body length, chest girth (circumference), chest depth and chest width in crossbred F_1 and B_1 lambs at the age of 3 months were found as 53.77 and 52.16; 54.55 and 51.41; 70.11 and 72.50; 25.25 and 23.50; 16.55 and 14.75 cm, respectively. The effect of genotypes was found to be significant on body length, chest girth ($p<0.05$) and chest width ($p<0.01$), while it did not in terms of withers height and chest depth at the age of 3 months. The same body measurement traits of the same genotypes at the age of 6 months were reported as 58.75 and 58.41; 54.75 and 52.50; 74.87 and 76.50; 26.12 and 26.16; 19.87 and 17.75 cm, respectively. Also, genotype affected significantly ($p<0.05$) on body length and chest width only, while it did not in terms of withers height, chest girth and chest depth at the age of 6 months for crossbred female lambs.

In the study on body measurements of Karadi lambs in Iraq, the overall mean of withers height, body length and chest girth at weaning (an average 3 months) were 52.97, 52.61 and 64.97 cm, respectively, and at the 6 months of age were 65.36, 60.25 and 73.74 cm, respectively (Hermiz and Mohammed, 2009).

2.5.1.2 Effect of Sex

Aljamaeen et al. (2023) in their study to determine some body measurement traits of male and female of Assaf lambs at birth, weaning (60 days of age) and marketing age (120 days of age). At birth, there was no significant effect of the sex on all measurement traits, while at weaning age, there was a significant differences between the sex of lamb in favor for male lambs of withers height and chest depth ($p<0.05$), but had no effect on both body length and chest girth, Whereas at marketing age, there was also a significant differences between the sex in favor of male lambs for body length ($p<0.01$) only, but had no effect on wither height, chest girth and chest depth.

Esen and Elmaci (2021) during their study the effect of sex of lamb on body measurement traits for different meat-type sheep of Kıvırcık, Bandirma, Karacabey Merino, Hampshire Down x Merino crossbreed, and Ramlic, at weaning age (90 days) there was a significant difference between the sex in favor for male lambs of withers height ($p<0.001$) and chest girth ($p<0.01$), while a non-significant difference was determined between male and female lambs for body length only. In contrast, there were a significant effect ($p<0.001$) of sex on all body measurement traits at 135 days of age.

In the study on Norduz lambs, there found a significant differences between the sex in favor of male lambs for withers height, chest depth ($p<0.01$) and body length ($p<0.05$), whereas reported no significant of sex of lambs on both chest width and girth (Akdag and Karakuş, 2020).

Alarslan (2018) during on his study on body measurement traits like withers height, body length, chest girth and chest depth for male and female Kıvırcık lambs at 30, 60, 90, 120, 150 (weaning age) and 180 days, and reported a non-significant effect of sex of lamb on all body measurement traits at 30, 90 and 120 days of age, while this effect was found to be statistically significant ($p<0.05$) on chest girth trait only at 60 days of age, in addition, at 150 and 180 days of age, the effect of sex of lamb was significant ($p<0.05$) on withers height and body length traits only.

Özmen et al. (2015) recorded an overall means of body measurements of Akkaraman lambs at the 3 months of age, and were 56.04 and 53.46 cm for withers

height, 48.71 and 46.03 cm for body length, 73.31 and 69.96 cm for chest girth, 24.39 and 21.15 cm for chest depth, 13.60 and 12.46 cm for chest width for male and female, respectively. Whereas, at the 6 months of age the overall means of withers height were (61.18 vs 57.10), body length (50.94 vs 49.75), chest girth (76.19 vs 73.75), chest depth (26.38 vs 22.60), chest width (14.21 vs 14.25 cm) for male and female, respectively.

Aslan (2013) indicated that sex of lamb had a non-significant effect on all body measurements of 34 male and 14 female of (Charollais x Romanov x Akkaraman) and (Charollais x Romanov x Morkaraman) crossbred lambs at the age of 150 days. Gül (2012) was determined some body measurement traits of male and female of Akkaraman and Tuj lambs at 30, 60 and 90 days (weaning age), at 30 days of age there was found a significant differences between the sex of lamb in favor of male lambs for withers height, body length ($p<0.01$), and chest girth ($p<0.05$), while at 60 days of age there was no significant effect between genders on the body measurement traits, also there was no significant effect of sex of lamb on the body traits examined at 90 days of age.

Işık (2010) determined the body measurement traits such as withers height, body length, chest girth and chest depth of male and female of Bafra lambs at birth, 30, 60, 90 (weaning age), 120, 150 and 180 days of age, the withers height was 34.27 and 34.15 cm, body length was 28.65 and 29.82 cm, chest girth was 33.87 and 33.84 cm, and chest depth was 11.55 cm and 11.49 cm for male and female, respectively at birth, and the differences between male and female lambs were found to be significant in term of body length ($p<0.05$), but didn't noticed this effect on withers height, chest girth and chest depth. Also, the sex of lamb had a significant effect on withers height ($p<0.05$), but no significant on body length, chest girth and chest depth at 30 days of age, while this effect was non-significant on all body measurement traits at 90 days (weaning age). Moreover, there was a significant effect of sex of lamb on chest girth and chest depth ($p<0.05$), in contrast effect on withers height and body length at 120 days of age. Furthermore, the differences between male and female lambs were found to be significant ($p<0.05$) and non-significant in all body measurement traits at 150 and 180 days of age, respectively.

At 6 months of age, the differences between the male and female Karadi lambs were significant ($p<0.01$) in their heart girth and withers height. Hermiz and

Mohammed (2009) reported that male lambs outperformed female lambs at all body measurements traits at weaning, with significant differences found in withers height alone ($p<0.05$).

Karakuş (2007) reported that the effect of sex of lamb was non-significant on all body measurements of purebred Karakaş lambs and (Ile de France x Akkaraman B_1) x Karakaş F_1 crossbred lambs at the age of 3 months (weaning age), whereas there was found a significant difference between sex of lamb in favor for male lambs for withers height and chest depth ($p<0.01$), but non-significant differences was reported between male and female lambs in terms of body length, chest girth, chest width and thigh circumference.

2.5.1.3 Effect of Type of Birth

In a study on Assaf lambs, Aljamaeen et al. (2023) claimed that the type of birth was significantly affected on chest girth, body length and withers height ($p<0.01$), but had no effect on chest girth ($p>0.05$) at birth, in contrast, there were no significant effect of type of birth on all body measurement traits at weaning (60 days of age) and marketing age (120 days of age).

A significant effect of type of birth on withers height and chest girth at the age 90 (weaning age) and 135 days (post weaning) of Kıvırcık, Bandirma, Karacabey Merino, Hampshire Down x Merino crossbreed, and Ramlic have been reported by Esen and Elmaci (2021), while such effect founded non-significant differences between the single and twin lambs on body length ($p>0.05$) at both lamb ages.

Alarslan (2018) determined the body measurement traits such as withers height, body length, chest girth and chest depth of single and twin Kıvırcık lambs at 30, 60, 90, 120, 150 (weaning age) and 180 days and indicated that the effect of type of birth on all body measurement traits were significant ($p<0.05$) at 60 days of lamb age, also reported a significant effect ($p<0.05$) of type of birth on both body length and chest width, and non-significant effect on wither height, chest girth and chest depth at 90 days of age, while such effect of type of birth was significant ($p<0.05$) on chest width only at 150 days of age and on both chest depth and chest width 180 days of age ($p<0.05$), whereas

the non-significant differences were found of type of birth on all body measurement traits in 30 and 120 days of lamb age.

Gül (2012) revealed that type of birth had highly significant effect in favor for single lambs for both body length and chest girth at 30 and 90 days of age, but this effect was no significant on wither height at both 30 and 90 days of age of Akkaraman and Tuj lambs, while type of birth was found to be significant effect on body length, withers height ($p<0.05$) and chest girth ($p<0.001$) at 60 days of age.

Işık (2010) determined the body measurement traits such as withers height, body length, chest girth and chest depth of single and twine Bafra lambs at birth, 30, 60, 90 (weaning age), 120, 150 and 180 days, and reported that the type of birth was affected significantly on chest depth ($p<0.001$), withers height, chest girth ($p<0.01$) and body length ($p<0.05$) at birth, also recorded a significant effect ($p<0.001$) of type of birth on all body measurement traits at 30 days of age, 60 days of age, 90 days (weaning age) and at120 days of age, in addition, the type of birth at 150 days of age was found to be significant effect on withers height, chest girth, chest depth ($p<0.001$) and body length ($p<0.05$), on the contrary, a non-significant effect of type of birth was recorded on all body measurement traits at 180 days.

In Iraq, Hermiz and Mohammed (2009) reported that the type of birth was found to be affected significantly ($p<0.01$) on all body measurement traits of Karadi lambs at 3 (weaning age) and 6 months of age.

Karakuş (2007) in her study on purebred Karakaş lambs and (Ile de France x Akkaraman B_1) x Karakaş F_1 crossbred lambs in Türkiye found a non-significant effect of type of birth on all body measurement traits at 3- and 6-month-old of lambs.

2.6 Carcass Characteristics

2.6.1 Carcass Weight and Dressing Percentage

Animal breeders should understand the significance of dressing percentage as it can greatly affect their profitability. A lot of packers frequently base their payments on formulas or percentages of carcass dressing. The dressing percentage, which is determined by comparing the dressed carcass weight to the live weight of the animal

after the skin and internal organs have been removed, shows how much meat a carcass will yield (Schweihofer, 2011). Whether it's hot or cold can be inferred from the carcass's weight. Further factors that may impact the dressing % of a carcass for a particular live body weight include the animal's age, breed, sex, physical condition, and length of fattening phase. Also, the success of lamb fattening programs is dependent on the high weight of the carcass and dressing percentage, as reported by Gökdal et al. (2012).

Akmaz et al. (2000a) revealed that the hot carcass weights were 21.93 kg, 23.5 kg, and 23.23 kg, cold carcass weights were 21.70 kg, 23.02 kg, and 22.88 kg, dressing percentages were 48.54%, 50.99%, and 50.97% for German Black Headed Mutton x Awassi F_1, Hampshire Down x Awassi F_1, and Hampshire Down x (Hampshire Down x Awassi) B_1, respectively and there were a highly significant differences in all traits between genetic groups ($p<0.01$).

Also, in Iraq, Al-Sherwany and Alkass (2021) revealed that the Awassi male lambs had significantly ($p<0.05$) higher dressing percentage than Karadi lambs (47.31% vs 45.77%). In contrast, Esen and Özbey (2001b) reported that the genetic groups had no significant differences in hot, cold carcass weights and dressing percentages between Chios x Akkaraman F_1 and Chios x (Chios x Akkaraman) B_1 crossbred lambs and they recorded 18.72 kg and 19.08 kg, 18.51 kg and 18.73 kg and 45.37% and 46.41% for hot, cold carcass weights and dressing percentages for both genetic groups, respectively.

Also, Özbey and Akcan (2003b) recorded that the hot carcass weights were 23.18 kg, 22.01 kg, and 22.57 kg, cold carcass weights were 23.05 kg, 22.31 kg, and 22.48 kg, dressing percentages were 50.52%, 48.53%, and 48.70% for Morkaraman, Chios x Morkaraman F_1, and Kıvırcık x Morkaraman F_1 crossbred lambs, respectively and the difference was non-significant in hot, cold carcass weights and dressing percentage among these three groups.

Moreover, Esen and Yıldız (2000b) claimed that there were no significant differences between purebred Akkaraman and Chios x Akkaraman F_1 crossbred lambs for hot, cold, and dressing percentage, the hot carcass weights were 22.38 and 22.10 kg, the cold carcass weights were 21.72 and 21.40 kg, and the dressing percentages were 48.88% and 47.15%, respectively.

Macit et al. (2002) found that the dressing percentage in their study of Tushin, Awassi, and Morkaraman lambs slaughtered at 29,34 and 29 kg were 49.1, 51.4 and 53.5%, respectively. The non-significant differences in hot, cold carcass weights and dressing percentages due to the breed and genetic groups agreed with results observed by Akmaz et al. (2000b), Gökdal et al. (2004), Esenbuga et al. (2009) and Oramari et al. (2014).

2.6.2 Rib Eye Area and Fat Thickness

In animal studies, the Musculus longissimus dorsi (MLD), also known as the rib eye area, can be used as an index of improvement or the amount of lean muscle associated with a carcass and the yield of quality cuts. The MLD is directly related to the amount of muscle in the carcass, particularly in the round and loin (Williams, 2002). The rib eye area is influenced by many factors including breed (Arganosa et al. 1977; Misra, 1984), age (Tahir et al., 1995), weight (Mohammed, 1988), fattening period and castration (Taha, 1990). Additionally, measurement of fat thickness, particularly in the loin and rib areas where the longissimus muscle provides a suitable base, has proven to be a valuable technique for predicting carcass composition and establishing standards for quality parameters (Lawrence and Fowler, 1997). Wide eye muscle sectional areas are signs of high lean tissue, while thicker back fat is an indication of poor carcass quality (Şahin, 2002). The valuable parts of the carcass can be determined by identifying the sectional area of the eye muscle, as noted by Ceyhan et al. (2008).

Özbey and Akcan (2003b) conducted a study on the eye muscle (MLD) area and back fat thickness of Morkaraman lambs, Chios x Morkaraman F_1 lambs, and Kıvırcık x Morkaraman F_1 crossbred lambs and the results showed that the MLD area for Morkaraman lambs was 11.58 cm² and the back fat thickness was 3.92 mm, for Chios x Morkaraman F_1 lambs, the MLD area was 12.54 cm² and the back fat thickness was 4.04 mm, but for Kıvırcık x Morkaraman F_1 crossbred lambs the MLD area was 10.24 cm^2 and the back fat thickness was 6.42 mm, while Kıvırcık x Morkaraman F_1 crossbred lambs had a significantly higher ($p<0.01$) back fat thickness when compared to

Morkaraman and Chios x Morkaraman F_1 lambs. However, there was no significant difference in rib eye area between the three groups.

Esen and Özbey (2001b) conducted research on the MLD area and back fat thickness of Chios x Akkaraman F_1 and Chios x (Chios x Akkaraman) B_1 crossbred lambs. The results found that the MLD area for Chios x Akkaraman F_1 and Chios x (Chios x Akkaraman) B_1 crossbred lambs was 10.68 cm² and 10.54 cm², while the back fat thickness was 6.62 mm and 6.64 mm, respectively. However, the difference in rib eye area and back fat thickness between the two breeds was not statistically significant.

Also, Esen and Yıldız (2000b) revealed that there was a non-significant effect in MLD (12.50 cm² vs 7.94 mm) and back fat thickness (11.20 cm² vs 7.49 mm) between purebred Akkaraman and Chios x Akkaraman F_1 crossbred lambs, respectively.

In Iraq, the result of Oramari et al. (2014) reported that rib eye area of Awassi and Hamdani lambs are almost the same (11.52 vs. 11.47 cm^2), also it was found that Awassi lambs had significantly ($p<0.01$) higher subcutaneous fat over MLD than Hamdani lambs (3.13 vs. 2.41 mm), but difference in MLD was non-significant between two breeds.

In addition, Al-Sherwany and Alkass (2021) indicated that the MLD and fat thickness were 15.18 cm² and 2.41 mm and 14.79 cm² and 3.31 mm for Karadi and Awassi lambs, respectively. Whereas, Awassi lambs had significantly higher ($p<0.05$) Fat thickness than Karadi lambs, while the differences in MLD was non-significant.

Esenbuga et al. (2009) reported that the effect of breed on MLD areas was significant ($p<0.05$) and the Morkaraman lambs had greater MLD areas (15.45 cm²) than Awassi lambs (12.58 cm²), while the difference in fat thickness (3.67 mm vs 3.70 mm) was non-significant. Conversely, many authors such as Akmaz et al. (2000b and 2000a), Gökdal et al. (2004) and Khadre and Karabacak (2018) found that breed did not significantly affect MLD areas and back fat thickness.

2.6.3 Commercial Cuts of the Carcass

Achieving a specific carcass weight can be seen as a crucial element in the meat trade, leading to a higher profit margin for farms. However, the methods used by the author for cutting the carcass may vary, resulting in differences in yield. The selection

of commercial cuts is typically based on customer demand and the desired composition of the meat (Setyaningrum, 2015).

In the case of sheep, the commercial cuts include the neck, shoulder, rack, loin, shank, breast, leg, and flank (Sunarlim, 2005). Among these cuts, the leg, loin, and rack are considered more valuable according to industry standards (Cameron et al., 2001).

Khadre and Karabacak (2018) found that Akkaraman lambs were higher weights significantly in the leg (3.20 kg vs 2.84 kg) and flank (1.14 kg vs 1.02 kg) when compared to Awassi lambs ($p<0.05$), but this effect was no significant in other commercial carcass cuts such as back-loin (2.13 kg vs 1.92 kg), shoulder (1.60 kg vs 1.52 kg) and neck (0.595 kg vs 0.762 kg).

Also, Esen and Özbey (2001b) reported that the genetic groups had a significant effect on some commercial carcass cuts for Chios x Akkaraman F_1 and Chios x (Chios x Akkaraman) B_1, Chios x Akkaraman F_1 had significantly higher weights in the shoulder (3.68 kg vs 2.81 kg) only when compared to Chios x (Chios x Akkaraman) B_1 crossbred lambs ($p<0.01$), but such effect was found non-significant in other commercial carcass cuts (leg and back-loin). On the other hand, other researchers noticed a non-significant effect of breed or genetic group on commercial carcass cuts in different breeds of sheep (Esen and Yıldız, 2000b, Özbey and Akcan, 2003b, Gökdal et al., 2004).

2.6.4 Non-Carcass Components

Non-carcass components, while not included in the commercial cuts of the carcass, account for a substantial portion of the live animal. Although they do not directly contribute to the producer's revenue, their value to the overall animal should not be overlooked. The meat industry seems unconcerned with edible components such as liver, kidney, heart, spleen, brain, and non-edible offal parts, but is more aware of the quantitative and qualitative qualities of the carcass in emerging nations. Age and diet of the animal have the most effects on non-carcass components (Wise et al., 1961).

Regarding to the comparison between the two studied breeds, Khadre and Karabacak (2018) recorded an average of the non-carcass components such as (heart + lung + liver), head, four feet, testicles, kidneys, and spleen weight and were 1.63 kg, 2.08 kg, 0.930 kg, 0.210 kg, 0.128 kg and 0.67 kg for Akkaraman lambs, respectively

and were 1.52 kg, 2.15 kg, 0.916 kg, 0.116 kg, 0.127 kg, and 0.70 kg for Awassi lambs, respectively. They also found that carcasses of Akkaraman lambs had significantly ($p<0.01$) higher weight of testicles than Awassi lambs' carcasses, but the differences between these two breeds had no significant effect on all non-carcass components under study.

Esen and Özbey (2001b) studied on the effect of genotype group Chios x Akkaraman F_1 and Chios x (Chios x Akkaraman) B_1 on non-carcass components, and reported that there were a significant differences ($p<0.05$) between genotypes for the testicle weight only, and recorded average weight of non-carcass components such as (heart + lung + liver), (head + feet), testicles, kidneys, and spleen and were 1.55 kg, 3.08 kg, 0.35 kg, 0.16 kg, and 0.09 kg for Chios x Akkaraman F_1 lambs, respectively. while these weights were 1.60 kg, 3.43 kg, 0.21 kg, 0.03 kg, and 0.01 kg, respectively for Chios x (Chios x Akkaraman) B_1 lambs.

Comparison between Turkish purebred Akkaraman and Chios x Akkaraman F_1 crossbred lambs, Esen and Yıldız (2000b) recorded that the weight of non-carcass components such as (heart + lung + liver), (head + feet), testicles, kidneys and spleen and were 1.64 kg, 3.10 kg 0.30 kg, 0.13 kg, and 0.10 kg, respectively for purebred Akkaraman lambs, and were 1.68 kg, 3.32 kg, 0.42 kg, 0.15 kg, and 0.09 kg, respectively for Chios x Akkaraman F_1 crossbred lambs, also they noticed that the testicles weight of purebred Akkaraman lambs was significantly greater ($p<0.01$) when compared to the Chios x Akkaraman F_1 crossbred lambs, while the difference in other non-carcass components was non-significant.

Özbey and Akcan (2003b) reported a significant difference between purebred Morkaraman lambs and Kıvırcık x Morkaraman F_1 crossbred lambs for the (heart + lungs + liver), spleen, testicles and kidney, the weight of (heart + lung + liver) was significantly ($p<0.05$) greater in Chios x Morkaraman F_1 crossbred lambs compared to Morkaraman and Kıvırcık x Morkaraman F_1 crossbred lambs, kidneys were significantly ($p<0.01$) greater in Kıvırcık x Morkaraman F1 crossbred lambs compared to Morkaraman and Chios x Morkaraman F_1 crossbred lambs, but the difference in spleen and testicles weight was no significant between these genetic groups.

Akmaz et al. (2000a) noticed that the weight of non-carcass components like (heart + lung + liver), head, four feet, testicles, kidneys, and spleen were 2.15 kg, 2.02

kg, 1.14 kg, 0.22 kg, 0.14 kg, 0.08 kg, respectively for German Black Headed Mutton x Awassi F_1. While these weights were 1.86 kg, 2.00 kg, 0.99 kg, 0.23 kg, 0.14 kg, 0.09 kg, respectively, for Hampshire Down x Awassi F_1. Whereas for Hampshire Down x (Hampshire Down x Awassi) B_1 were 1.95 kg, 2.10 kg, 1.05 kg, 0.26 kg, 0.14 kg, 0.09 kg, respectively. In addition, the German Black Headed Mutton x Awassi F_1 group recorded a significant greater weight only for (heart + lung + liver) ($p<0.05$) and four feet ($p<0.01$) when compared to other groups and the differences between them were found to be significant.

In contrast, Akmaz et al. (2000b) reported a non-significant difference between genotype groups for the non-carcass components such as (heart + lung + liver), head, four feet, testicles, kidneys, and spleen weight.

2.6.5 Fat Weights

Khadre and Karabacak (2018) during their study on Akkaraman and Awassi lambs, recorded an average weight of kidney and fat tail and were 0.284 kg and 3.17 kg for Akkaraman lambs and 0.220 kg and 2.31 kg for Awassi lambs, respectively, and Akkaraman lambs had a significantly higher fat tail weight than Awassi lambs, while there were no significant differences between these two breeds in kidney fat weights.

Esen and Özbey (2001b), while evaluating the effect of genotype on lamb carcass components, concluded that a significant difference was shown in kidney, internal, and fat tail weights of Chios x Akkaraman F_1 lambs (0.32 kg, 0.39 kg, and 1.92 kg) and Chios x (Chios x Akkaraman) B_1 lambs (0.18 kg, 0.27 kg, and 1.06 kg), respectively.

Esen and Yıldız (2000b) reported that the fat tail weights were significantly ($p<0.01$) greater in purebred Akkaraman lambs (3.95 kg) than Chios x Akkaraman F_1 crossbred lambs (2.18 kg).

Özbey and Akcan (2003b), observed that the fat tail weight had significantly higher ($p<0.01$) in Morkaraman lambs (4.20 kg) than that of Chios x Morkaraman F_1 (1.96 kg) and Kıvırcık x Morkaraman F_1 (2.71 kg) crossbred lambs. While they found that there were no significant effects among Morkaraman, Chios x Morkaraman F_1 and

Kıvırcık x Morkaraman F_1 lambs in kidney fat (0.25 kg, 0.34 kg and 0.32 kg) and internal fat (0.44 kg, 0.74 kg and 0.39 kg), respectively.

Akmaz et al. (2000a) reported that German Black Headed Sheep x Awassi F_1, Hampshire Down x Awassi F_1 and Hampshire Down x (Hampshire Down x Awassi) B_1 lamb carcasses did not show significant differences in terms of kidney and internal fat weights. Akmaz et al. (2000b) noticed a non-significant variation in kidney and internal fat weights among these four genotype groups of German Black Headed Mutton x Akkaraman F_1 (0.33 kg and 0.46 kg), German Black Headed Mutton x (German Black Headed Mutton x Akkaraman) B_1 (0.38 kg and 0.55 kg), Hampshire Down x Akkaraman F_1 (0.29 kg and 0.51 kg) and Hampshire Down x (Hampshire Down x Akkaraman) B_1 (0.40 kg and 0.50 kg), respectively.

Gökdal et al. (2004) found that there was a significant effect between purebred Karakaş lambs and (Ile de France x Akkaraman B_1) x Karakaş F_1 crossbred lambs in kidney and pelvic fat weight (0.10 kg and 0.18 kg, $p<0.05$) and fat tail (2.84 kg and 0.96 kg, $p<0.01$), respectively, while there was no significant difference between two genotype groups in internal fat weight.

3. MATERIALS AND METHODS

3.1 Animal Material

The animal material of the study consisted of 150 Akkaraman sheep and 5 Akkaraman rams, aged 2-6 years, kept under breeding conditions in Gülsünler village, Van province, Türkiye (Figure 3.1). Two purebred Assaf rams (2 and 3 years old) used for crossbreeding were purchased from a commercial enterprise producing Spanish Assaf sheep (Figure 3.2). The growth characteristics and body measurements of Akkaraman and Assaf x Akkaraman (ASF x AK) F_1 crossbred lambs were determined up to 6 months of age. In addition, testicular characteristics of purebred and crossbred male lambs weaned at 3 months of age were determined at 3 and 6 months of age; fattening performance and carcass characteristics of 10 heads Akkaraman and 9 heads ASF x AK F_1 crossbred male lambs were evaluated.

Figure 3.1 Akkaraman sheep

Figure 3.2 Assaf rams

3.2 Management and Feeding

There is a semi-intensive production system on the farm where the research material animals are kept. The animals were allowed to graze natural pasture for all day during the spring, summer, and autumn. All sheep were housed indoors during the winter months and were fed mainly good quality alfalfa hay (250 g/head/day), barley straw (1.05 kg/head/day), barley grain (250 g/head/day), with the 250 g of commercial feed containing 15% crude protein, 3% crude fat, 9% crude fiber, 8% crude ash and 0.5% sodium/kg head/day. Three weeks before the mating season, all sheep and rams on the farm were given 300-450 g of wheat and 100 g of flour/head/day as a flushing in addition to pasture. In addition, ewes were offered the same amount of the above feed daily during the last five weeks of pregnancy and after lambing until weaning (the lactation period). Sheep milking generally started in April and continued until September. The sheep also had free access to clean water and mineral blocks, always available. The age of the ewes and rams was recorded in the animal records of the General Directorate of Agriculture in the province of Van.

Purebred and crossbred lambs were fed mixed diets and chopped dried sainfoin grass during intensive fattening. The raw nutrient composition of the mixed diet and chopped dried sainfoin grass fed to Akkaraman and ASF x AK F_1 crossbred lambs is shown in Table 3.1. All sheep on the farm were regularly vaccinated against common diseases and dewormed against endoparasites. In addition, all animals received an annual oral dose of ivermectin (Durvet-Animal Health product/ Blue Springs, Missouri U.S.A.) to control external parasites.

3.3 Methods

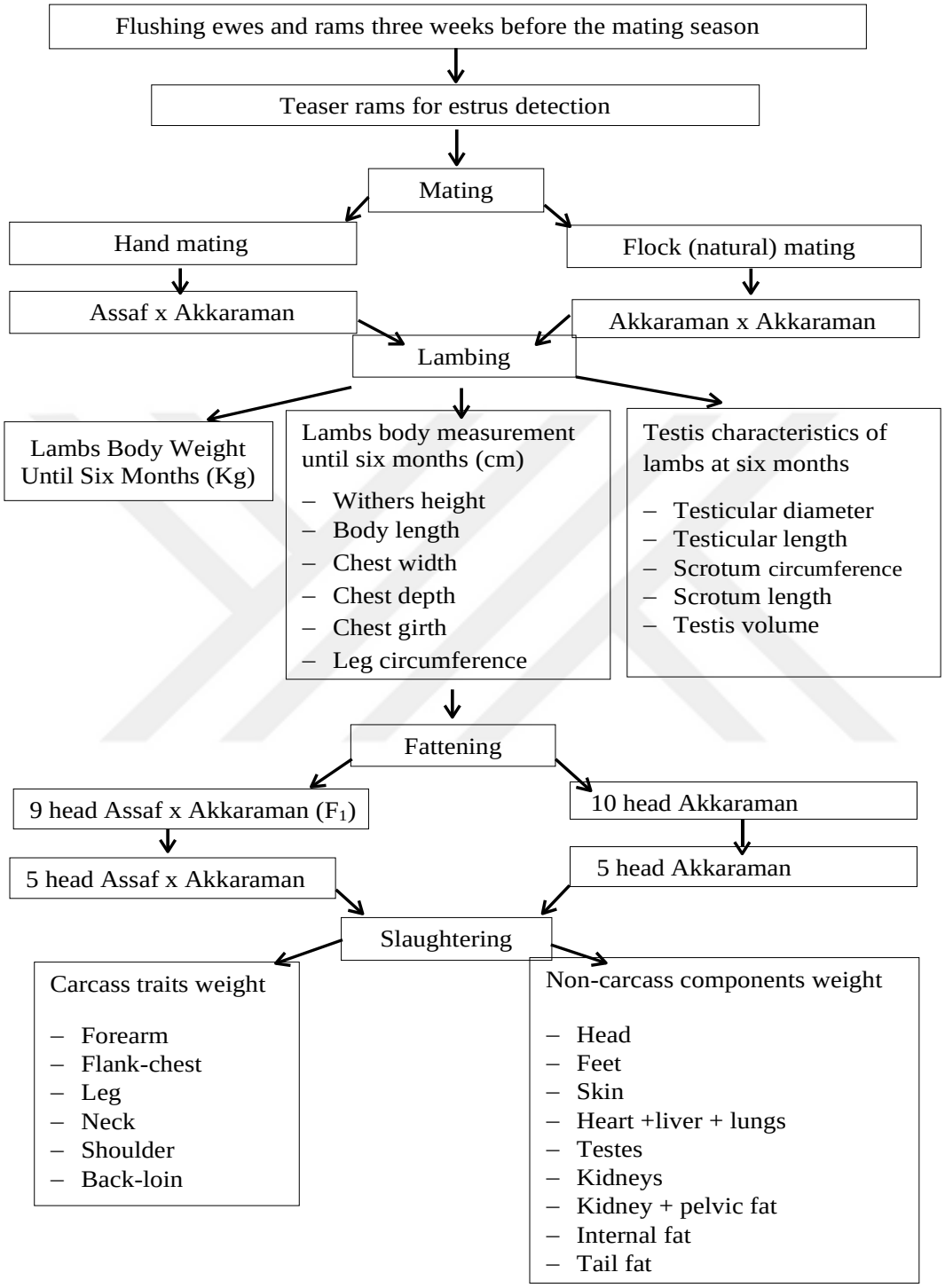


Figure 3.3 Plan of the study

3.3.1 Mating Program

On the farm, the breeding season started from mid-August to mid-November 2022. Before the start of the breeding season, all sheep were sheared once a year in June-July and all rams and ewes were checked for general health and physical examination of the external reproductive organs, particularly the testes and udders.

All sheep were managed together as a single group and kept in the pasture during the day, and teaser rams, with their genitals and lumbar region covered with a cotton cloth, were left among them to detect the estrus (Figure 3.4 and 3.5). The first observation was made on the pasture until the herd returned to the farm at 10:00 in the morning, and the second observation was made in the evening after the herd returned from the pasture at 14:00 in the afternoon. Thus, ewes determined to be in heat by the teaser rams were separated and placed in a small mating pen with Assaf ram for hand mating. A natural mating program was applied to Akkaraman rams and ewes at pasture (Akkaraman x Akkaraman). Due to the difficulty of mating semi-fat-tailed Assaf rams with fat-tailed Akkaraman ewes, hand mating was used between Akkaraman ewes and Assaf rams (Assaf x Akkaraman). The tail region of the Akkaraman ewe was lifted and the Assaf ram was allowed to mate easily (Figure 3.6). Each mature Akkaraman ewe was mated four times by Assaf rams within 24 hours to ensure the maximum amount of sperm was deposited in the vagina and to optimize the chance of conception. Ewes that were found to be in estrus in the morning were mated twice in the morning and again in the afternoon, and ewes that were found to be in estrus in the afternoon were mated twice in the afternoon and then again, the following morning. After the process of hand mating, ewes that were mated by Assaf rams were marked, and the tag numbers of both rams and ewes were recorded. The ewes were then separated and taken to pasture with a teaser ram as a separate flock for about two months to identify unsuccessful mating. These ewes were mated again, and the mating dates and numbers of ewes were recorded.

Figure 3.4 Teaser of Akkaraman rams

Figure 3.5 Estrus detection by teaser rams

Figure 3.6 Hand mating

3.3.2 Reproductive Performance Characteristics

Some reproductive characteristics of Akkaraman sheep were determined according to the formulas stated below (Aksoy et al., 2023; Şirin, 2023).

Fertility (%) = (Number of ewes lambing / Number of ewes exposed to the ram) x 100

Fecundity = Number of lambs born / Number of ewes exposed to the ram

Litter Size = Number of lambs born / Number of lambing ewes

Infertility Rate (%) = (Infertile ewes / Number of ewes exposed to the ram) x 100

Twin Rate (%) = (Number of lambs born twins / Number of ewes lambed) x100

3.3.3 Lambing

The lambing season started in mid-January and lasted until mid-April 2023. The pregnant ewes were moved to a lambing pen as the time of birth approached. The lambs were kept with their mothers for approximately 5-7 days, then separated from their mothers and suckled twice a day. Lambs were housed and fed indoors from two weeks of age, receiving 600g/day alfalfa hay and 800g/day barley grain. After April, the ewes were grazed on pasture, milked once a day and the lambs remained with their mothers

until weaning (3 months). Weaned lambs were separated from their mothers and taken to pasture in separate flocks, where they remained for an average of 7 months (Figure 3.7 and 3.8)

3.3.4 Data of Live Weights for Lambs

Plastic ear tags were attached to newborn lambs and the lambs were recorded. They were then weighed using a scale sensitive to 10 g within 12 hours of birth (Figure 3.9). Birth weight, date of birth, genotype, sex, type of birth, dam's ear number, dam's age and dam's weight at birth were recorded for each newborn lamb. Lambs were weighed at 14-day intervals up to an average age of 6 months to monitor growth and development.

Figure 3.7 Akkaraman lambs

Figure 3.8 Assaf x Akkaraman F_1 lamb

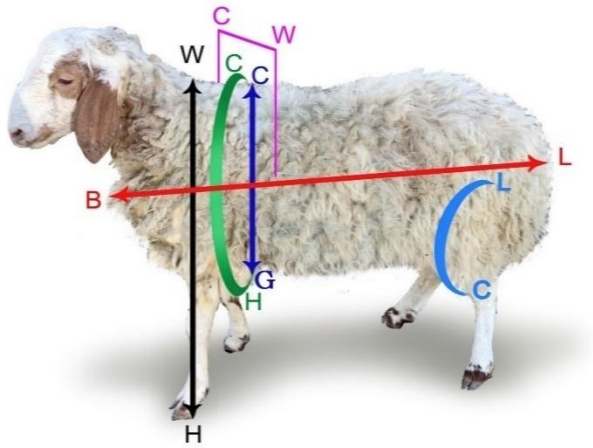
Figure 3.9 Weighing of newborn lambs within the first 12 hours after birth

3.3.5 Body Measurements

Various body measurements of purebred and crossbred lambs were taken at 30-day intervals after birth and continued until 6 months of age. With the help of a measuring stick, the withers height, body length, chest width and chest depth

measurements were determined, while the chest girth (circumference) and leg (thigh) circumference were measured with a measuring tape (Figure 3.10 and 3.11). When taking body measurements, care was taken to ensure that the animals were standing quietly on a flat surface. All measurements were taken by the same person using the same tools to minimize inter-individual variation.

Figure 3.10 Measuring stick and tape



WH: Withers height

BL: Body length

CW: Chest width

CD: Chest depth

CG: Chest girth

LC: Leg (Thigh) circumference

Figure 3.11 Body measurements of lambs

The body measurements were taken as below:

1. Withers Height: The vertical distance from the highest point of the withers (the height from shoulder blades) to the ground. It was measured with a measuring stick (Figure 3.12).

Figure 3.12 Wither height measurement by graduated measuring stick

2. Body Length: The distance from the tip of sternum to the base of the tail (tuber ischii). It was measured with a measuring stick (Figure 3.13).

Figure 3.13 Body length measurement by graduated measuring stick

3. Chest Width: Maximum intercostal diameter at the level of the 6th rib behind the articulatio humeri. It was measured with a measuring stick (Figure 3.14).

Figure 3.14 Chest width measurement by graduated measuring stick

4. Chest Depth: Vertical distance between the top of the withers and the chest bone (sternum). It was measured with a measuring stick. (Figure 3.15).

Figure 3.15 Chest depth measurement by graduated measuring stick

5. Chest Girth (Circumference): The measurement that passes through the withers and sternum and completely surrounds the chest. It was measured with a measuring tape (Figure 3.16)

Figure 3.16 Chest circumference measurement by measuring tape

6. Leg or Thigh Circumference: The measurement taken by passing the measuring tape diagonally from the tuber ischii to the tuber coxae and surrounding the thigh (Figure 3.17).

Figure 3.17 Thigh circumference measurement by measuring tape

3.3.6 Survivability of Lambs

Survival data included lambs that were born alive but died during the growing periods. The survival rate was calculated as the ratio of the number of live lambs to the number of live born lambs in the live weight periods analyzed. The data up to 3 months of age were used to determine survivability of lambs.

3.3.7 Testis Characteristics of Male Lambs

Testis diameter, testis length, scrotum circumference and scrotum length measurements of Akkaraman and crossbred male lambs were determined at 3 and 6 months of age. Testis diameter and testis length were measured with electronic caliper and scrotum circumference and scrotum length were measured with measuring tape (Figure 3.18). Testis characteristics were determined as reported by Yılmaz (2006).

Figure 3.18 Testis measurement of male lambs

Testicular diameter (cm): The diameter of each testicle determined at its widest point with a metal caliper.

Testicular length (cm): It is the length between the tip of the testicle and the epididymis and was determined with a metal caliper.

Scrotum circumference (cm): It is the circumference taken from the widest part of a pair of testicles with a measuring tape.

Scrotum length (cm): It is the length from where the scrotum joins the inguinal region to the tip.

Testis volume (cm^3): 0.0396 x average testis length x (scrotum circumference)^2

3.3.8 Fattening Performance

To determine fattening performance, 10 heads of Akkaraman and 9 heads of ASF x AK F_1 crossbred singleton male lambs with a maximum age difference of 1 month were randomly selected. After the lambs were weaned at the age of 3 months, they were taken to the fattening pens and treated for internal parasites.

After an adaptation period for 7 days, the lamb weights were recorded and raised under the similar environmental, nutrition and management conditions. Each main group of lambs was kept in a separate pen and fed in a group basis. Lambs were fed ad libitum with a concentrate feed mixture and 100 g/day of alfalfa hay per lamb. Clean water and mineral blocks were available constantly. The chemical composition of the concentrated feed used in fattening is given in Table 3.1, and the nutrient analysis of alfalfa hay is given in Table 3.2, which was analyzed by the device Near Infrared Spectroscopy (NIR) Perten DA 7250.

Live weights of all lambs were recorded biweekly before feeding at the morning. Also, body measurements of lams were taken at the same time. In addition, the daily concentrate consumption of each group was recorded. At the end of fattening period the final live weight and body measurements of all lambs were recorded. The formulas used in calculating daily feed consumption, feed utilization efficiency and daily live weight gain are given in Equations 3.1, 3.2 and 3.3.

Daily feed consumption = The amount of feed given (kg) – remaining feed (kg) / number of days / number of lambs (3.1)

Feed conversion efficiency = Average feed intake (kg) / Average body weight gain (kg) (3.2)

Daily live weight gain (kg) = (Weight achieved – previous weight) / 14 days (3.3)

Table 3.1 The chemical composition of the concentrated feed used in fattening

Item	Amount
Crude protein	17%
Crude fiber	6%
Ash	7.5%
Crude fat	4%
Sodium	0.2%
Vitamin A	20000 IU
Vitamin D3	3000 IU
Vitamin E	50 Mg
Vitamin B1	4 Mg
Vitamin B2	6 Mg
Cobalt	0.15%
Selenium	0.3%
Manganese	50 mg/kg
Iron	50 mg/kg
Zinc	50 mg/kg
Copper	10 mg/kg

Table 3.2 The nutrient analysis of alfalfa hay

Nutrients (Dry matter)	%
Crude protein	14.73
Crude fat	0.95
Crude fiber	30.05
Crude ash	4.15
ADF (Acid Detergent Fiber)	50.7
NDF (Neutral Detergent Fiber)	51.7

3.3.9 Slaughtering and Carcass Characteristics

At the end of the fattening period, slaughtering and carcass characteristics of 5 lambs from each genotype were determined. The lambs were fasted for 18-h, with free access to water and weighed immediately prior to slaughter. Slaughtering and carcass dissection were carried out in a private abattoir.

Lambs were slaughtered by Islamic method and laws as halal technique. Immediately after slaughter the head was removed at the atlanto – occipital. Joint, fore and hind feet at the carpal and tarsal joints were separated, respectively. Then the carcass was partially skinned on the floor and then hanged in the racks by hind legs and skinning was completed. After evisceration was carried out, the carcass and non-carcass components (head, feet, skin, heart + liver + lungs and internal fat) were weighed with a scale sensitive to 10 g. After slaughter, the carcass was weighed, and the hot carcass weight was determined. After chilling the carcasses at 4 C° for 24 hours in the cold storage, cold carcasses were weighed, and then kidney, testicle, kidney-pelvis fat and tail weights were removed and weighed separately. Then, the tailless cold carcass was split into two symmetrical parts along the vertebral column into left and right halves using an electrical saw. The weight of the left half carcass was recorded, and all cutting operations were carried out on the left half carcass. The left half of the carcass was divided into 6 commercial cuts leg (thigh), back-loin, forearm, shoulder, neck, flank-chest) according to the procedure of Colomer-Rocher et al. (1987) and each cut was weighed separately and calculated as a percent of chilled carcass weight (Figure 3.19). From these data obtained, carcass yield, chill loss, by-products, proportions of various organs and proportions of carcass parts were calculated according to the formulas below.

Dressing percentage (%)	:	(Cold carcass weight / Slaughter weight) x 100
Cooling loss (%)	:	100 –(Cold carcass weight/Hot carcass weight x 100)
Head percentage (%)	:	(Head weight / Slaughter weight) x 100
Feet percentage (%)	:	(Feet weight / Slaughter weight) x 100
Hide percentage (%)	:	(Hide weight / Slaughter weight) x 100
Heart+liver+lungs percentage (%)	:	(Heart+liver+lungs weight / Slaughter weight) x 100
Testes percentage (%)	:	(Testes weight / Hot carcass weight) x 100
Kidney percentage (%)	:	(Kidney weight / Cold carcass weight) x 100
Kidney-pelvic fat percentage (%)	:	(Kidney-pelvic fat weight/Cold carcass weight) x 100
Internal fat percentage (%)	:	(Internal fat weight / Hot carcass weight) x 100

Tail percentage (%) : (Tail weight / Cold carcass weight) x 100

Leg percentage (%) : (Leg weight / Left half carcass weight) x 100

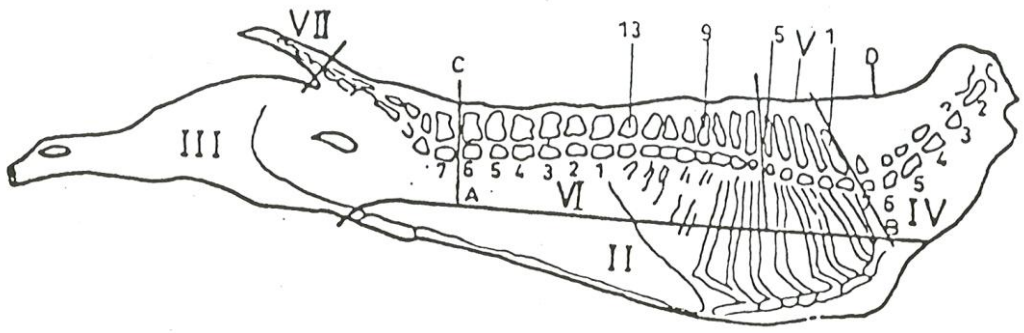
Back-loin percentage (%) : (Back-loin weight / Left half carcass weight) x 100

Forearm percentage (%) : (Forearm weight / Left half carcass weight) x 100

Shoulder percentage (%) : (Shoulder weight / Left half carcass weight) x 100

Neck percentage (%) : (Neck weight / Left half carcass weight) x 100

Flank-chest percentage (%) : (Flank-chest weight / Left half carcass weight) x 100



Anatomical parts of the carcass
I- Forearm
II- Flank-chest
III- Leg
IV- Neck
V- Shoulder
VI- Back-loin
VII- Tail

Figure 3.19 Commercial cuts of the lamb carcass (Colomer–Rocher et al., 1987)

The area of the musculus longissimus dorsi (MLD) between the 12th and 13th vertebrae of the left half of the carcass was measured using a planimeter (Placom digital planimeter, Figure 3.20). In addition, the thickness of the subcutaneous fat over the area of the MLD was measured using a digital caliper.

Figure 3.20 Placom digital planimeter

3.3.10 Statistical Analysis

The growth and fattening performance, slaughter and carcass characteristics of Akkaraman and ASF x AK F_1 crossbred lambs were assessed. The effects of some environmental factors affected on growth characteristics of lambs such as genotype, dam age, sex, birth type and birth weight were analyzed using Least Squares Method (SAS, 2005). Significant differences among means were examined using Duncan's multiple range tests. Lamb survival rates were analyzed by Chi-square test. Data on fattening performance, slaughter and carcass characteristics were analyzed by one-way analysis of variance.

In the evaluation of the data obtained from Akkaraman and ASF x AK F_1 crossbred lambs in the study for birth weight;

$Y_{ijklm} = \mu + a_i + b_j + c_k + d_l + b_1 x_{ijklm} + e_{ijklm}$ was used. In the model;

Y_{ijklm} = observed value m for genotype i, sex j, birth type k, dm age l

μ = overall mean

a_i = effect of genotype (i= 1, 2; Akkaraman, ASF x AK F_1)

b_j = effect of sex (j= 1, 2; male, female)

c_k = effect of birth type (k= 1, 2; single, twin)

d_l = effect of dam age (l= 1, 2, 3, 4, 5; age of 2, 3, 4, 5 and 6)

b_1 = regression coefficient of live weights or daily live weight gains on dam weight at lambing

x_{ijklm} = dam weight of each lamb (genotype i, sex j, birth type k, dm age l)

e_{ijklm} = random error NID $(0, I\sigma^2 e)$

For different period live weights and daily live weight gains;

$Y_{ijklm} = \mu + a_i + g_j + c_k + d_l + b_1 x_{ijklm} + b_2 w_{ijklm} + e_{ijklm}$ was used. In the model;

Y_{ijklm} = observed value m for genotype i, sex j, birth type k, dm age l

μ = overall mean

a_i = effect of genotype (i= 1, 2; Akkaraman, ASF x AK F_1)

b_j = effect of sex (j= 1, 2; male, female),

c_k = effect of birth type (k= 1, 2; single, twin)

d_l = effect of dam age (l= 1, 2, 3, 4, 5; age of 2, 3, 4, 5 and 6)

b_1 = regression coefficient of live weights or daily live weight gains on birth weight

b_2 = regression coefficient of live weights or daily live weight gains on dam weight at lambing

$x_{ijklm,}$ = birth weight of each lamb (genotype i, sex j, birth type k, dm age l)

w_{ijklm} = dam weight of each lamb (genotype i, sex j, birth type k, dm age l)

e_{ijklm} = random error NID $(0, I\sigma^2 e)$

4. RESULTS

4.1 Reproductive Performance Characteristics

Table 4.1 shows some of the reproductive characteristics of the Akkaraman sheep. In the study, the number of ewes giving birth was determined as 144, while the number of ewes exposed to the ram was 150. Ten ewes gave birth to twin lambs, whereas 134 ewes gave birth to single lambs. A total of 154 lambs were obtained within the scope of the study. As a result, the Akkaraman ewes had a 96% fertility rate, 1.03 fecundity, 1.07 litter size, 4% infertility, and 6.94% twinning rate.

Table 4.1 Some reproductive performance characteristics of Akkaraman sheep

Traits	Number
Number of ewes exposed to the ram	150
Number of ewes lambing	144
Number of sheep giving birth to single	134
Number of sheep giving birth to twins	10
Total number of lambs born	154
Fertility (%)	96
Fecundity	1.03
Litter Size	1.07
Infertility Rate	4
Twin Rate	6.94

4.2 Growth

4.2.1 Live Weight of the Lambs at Different Periods

Least squares means ± standard errors for live weights of Akkaraman and ASF x AK F_1 lambs at different periods are presented in Table 4.2. At the same time, the changes in live weight of purebred and crossbred F_1 lambs from birth to day 180 are shown in Figure 4.1. Birth weights of Akkaraman and crossbred F_1 lambs were found to

be similar. While the dam age and sex of the lamb had no effect on birth weight, the effect of birth type was found to be significant. Single lambs had a higher birth weight than twin lambs (3.90 vs. 3.44 kg).

Akkaraman and ASF x AK F_1 lambs weighed 7.26 kg and 7.85 kg respectively, on day 15 ($p<0.01$). In addition, it was determined that the weights of lambs belonging to 2 and 6-year-old mothers on the 15th day were lighter than the weights of lambs belonging to 3, 4 and 5-year-old mothers on the 15^{th} day, and the differences between the dam ages were found to be statistically significant ($p<0.01$). During this period, the weights of single born lambs were found to be significantly higher than those of twin born lambs (7.73 kg vs. 5.64 kg, $p<0.001$). The regression effect of birth weight and maternal weight on 15^{th} day live weight of lambs was found to be highly significant at $p<0.01$ and $p<0.001$ levels.

The weights of crossbred F_1 lambs were found to be 0.8 kg heavier on the 30th day ($p<0.01$) and 1.44 kg heavier on the 45^{th} day ($p<0.001$) than the weights of Akkaraman lambs. It was reported that lambs of 2- and 6-year-old ewes were lighter than lambs of other ages in both periods ($p<0.01$, $p<0.001$). In the study, single-born lambs were found to be 3.46 kg heavier on the 30^{th} day ($p<0.01$) and 4.14 kg heavier on the 45th day ($p<0.001$) than lambs of twins. It was also observed that the birth type had a very significant effect on live weight. The regression coefficient of 30-day live weight according to the dam weight was found to be 0.073 and the effect of dam weight was significant ($p<0.01$). The regression effect of dam weight on 30^{th} ($p<0.01$) and 45^{th} day ($p<0.05$) live weight was significant, while the effect of birth weight was insignificant.

While the live weights of Akkaraman lambs on the 60^{th} and 75^{th} days were determined as 14.98 kg and 18.18 kg, respectively, in F_1 crossbreed lambs were determined as 16.82 kg and 19.56 kg, respectively. These differences between the breeds were found to be statistically very significant in favor of ASF x AK F_1 crossbreed lambs ($p<0.01$, $p<0.001$). In both periods, it was found that the lambs of 2-year-old dams had the lowest live weight, while the lambs of 4-year-old dams had the heaviest live weight. According to these results obtained in the study, it was shown that there were statistically significant ($p<0.01$ and $p<0.001$) differences between the dam ages. In single and twin born lambs, the live weights on the 60^{th} day were 16.17 kg and 11.59 kg ($p<0.001$), respectively, and the live weights on the 75^{th} day were 19.25 kg and

14.39 kg ($p<0.001$). The regression effect of birth weight on lamb live weights on the 75th day was at $p<0.01$ level and this effect was found to be quite significant.

No significant differences were found between breeds at weaning weight at day 90. On the 90th day, the lambs of ewes of 2, 3, 4, 5 and 6 years of age were weighed as 18.98 kg, 23.06 kg, 22.65 kg, 21.08 kg and 21.09 kg, respectively ($p<0.01$). At weaning, single and twin lambs were 22.78 kg and 17.53 kg ($p<0.001$), respectively.

When the live weights of the lambs on the 105th day were examined in the study, it was determined that only the effects of dam age ($p<0.05$) and birth type ($p<0.001$) were significant. According to the results obtained, the live weights of the lambs of 2-year-old ewes were determined to be the lowest, while the live weights of the lambs of 3-year-old ewes were found to be the heaviest ($p<0.05$). When the birth type was considered, the live weights of the single-born lambs were reported to be 4.7 kg heavier than the twin-born lambs ($p<0.001$).

As in the 105th day, it was determined that the dam age ($p<0.01$) and birth type ($p<0.001$) had significant effects on the live weight on the 120th day. When the 120th day lamb live weights were examined in terms of birth type, it was reported that single-born lambs were significantly superior to twin-born lambs (26.29 kg vs. 21.42 kg) and the statistical difference was very significant ($p<0.001$).

The 135th day live weights of Akkaraman and crossbred F_1 lambs were 27.04 kg and 28.14 kg, respectively ($p<0.01$). During this period, lambs from 3-year-old ewes performed best, while lambs from 2-year-old ewes performed worst ($p<0.05$). The 135th day weight of single and twin lambs were 28.35 kg and 23.37 kg, respectively ($p<0.001$). The live weight of Akkaraman and ASF x AK F_1 lambs was measured on day 150 and was found to differ significantly ($P<0.001$), weighing 28.72 kg and 30.44 kg, respectively. During this time, the effects of dam age ($p<0.05$) and birth type ($p<0.001$) on live weight were shown to be statistically significant.

At 165 and 180 days, the live weights of Akkaraman lambs were 30.29 kg and 32.02 kg, respectively, whereas the live weights of the crossbred F_1 lambs were 32.95 kg and 35.67 kg. The difference between the breeds was found to be very significant at $p<0.001$ level in both periods.

Table 4.2 Least squares means ± standard errors for live weights of Akkaraman and ASF x AK F_1 lambs at different periods (kg)

Traits	Birth Weight		15th Day Weight		30th Day Weight		45th Day Weight		60th Day Weight		75th Day Weight		90th Day Weight	
	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$
Overall	154	3.84±0.06	150	7.46±0.12	149	10.06±0.18	146	12.97±0.22	145	15.61±0.27	145	18.65±0.30	139	22.10±0.34
Genotype				**		**		***		***		**		
Akkaraman	103	3.87±0.08	99	7.26±0.12	99	9.79±0.18	97	12.49±0.23	96	14.98±0.27	96	18.18±0.33	93	22.11±0.37
ASF x AK F_1	51	3.79±0.10	51	7.85±0.25	50	10.59±0.40	49	13.93±0.47	49	16.82±0.54	49	19.56±0.60	46	22.09±0.70
Dam age				**		**		***		***		***		**
2	13	3.77±0.25	11	6.99±0.39^{ab}	11	8.98±0.60^{b}	11	11.45±0.81^{b}	11	13.24±1.09^{c}	11	15.99±1.19^{b}	11	18.98±1.22^{b}
3	73	3.89±0.09	72	7.73±0.16^{a}	72	10.45±0.27^{a}	71	13.48±0.31^{a}	71	16.12±0.36^{ab}	71	19.40±0.41^{a}	68	23.06±0.48^{a}
4	21	3.83±0.13	21	7.69±0.32^{a}	21	10.49±0.46^{a}	21	13.68±0.53^{a}	21	16.60±0.55^{a}	21	19.58±0.59^{a}	19	22.65±0.66^{a}
5	14	3.61±0.21	14	7.52±0.32^{ab}	14	10.00±0.41^{ab}	13	12.70±0.65^{ab}	12	15.01±0.85^{ab}	12	17.79±0.95^{ab}	11	21.08±0.97^{ab}
6	33	3.87±0.15	32	6.86±0.26^{b}	31	9.25±0.42^{b}	30	11.95±0.54^{b}	30	14.80±0.64^{bc}	30	17.53±0.73^{ab}	30	21.09±0.75^{ab}
Sex														
Male	79	3.89±0.08	76	7.55±0.16	75	10.26±0.26	74	13.13±0.33	74	15.80±0.41	74	18.81±0.46	70	22.30±0.54
Female	75	3.79±0.09	74	7.37±0.17	74	9.85±0.26	72	12.82±0.30	71	15.41±0.34	71	18.47±0.39	69	21.90±0.40
Birth type		**		***		**		***		***		***		***
Single	134	3.90±0.07	131	7.73±0.11	130	10.50±0.17	128	13.48±0.21	127	16.17±0.25	127	19.25±0.28	121	22.78±0.32
Twin	20	3.44±0.17	19	5.64±0.23	19	7.04±0.38	18	9.34±0.52	18	11.59±0.74	18	14.39±0.92	18	17.53±0.92
Regression (Lin.)														
Birth weight		-		0.306±0.123**		0.249±0.193		0.279±0.229		0.501±0.280		0.795±0.340*		0.175±0.404
Dam weight		0.008±0.011		0.049±0.017***		0.073±0.026**		0.071±0.033*		0.066±0.039		0.086±0.047		0.082±0.056

*: p<0.05; **: p<0.01; ***: p<0.001

a, b, c: Means values with different letters are significant.

Table 4.2 Least squares means ± standard errors for live weights of Akkaraman and ASF x AK F_1 lambs at different periods (kg) (continued)

Traits	**105th Day Weight**		**120th Day Weight**		**135th Day Weight**		**150th Day Weight**		**165th Day Weight**		**180th Day Weight**	
	n	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$
Overall	106	23.45±0.38	102	25.43±0.42	102	27.47±0.43	102	29.39±0.45	102	31.33±0.48	102	33.45±0.52
Genotype						**		***		***		***
Akkaraman	66	23.33±0.38	62	25.17±0.40	62	27.04±0.40	62	28.72±0.44	62	30.29±0.49	62	32.02±0.54
ASF x AK F_1	40	23.66±0.81	40	25.84±0.87	40	28.14±0.89	40	30.44±0.90	40	32.95±0.90	40	35.67±0.91
Dam age		*		**		*		*		**		*
2	11	21.45±1.35^{b}	11	23.47±1.36^{b}	11	25.58±1.35^{b}	11	27.32±1.30^{b}	11	29.09±1.30^{b}	11	31.45±1.32^{b}
3	50	24.50±0.55^{a}	47	26.63±0.64^{a}	47	28.58±0.66^{a}	47	30.54±0.68^{a}	47	32.46±0.74^{a}	47	34.55±0.82^{a}
4	12	23.91±0.73^{ab}	12	26.05±0.69^{a}	12	28.38±0.65^{a}	12	30.38±0.67^{ab}	12	32.49±0.70^{a}	12	34.60±0.85^{a}
5	7	22.24±1.24^{ab}	7	24.76±1.36^{ab}	7	26.84±1.45^{ab}	7	28.65±1.54^{ab}	7	30.46±1.91^{ab}	7	32.26±2.34^{ab}
6	26	22.42±0.80^{ab}	25	23.92±0.81^{b}	25	25.95±0.84^{ab}	25	27.90±0.93^{ab}	25	29.88±0.96^{ab}	25	32.04±1.01^{b}
Sex										*		**
Male	44	23.25±0.68	43	25.46±0.72	43	27.58±0.74	43	29.75±0.76	43	32.04±0.77^{a}	43	34.46±0.80^{a}
Female	62	23.60±0.45	59	25.41±0.50	59	27.39±0.51	59	29.13±0.54	59	30.82±0.60^{b}	59	32.71±0.67^{b}
Birth type		***		***		***		***		***		***
Single	88	24.25±0.36	84	26.29±0.40	84	28.35±0.41	84	30.35±0.43	84	32.34±0.47	84	34.52±0.52
Twin	18	19.55±0.99	18	21.42±1.03	18	23.37±1.04	18	24.92±1.01	18	26.61±1.00	18	28.44±1.00
Regression (Lin.)												
Birth weight		0.275±0.493		0.287±0.529		0.310±0.537		0.358±0.532		0.483±0.538		0.760±0.547
Dam weight		-0.002±0.065		0.018±0.070		0.003±0.071		0.003±0.070		0.008±0.071		0.003±0.072

*: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

a, b: Means values with different letters are significant.

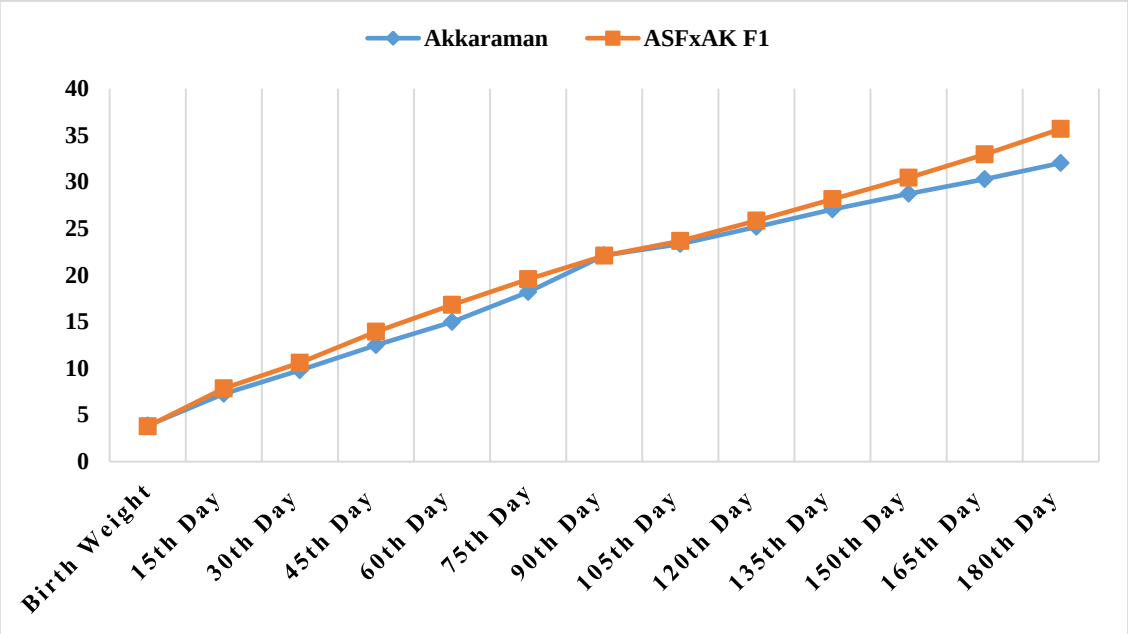


Figure 4.1 Live weights of Akkaraman and ASF x AK F_1 lambs at different growth periods

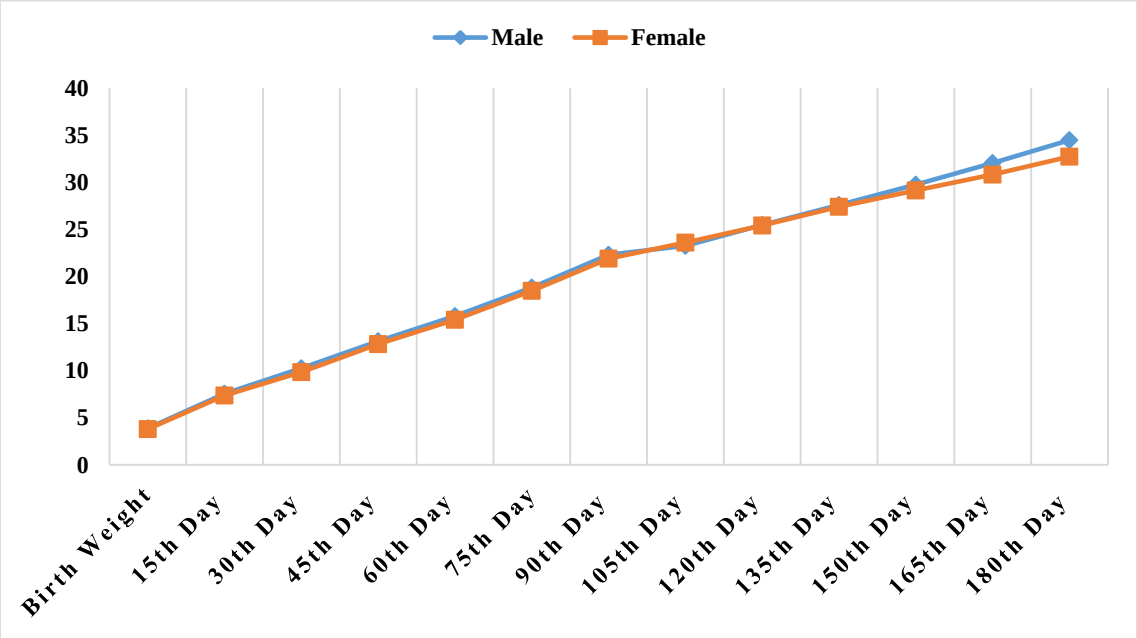


Figure 4.2 Live weights of male and female lambs at different growth periods

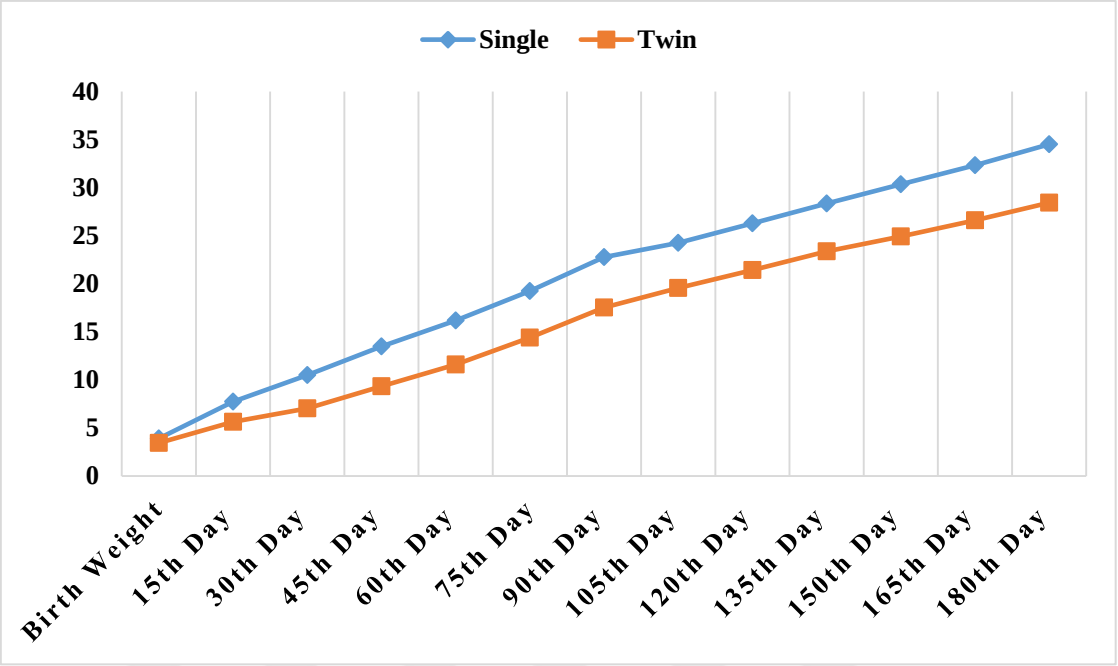


Figure 4.3 Live weights of single and twin lambs at different growth periods

On the 165th day, lambs from 3- and 4-year-old dams were statistically superior to lambs from 2-year-old dams ($p<0.01$). The lambs from 3- and 4-year-old dams were statistically superior to the lambs from 2-year-old dams on day 165 ($p<0.01$), and they were statistically superior to the lambs from 2- and 6-year-old dams on day 180 ($p<0.05$). The growth curve according to sex and birth type is given in Figure 4.2 and 4.3. There was no significant effect of sex on growth from birth to day 150. However, on days 165 and 180, male lambs were significantly heavier than female lambs ($p<0.05$; $p<0.01$). The superiority of single lambs over twin lambs continued at 165 and 180 days. During both growth periods, single lambs were 5.73 kg and 6.08 kg heavier than twins, respectively ($p<0.001$).

4.2.2 Daily Live Weight Gains Between Various Periods

The least squares means ± standard errors for the daily live weight gains of Akkaraman and ASF x AK F_1 lambs at various periods are displayed in Table 4.3. In addition, the changes in daily live weight gains of purebred Akkaraman and ASF x AK F_1 lambs from birth to day 180 are shown in Figure 4.4. Accordingly, while Akkaraman lambs gained 0.196 kg daily live weight gain between birth and day 30, ASF x AK F_1

lambs gained 0.227 kg ($p<0.01$). During this period, lambs from 3-, 4- and 5-year-old dams statistically gained more weight than lambs from 2-year-old dams ($p<0.01$). The live weight gain of twin lambs was 0.120 kg, while that of single lambs was 0.219 kg ($p<0.001$). The regression effect of birth weight ($p<0.001$) and dam weight ($p<0.01$) on this period was found to be very significant.

When the 60th day live weight gains were examined, it was found that the difference between genotypes was statistically significant in favor of ASF x AK F_1 crossbred lambs ($p<0.001$). In the same period, when dam ages were taken into consideration, it was found that the difference between the live weight gains of lambs born from 2-year-old dams and the live weight gains of lambs born from 3-, 4- and 5-year-old dams was significant ($p<0.001$). It was also determined that the difference between the live weight averages of lambs born to 6-year-old dams and the live weight averages of lambs born to 4-year-old dams was significant ($p<0.001$). When the type of birth was taken into consideration, the difference between the live weight gains of single-born and twin-born lambs was found to be significant ($p<0.001$).

Dam age ($p<0.01$) and birth type ($p<0.001$) were found to have significant effects on live weight gains between 90 and 120 days after birth. Lambs from 2-year-old ewes and twins had the lowest performance in both periods. The regression effect of birth weight on daily live weight gain between birth-90th days was found to be -0.009 ($p<0.05$). During the birth-150 and birth-180 days, Akkaraman lambs gained 0.166 kg and 0.156 kg daily live weight, while crossbred F_1 lambs gained 0.178 kg and 0.177 kg. These advantages of crossbreed lambs were found to be significant at $P<0.05$ and $P<0.001$, respectively.

While the effect of dam's age on live weight gain between birth-150 days was significant ($p<0.05$), the effect of sex between birth-180 days was found to be significant ($p<0.05$). In both periods, significant effects of birth type were determined at the $p<0.001$ level. When the performance between 90-180 days was evaluated, it was determined that Akkaraman and ASF x AK F_1 lambs gained 0.123 kg and 0.155 kg ($p<0.001$) live weight, respectively. Between these periods, male and female lambs gained 0.152 kg and 0.124 kg live weight respectively, while single and twin lambs gained 0.139 kg and 0.121 kg daily weight gain respectively. The effects of sex and birth type were found to be very significant ($p<0.001$).

Table 4.3 Least squares means ± standard errors for daily live weight gains of Akkaraman and ASF x AK F_1 lambs at different periods (kg)

Traits	**Birth-30th Days**		**Birth-60th Days**		**Birth-90th Days**		**Birth-120th Days**		**Birth-150th Days**		**Birth-180th Days**		**90th – 180th Days**	
	n	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$
Overall	149	0.207±0.006	145	0.196±0.004	139	0.203±0.004	102	0.181±0.003	102	0.170±0.003	102	0.165±0.003	102	0.136±0.004
Genotype		**		***						*		***		***
Akkaraman	99	0.196±0.006^{b}	96	0.185±0.004^{b}	93	0.202±0.004	62	0.178±0.003	62	0.166±0.003^{b}	62	0.156±0.003^{b}	62	0.123±0.004^{b}
ASF x AK F_1	50	0.227±0.013^{a}	49	0.217±0.009^{a}	46	0.204±0.008	40	0.186±0.007	40	0.178±0.006^{a}	40	0.177±0.005^{a}	40	0.155±0.005^{a}
Dam age		**		***		**		**		*				
2	11	0.170±0.019^{c}	11	0.156±0.017^{c}	11	0.168±0.013^{b}	11	0.163±0.011^{b}	11	0.156±0.008^{b}	11	0.153±0.007	11	0.139±0.012
3	72	0.218±0.009^{ab}	71	0.203±0.006^{ab}	68	0.213±0.005^{a}	47	0.191±0.005^{a}	47	0.178±0.005^{a}	47	0.170±0.004	47	0.135±0.007
4	21	0.222±0.016^{a}	21	0.213±0.009a	19	0.210±0.008^{a}	12	0.185±0.006^{ab}	12	0.177±0.005^{ab}	12	0.171±0.005	12	0.145±0.008
5	14	0.213±0.015^{ab}	12	0.193±0.014^{ab}	11	0.197±0.010^{a}	7	0.179±0.011^{ab}	7	0.169±0.010^{ab}	7	0.161±0.013	7	0.142±0.019
6	31	0.179±0.012^{bc}	30	0.181±0.010^{bc}	30	0.191±0.008^{ab}	25	0.167±0.006^{ab}	25	0.160±0.006^{ab}	25	0.156±0.005	25	0.130±0.005
Sex												*		***
Male	75	0.212±0.008	74	0.198±0.007	70	0.205±0.006	43	0.180±0.006	43	0.173±0.005	43	0.170±0.004^{a}	43	0.152±0.005^{a}
Female	74	0.201±0.009	71	0.193±0.006	69	0.201±0.004	59	0.181±0.004	59	0.169±0.004	59	0.161±0.004^{b}	59	0.124±0.005^{b}
Birth type		***		***		***		***		***		***		***
Single	130	0.219±0.006^{a}	127	0.204±0.004^{a}	121	0.210±0.004^{a}	84	0.188±0.003^{a}	84	0.176±0.003^{a}	84	0.170±0.003^{a}	84	0.139±0.004^{a}
Twin	19	0.120±0.013b	18	0.135±0.013^{b}	18	0:156±0.011^{b}	18	0.149±0.009^{b}	18	0.143±0.007^{b}	18	0.139±0.006^{b}	18	0.121±0.007^{b}
Regression (Lin.)														
Birth weight	-0.025±0.006***		-0.083±0.005		-0.009±0.004*		-0.005±0.004		-0.004±0.003		-0.001±0.003		0.006±0.004	
Dam weight	0.002±0.001**		0.001±0.001		0.001±0.001		-0.000±0.000		0.000±0.000		0.000±0.000		-0.000±0.000	

*: p<0.05; **: p<0.01; ***: p<0.001

a, b: Means values with different letters are significant

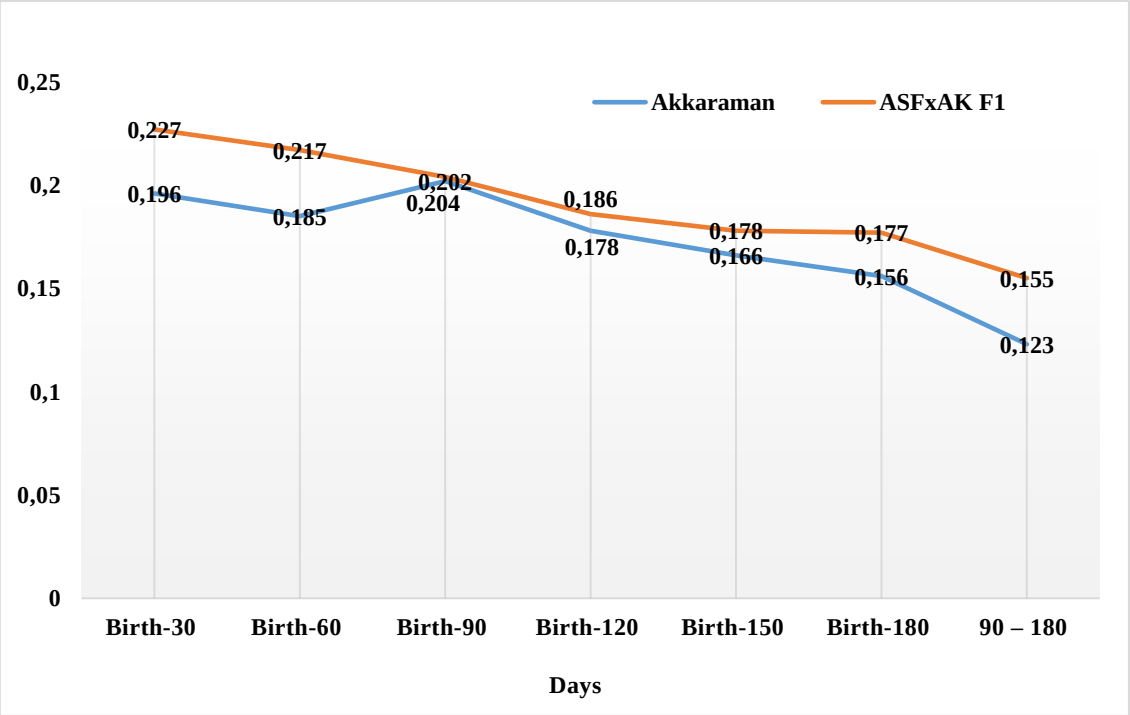


Figure 4.4 Daily live weight gains of Akkaraman and ASF x AK F_1 lambs at different growth periods

4.2.3 Body Measurements

Body measurements of Akkaraman and ASF x AK F_1 crossbred lambs at different periods of the growth period are presented in Table 4.4. On the 30th day of growth, the body length of Akkaraman and crossbred F_1 lambs was 42.15 cm and 43.98 cm ($p<0.01$) respectively, and the leg (thigh) circumference was 24.32 cm and 27.69 cm ($p<0.001$) respectively. At 60th day, except chest depth, withers height ($p<0.05$), body length ($p<0.001$), chest width ($p<0.01$), chest girth ($p<0.01$) and leg circumference ($p<0.001$) measurements of crossbred F_1 lambs were higher than Akkaraman lambs and the differences were statistically significant.

At the withers height and body length of 90-day-old Akkaraman lambs were 54.96 cm and 50.88 cm, while ASF x AK F_1 crossbred lambs were 56.91 cm and 54.37 cm, respectively. The superiority of crossbred lambs over purebred lambs was found to be highly significant at the $p<0.01$ level for withers height and at the $p<0.001$ level for body length. During this period, the chest girth of Akkaraman and crossbreed F_1 lambs was measured as 60.85 cm and 62.76 cm ($p<0.01$), and the leg circumference was measured as 30.09 cm and 33.13 cm ($p<0.001$), respectively.

Table 4.4 Body measurements (cm) of Akkaraman and ASF x AK F_1 lambs at different periods of the growth period

Traits	Akkaraman		ASF x AK F_1	
	n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$
		30th day		
Withers height	99	47.21±0.41	50	46.47±0.50
Body length		42.15±0.38		43.98±0.57**
Chest width		11.23±0.16		10.73±0.23
Chest depth		17.00±0.18		17.45±0.36
Chest girth		50.73±0.40		49.25±0.73
Leg (thigh) circumference		24.32±0.23		27.69±0.56***
		60th day		
Withers height	96	51.31±0.32	49	52.86±0.64*
Body length		46.93±0.34		49.80±0.68***
Chest width		11.98±0.14		12.57±0.18**
Chest depth		20.15±0.18		20.76±0.31
Chest girth		56.03±0.36		57.84±0.73**
Leg (thigh) circumference		27.27±0.23		31.04±0.47***
		90th day		
Withers height	93	54.96±0.30	46	56.91±0.63**
Body length		50.88±0.29		54.37±0.64***
Chest width		13.11±0.11		13.13±0.20
Chest depth		21.98±0.18		22.30±0.27
Chest girth		60.85±0.40		62.76±0.78**
Leg (thigh) circumference		30.09±0.24		33.13±0.44***
		120nd day		
Withers height	62	57.27±0.31	40	60.23±0.54***
Body length		52.45±0.34		56.78±0.61***
Chest width		13.27±0.10		13.68±0.20*
Chest depth		22.71±0.16		23.40±0.29*
Chest girth		63.65±0.41		65.53±0.88*
Leg (thigh) circumference		31.18±0.30		36.18±0.55***
		150th day		
Withers height	62	59.44±0.36	40	63.28±0.57***
Body length		54.61±0.36		59.83±0.65***
Chest width		14.06±0.14		14.10±0.22
Chest depth		23.79±0.16		24.73±0.30**
Chest girth		66.65±0.46		69.50±0.83***
Leg (thigh) circumference		33.03±0.36		38.13±0.62***
		180th day		
Withers height	62	61.68±0.39	40	65.76±0.53***
Body length		56.40±0.39		62.48±0.53***
Chest width		14.97±0.18		15.33±0.24
Chest depth		24.85±0.21		25.88±0.26**
Chest girth		69.45±0.50		73.35±0.82***
Leg (thigh) circumference		35.27±0.39		40.53±0.67***

*: p<0.05; **: p<0.01; ***: p<0.001

At 120 days, the crossbred F_1 lambs had a taller and longer body, greater chest width and depth, and a wider chest and leg circumference than Akkaraman lambs. The differences observed between breeds in terms of all measured body measurements were statistically significant ($p<0.05$, $p<0.001$). On the 150th day, withers height, body length, chest depth, chest girth and leg circumference measurements were determined as 59.44 cm, 54.61 cm, 23.79 cm, 66.65 cm, and 33.03 cm in Akkaraman lambs and 63.28 cm, 59.83 cm, 24.73 cm, 69.50 cm, and 38.13 cm in ASF x AK F_1 lambs. These differences between breeds were found significant at $p<0.01$ and $p<0.001$ levels. At 180 days of age, crossbred F_1 lambs were 4.08 cm higher ($p<0.001$) and 6.08 cm longer ($p<0.001$) than Akkaraman lambs. Chest depth ($p<0.01$), chest girth ($p<0.001$) and leg circumference ($p<0.001$) measurements were also higher in crossbred lambs than purebred lambs. The body measurements of Akkaraman and ASF x AK F_1 lambs at different growth periods according to birth type and sex are given in Table 4.5.

Table 4.5 Body measurements (cm) of Akkaraman and ASF x AK F_1 lambs at different growth periods according to birth type and sex

Traits		**Birth type and sex**	**Akkaraman**		**ASF x AK F_1**	
			n	$\bar{x} \pm S_{\bar{x}}$	**n**	$\bar{x} \pm S_{\bar{x}}$
1. month	Withers height	Single male	44	47.80±0.59	20	48.10±0.76
		Single female	48	47.56±0.50	18	47.12±0.58
		Twin male	3	39.67±0.88	7	42.71±0.89
		Twin female	4	42.25±3.28	5	43.00±0.89
	Body length	Single male	44	42.70±0.54	20	45.85±0.57
		Single female	48	42.21±0.55	18	44.82±0.91
		Twin male	3	38.33±2.03	7	39.57±1.48
		Twin female	4	38.25±1.89	5	39.80±0.66
	Chest width	Single male	44	11.50±0.25	20	11.40±0.31
		Single female	48	11.27±0.19	18	10.94±0.35
		Twin male	3	9.33±0.88	7	8.86±0.67
		Twin female	4	9.25±0.48	5	10.00±0.32
	Chest depth	Single male	44	17.25±0.22	20	18.35±0.46
		Single female	48	17.10±0.27	18	17.29±0.62
		Twin male	3	15.33±1.20	7	16.43±1.21
		Twin female	4	14.25±0.75	5	15.80±1.16
	Chest girth	Single male	44	51.30±0.51	20	51.42±0.91
		Single female	48	51.31±0.50	18	50.59±0.96
		Twin male	3	45.00±0.58	7	44.43±1.99
		Twin female	4	41.75±2.59	5	43.20±1.16
	Leg (thigh) circumference	Single male	44	24.64±0.37	20	29.42±0.68
		Single female	48	24.35±0.28	18	28.71±0.68
		Twin male	3	22.67±0.88	7	23.29±1.67
		Twin female	4	21.75±1.25	5	23.80±0.97

Table 4.5 Body measurements (cm) of Akkaraman and ASF x AK F_1 lambs at different growth periods according to birth type and sex (continued)

Traits		Birth type and sex	Akkaraman		ASF x AK F_1	
			n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$
2. month	Withers height	Single male	44	51.82±0.51	20	55.35±0.57
		Single female	46	51.26±0.37	17	53.12±0.77
		Twin male	3	47.33±0.33	7	49.00±2.15
		Twin female	3	48.67±3.38	5	47.40±2.42
	Body length	Single male	44	47.70±0.51	20	52.05±0.63
		Single female	46	46.74±0.44	17	50.94±0.74
		Twin male	3	42.33±1.45	7	45.29±2.08
		Twin female	3	43.00±1.00	5	43.20±2.37
	Chest width	Single male	44	12.14±0.25	20	12.85±0.18
		Single female	46	11.98±0.14	17	13.12±0.22
		Twin male	3	11.00±0.01	7	11.29±0.61
		Twin female	3	10.67±0.33	5	11.40±0.68
	Chest depth	Single male	44	20.59±0.27	20	21.55±0.46
		Single female	46	20.15±0.21	17	21.06±0.35
		Twin male	3	17.00±0.01	7	19.43±0.92
		Twin female	3	16.67±0.33	5	18.40±1.03
	Chest girth	Single male	44	56.14±0.58	20	59.85±0.70
		Single female	46	56.78±0.36	17	59.53±0.68
		Twin male	3	48.67±0.67	7	52.57±2.17
		Twin female	3	50.33±0.67	5	51.40±3.25
	Leg (thigh) circumference	Single male	44	27.77±0.38	20	32.40±0.54
		Single female	46	27.00±0.28	17	31.82±0.39
		Twin male	3	25.67±1.76	7	27.86±1.44
		Twin female	3	25.66±1.76	5	27.40±2.16
3. month	Withers height	Single male	44	55.75±0.43	17	59.06±0.72
		Single female	44	54.73±0.36	17	57.41±0.89
		Twin male	3	49.67±0.33	7	53.14±2.02
		Twin female	3	52.00±2.52	5	53.20±1.32
	Body length	Single male	44	51.77±0.40	17	56.06±0.92
		Single female	44	50.57±0.40	17	55.12±0.91
		Twin male	3	46.33±0.33	7	51.00±1.93
		Twin female	3	47.00±1.15	5	50.80±1.24
	Chest width	Single male	44	13.36±0.16	17	13.35±0.27
		Single female	44	12.95±0.17	17	13.76±0.30
		Twin male	3	12.00±0.58	7	12.00±0.49
		Twin female	3	12.67±0.33	5	11.80±0.49
	Chest depth	Single male	44	22.66±0.24	17	23.18±0.33
		Single female	44	21.64±0.24	17	22.65±0.34
		Twin male	3	20.67±0.33	7	20.71±0.68
		Twin female	3	18.33±0.88	5	20.40±0.87
	Chest girth	Single male	44	61.55±0.60	17	65.00±1.16
		Single female	44	60.93±0.47	17	63.71±0.91
		Twin male	3	54.00±2.08	7	58.43±2.48
		Twin female	3	56.33±2.18	5	58.00±1.92
	Leg (thigh) circumference	Single male	44	30.98±0.32	17	34.41±0.53
		Single female	44	29.48±0.31	17	33.71±0.55
		Twin male	3	27.67±1.86	7	30.57±1.72
		Twin female	3	28.33±0.67	5	30.40±0.51

Table 4.5 Body measurements (cm) of Akkaraman and ASF x AK F_1 lambs at different growth periods according to birth type and sex (continued)

Traits		Birth type and sex	Akkaraman		ASF x AK F_1	
			n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$
4. month	Withers height	Single male	22	58.23±0.48	11	62.00±0.89
		Single female	34	56.88±0.41	17	60.76±0.59
		Twin male	3	55.67±1.20	7	58.43±1.88
		Twin female	3	56.33±1.86	5	57.00±0.71
	Body length	Single male	22	53.86±0.42	11	58.73±1.03
		Single female	34	51.97±0.46	17	57.53±0.65
		Twin male	3	49.67±1.67	7	54.86±1.92
		Twin female	3	50.33±1.45	5	52.60±1.29
	Chest width	Single male	22	13.55±0.16	11	14.18±0.33
		Single female	34	13.24±0.11	17	14.24±0.22
		Twin male	3	12.00±0.58	7	12.43±0.43
		Twin female	3	13.00±0.58	5	12.40±0.51
	Chest depth	Single male	22	23.41±0.20	11	24.00±0.52
		Single female	34	22.41±0.22	17	23.88±0.32
		Twin male	3	22.67±0.88	7	22.71±0.78
		Twin female	3	21.00±0.58	5	21.40±0.87
	Chest girth	Single male	22	65.45±0.65	11	68.55±1.33
		Single female	34	62.91±0.48	17	67.00±1.07
		Twin male	3	61.67±1.86	7	61.43±2.39
		Twin female	3	60.67±1.76	5	59.60±1.44
	Leg (thigh) circumference	Single male	22	32.91±0.38	11	37.91±0.85
		Single female	34	30.38±0.37	17	37.29±0.75
		Twin male	3	30.00±1.00	7	33.14±1.06
		Twin female	3	28.67±0.88	5	32.80±1.02
5. month	Withers height	Single male	22	61.45±0.51	11	65.27±1.05
		Single female	34	58.38±0.43	17	63.94±0.46
		Twin male	3	58.00±1.53	7	61.00±1.95
		Twin female	3	58.00±1.53	5	59.80±1.11
	Body length	Single male	22	56.18±0.46	11	61.82±0.99
		Single female	34	53.88±0.49	17	61.00±0.64
		Twin male	3	53.33±1.20	7	57.29±2.16
		Twin female	3	52.67±2.03	5	55.00±0.77
	Chest width	Single male	22	14.82±0.26	11	14.73±0.33
		Single female	34	13.79±0.13	17	14.59±0.30
		Twin male	3	12.67±0.33	7	12.86±0.46
		Twin female	3	13.00±0.58	5	12.80±0.20
	Chest depth	Single male	22	24.64±0.21	11	25.55±0.56
		Single female	34	23.38±0.19	17	25.35±0.31
		Twin male	3	23.67±0.33	7	23.43±0.78
		Twin female	3	22.33±0.88	5	22.60±0.68
	Chest girth	Single male	22	69.55±0.60	11	71.82±1.23
		Single female	34	65.29±0.51	17	71.47±0.90
		Twin male	3	65.00±1.00	7	65.71±2.26
		Twin female	3	62.33±1.86	5	63.00±1.30
	Leg (thigh) circumference	Single male	22	35.45±0.42	11	40.45±0.99
		Single female	34	31.88±0.39	17	39.18±0.81
		Twin male	3	32.00±1.00	7	34.71±1.06
		Twin female	3	29.33±0.88	5	34.20±1.24

Table 4.5 Body measurements (cm) of Akkaraman and ASF x AK F_1 lambs at different growth periods according to birth type and sex (continued)

Traits		Birth type and sex	Akkaraman		ASF x AK F_1	
			n	$\bar{x} \pm S_{\bar{x}}$	n	$\bar{x} \pm S_{\bar{x}}$
6. month	Withers height	Single male	22	64.27±0.48	11	67.82±0.98
		Single female	34	60.50±0.41	17	66.47±0.56
		Twin male	3	59.00±1.53	7	63.57±1.36
		Twin female	3	58.67±1.86	5	62.00±0.89
	Body length	Single male	22	58.68±0.49	11	64.45±0.92
		Single female	34	55.35±0.45	17	63.06±0.59
		Twin male	3	55.33±0.88	7	60.57±1.44
		Twin female	3	52.67±2.03	5	58.80±0.80
	Chest width	Single male	22	16.23±0.26	11	15.82±0.35
		Single female	34	14.41±0.15	17	16.12±0.28
		Twin male	3	13.67±0.33	7	14.29±0.29
		Twin female	3	13.33±0.33	5	13.00±0.32
	Chest depth	Single male	22	26.18±0.29	11	26.55±0.51
		Single female	34	24.29±0.22	17	26.47±0.23
		Twin male	3	24.00±0.01	7	24.71±0.68
		Twin female	3	22.33±0.88	5	24.00±0.45
	Chest girth	Single male	22	73.09±0.53	11	75.82±1.33
		Single female	34	67.85±0.51	17	75.35±0.93
		Twin male	3	67.00±0.58	7	69.00±1.99
		Twin female	3	63.33±1.33	5	67.20±0.58
	Leg (thigh) circumference	Single male	22	38.14±0.34	11	43.09±0.99
		Single female	34	33.97±.0.43	17	41.94±0.82
		Twin male	3	34.00±0.58	7	36.71±1.15
		Twin female	3	30.33±1.20	5	35.40±0.93

4.2.4 Survivability

The survival rates of Akkaraman and ASF x AK F_1 lambs until weaning are displayed in Table 4.6. Up to 1 month of age, the survival rates for Akkaraman and ASF x AK F_1 lambs were 96.12% and 98.04%, respectively, and 93.20% and 96.08%, up to 2 months of age. On the other hand, the survival rates until weaning at 3 months of age were found to be 90.29% and 90.20% in Akkaraman and crossbred F_1 lambs, respectively.

Table 4.6 Survival rates of Akkaraman and ASF x AK F_1 lambs at different ages (%)

Genotype	Number of lambs born	Up to 1 months		Up to 2 months		Up to 3 months	
		n	%	n	%	n	%
Akkaraman	103	99	96.12	96	93.20	93	90.29
ASF x AK F_1	51	50	98.04	49	96.08	46	90.20

4.3 Testis Characteristics of Male Lambs

Among the testicular characteristics measured at 3 months of age, testicular diameter and length were found to be similar in Akkaraman and ASF x AK F_1 crossbred lambs. On the other hand, scrotum circumference, scrotum length and testicular volume were found to be 14.40 cm, 7.75 cm and 51.00 cm^3 in Akkaraman and 17.37 cm, 12.40 cm and 73.07 cm^3 in ASF x AK F_1 crossbred lambs, respectively, and the differences for the three traits were found to be significant at $p<0.01$ level.

When the testicular characteristics measured at 6 months reported in Table 4.7 are examined, testicular diameter in pure Akkaraman and ASF x AK F_1 crossbred lambs was determined as 3.60 cm and 4.35 cm, respectively, and the differences between the means were found to be significant in favor of the crossbred lambs ($p<0.05$). Although testicular length, scrotum circumference and testicular volume were larger in ASF x AK F_1 crossbred lambs, they were reported to be insignificant. The scrotum length measured at 6 months in Akkaraman lambs was determined as 12.66 cm, and in ASF x AK F_1 crossbred lambs as 16.64 cm, and the difference between the means of testicular measurements was found to be significant at the level of $p<0.01$. Although testicular length, scrotum circumference and testicular volume were larger in ASF x AK F_1 crossbred lambs than in pure Akkaraman lambs, the differences between the means were not found to be significant.

Table 4.7 Some testicular characteristics of Akkaraman and ASF x AK F_1 lambs at 3 and 6 months of age

Genotype	n	Testicular diameter (cm) $\bar{x} \pm S_{\bar{x}}$	Testicular length (cm) $\bar{x} \pm S_{\bar{x}}$	Scrotum circumference (cm) $\bar{x} \pm S_{\bar{x}}$	Scrotum length (cm) $\bar{x} \pm S_{\bar{x}}$	Testis volume (cm^3) $\bar{x} \pm S_{\bar{x}}$
		3 months of age				
				**	**	**
Akkaraman	46	2.68±0.11	5.21±0.19	14.40±0.71	7.75±0.39	51.00±6.45
ASF x AK F_1	24	2.77±0.14	5.80±0.26	17.37±0.80	12.40±0.73	73.07±7.44
		6 months of age				
		*			**	
Akkaraman	25	3.60±0.18	7.10±0.37	19.29±0.90	12.66±0.64	120.37±16.40
ASF x AK F_1	18	4.35±0.12	8.15±0.32	20.73±0.96	16.64±0.78	127.82±15.80

*: $p<0.05$; **: $p<0.001$

4.4 Fattening Performance

The means for the fattening performance traits of Akkaraman and ASF x AK F_1 lambs are presented in Table 4.8. Figure 4.5 shows the changes in live weight of Akkaraman and ASF x AK F_1 lambs on different days of fattening.

When the lambs were fattened, the live weights at the beginning of fattening, on the 14th day, 28^{th} day and 42nd day were similar in pure Akkaraman and ASF x AK F_1 crossbred lambs and the live weights in these periods were determined as 23.89 kg and 23.77 kg; 27.80 kg and 28.27kg; 31.82 kg and 31.89 kg; 35.27 kg and 36.47 kg, respectively. The differences between the average live weights of the genotypes in these periods were insignificant.

There was no statistically significant difference between the live weights of purebred and crossbred lambs up to day 42 of intensive fattening. However, the live weights of Akkaraman and ASF x AK F_1 lambs on day 56 were 38.12 kg and 41.01 kg, respectively ($p<0.01$).

The final live weight of ASF x AK F_1 lambs was 3.01 kg higher than that of Akkaraman lambs ($p<0.01$). At the end of fattening (day 70), purebred and crossbred lambs gained 17.14 kg and 20.26 kg of total live weight, respectively ($p<0.01$). No

significant differences were found in the average daily weight gain between Akkaraman and ASF x AK F_1 lambs. Purebred lambs had an average daily gain of 0.245 kg, while crossbred lambs had an average daily gain of 0.289 kg.

During the fattening period, daily concentrate feed consumption was 1.15 kg in Akkaraman and 1.20 kg in ASF x AK F_1 lambs. When the values related to feed consumption per 1 kg of live weight gain were examined, the feed utilization coefficients of Akkaraman and crossbred F_1 lambs at the end of intensive fattening were 4.70 and 4.15 kg, respectively.

Table 4.8 Mean (±s.e.) values for fattening performance of Akkaraman and ASF x AK F_1 lambs

Traits	**Akkaraman (n=10)**	**ASF x AK F_1 (n=9)**
	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$
Initial live weight (kg)	23.89±0.26	23.77±0.24
14th day live weight (kg)	27.80±0.25	28.27±0.39
28th day live weight (kg)	31.82±0.39	31.89±0.55
42nd day live weight (kg)	35.27±0.60	36.47±0.56
56th day live weight (kg)	38.12±0.68	41.01±0.71**
Final live weight (kg)	41.02±0.76	44.03±0.65**
Total weight gain (kg)	17.14±0.91	20.26±0.51**
Average daily weight gain (kg)	0.245±0.013	0.289±0.007
Daily feed consumption (kg)	1.15	1.20
Feed conversion efficiency	4.70	4.15

s.e.: standard error; **: $p<0.01$

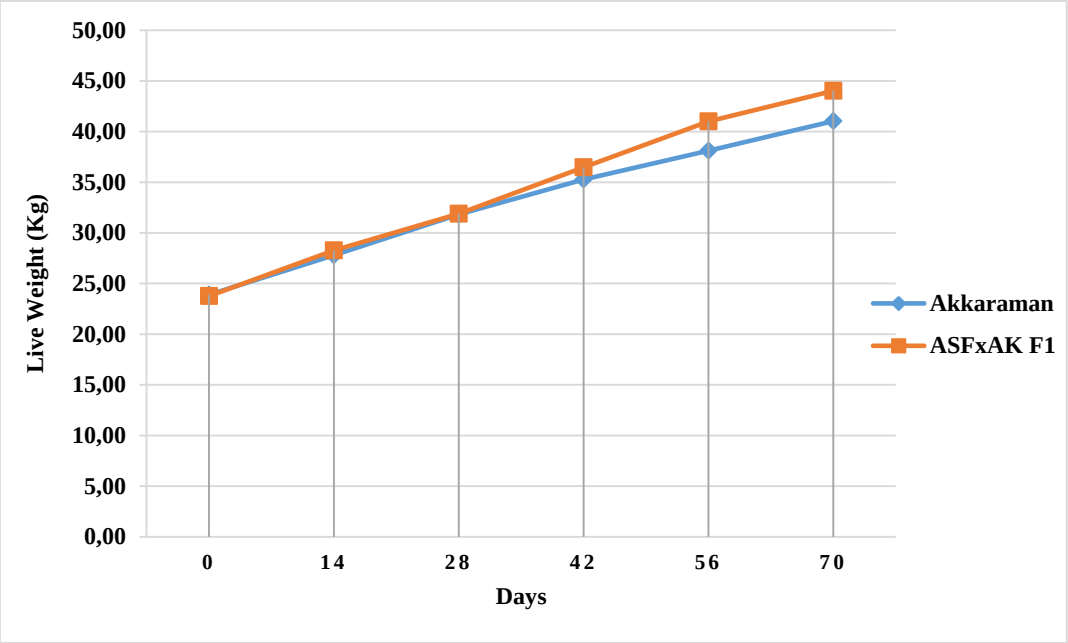


Figure 4.5 Live weight changes of Akkaraman and ASF x AK F_1 lambs on different fattening days

4.5 Body Measurements of the Lambs at Fattening

Table 4.9 shows the mean values for body measurements of purebred and crossbred lambs during the fattening periods. At the beginning of the fattening (day 0), ASF x AK F_1 lambs were found to have a higher withers height ($p<0.01$) and body length than Akkaraman lambs, and the differences were statistically significant ($p<0.01$).

In day 0, the wither height and body length of ASF x AK F_1 lambs were measured as 59.78 cm and 56.33 cm, respectively, while those of Akkaraman lambs were measured as 57.20 cm and 53.60 cm, respectively. Crossbred lambs maintained their statistical superiority for both traits throughout the entire fattening period. At the end of fattening (day 70), withers height was 68.10 cm and 70.44 cm ($p<0.01$), body length was 62.70 cm and 67.11 cm ($p<0.01$) in Akkaraman and ASF x AK F_1 lambs, respectively.

Table 4.9 Body measurements (cm) of Akkaraman and ASF x AK F_1 lambs at different periods of the fattening

Traits	Akkaraman $\bar{x} \pm S_{\bar{x}}$	ASF x AK F_1 $\bar{x} \pm S_{\bar{x}}$
	0th day	
Withers height	57.20±0.53	59.78±0.28**
Body length	53.60±0.56	56.33±0.41**
Chest width	12.90±0.18	13.00±0.17
Chest depth	22.60±0.27	23.11±0.26
Chest girth	65.50±0.65	65.89±0.56
Leg (thigh) circumference	33.20±0.33	33.56±0.38
	14th day	
Withers height	58.50±0.40	61.89±0.70**
Body length	54.70±0.34	59.11±0.54**
Chest width	13.70±0.15	13.67±0.24
Chest depth	23.40±0.27	24.22±0.36
Chest girth	66.80±0.53	67.11±0.70
Leg (thigh) circumference	34.10±0.31	34.89±0.35
	28th day	
Withers height	62.20±0.49	64.33±0.37**
Body length	57.50±0.48	62.00±0.41**
Chest width	15.20±0.20*	14.33±0.37
Chest depth	24.90±0.23	25.11±0.45
Chest girth	71.10±0.23	70.67±0.69
Leg (thigh) circumference	36.30±0.30	36.56±0.29
	42nd day	
Withers height	64.20±0.42	66.56±0.63**
Body length	59.00±0.54	63.44±0.56**
Chest width	16.30±0.26*	15.56±0.18
Chest depth	26.20±0.29	26.00±0.24
Chest girth	73.70±0.45	74.22±0.94
Leg (thigh) circumference	38.10±0.23	40.56±0.41**
	56th day	
Withers height	66.20±0.51	68.78±0.49**
Body length	60.90±0.59	65.67±0.47**
Chest width	17.30±0.26*	16.33±0.33
Chest depth	27.30±0.21	27.56±0.44
Chest girth	75.10±0.48	78.22±1.16*
Leg(thigh) circumference	39.10±0.57	46.22±0.62**
	70th day	
Withers height	68.10±0.48	70.44±0.50**
Body length	62.70±0.67	67.11±0.56**
Chest width	18.10±0.35	17.33±0.33
Chest depth	28.40±0.22	28.22±0.32
Chest girth	77.50±0.70	80.11±0.99*
Leg (thigh) circumference	42.30±0.83	49.33±0.71**

*: $p<0.05$; **: $p<0.01$

When the chest width trait was analyzed, it was determined that the chest width of Akkaraman lambs was significantly higher than that of ASF x AK F_1 lambs at 28, 42, and 56 days ($p<0.05$). On day 28, the chest width was measured as 15.20 cm and 14.33 cm ($p<0.05$) in purebred and crossbred lambs, 16.30 cm and 15.56 cm ($p<0.05$) on day 42, and 17.30 cm and 16.33 cm ($p<0.05$) on day 56, respectively.

On days 0, 14, 28 and 42, the chest girth measurements of Akkaraman and ASF x AK F_1 lambs were 65.50 cm and 65.89 cm, 66.80 cm and 67.11 cm, 71.10 cm and 70.67 cm, 73.70 cm and 74.22 cm, respectively. At 56 and 70 days, crossbred lambs had larger chest girth measurements than purebred lambs. Specifically, on day 56, purebred and crossbred lambs had chest girths of 75.10 cm and 78.22 cm ($p<0.05$), respectively, while on day 70, the measurements were 77.50 cm and 80.11 cm ($p<0.05$), respectively.

Statistically insignificant differences were found between the breeds for leg circumference between days 0-28. On the other hand, the leg circumferences of Akkaraman and ASF x AK F_1 lambs were 38.10 cm and 40.56 cm ($p<0.01$) on day 42, 39.10 cm and 46.22 cm ($p<0.01$) on day 56 and 42.30 cm and 49.33 cm ($p<0.01$) on day 70, respectively.

4.6 Slaughter and Carcass Characteristics

The data in Table 4.10 shows mean values (±s.e.) for slaughter and carcass characteristics of Akkaraman and ASF x AK F_1 lambs. It was found that crossbred lambs had a mean slaughter weight of 44.34 kg, while the purebred lambs had a mean slaughter weight of 39.22 kg ($p<0.05$). Although hot and cold carcass weights of ASF x AK F_1 lambs were higher than Akkaraman lambs, the difference was statistically significant only for cold carcass weight ($p<0.05$).

The cold carcass weight without tail after removal of the tail, which is a low-value part of the carcass, was 15.86 kg and 19.22 kg for Akkaraman and F_1 crosses, respectively ($p<0.01$). The left half carcass weight of ASF x AK F_1 crossbred lambs was significantly higher than Akkaraman lambs (7.20 kg vs. 9.41 kg, $p<0.001$).

Although dressing percentage was 50.04% for the Akkaraman lambs and 48.28% for the crossbred F_1 lambs, the difference was not statistically significant.

Untailed dressing percentage was found as 40.47% and 43.37% in Akkaraman and ASF x AK F_1 lambs ($p<0.01$).

Table 4.10 Means (±s.e.) for slaughter and carcass characteristics of Akkaraman and ASF x AK F_1 lambs

Traits	**Akkaraman (n=5)**	**ASF x AK F_1 (n=5)**
	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$
Carcass weight (kg) and dressing percentage (%)		
Slaughter weight	39.22±1.62	44.34±0.53*
Hot carcass weight	20.24±0.78	22.00±0.28
Cold carcass weight	19.60±0.70	21.40±0.26*
Untailed cold carcass weight	15.86±0.61	19.22±0.24**
Left half carcass weight	7.20±0.24	9.41±0.34***
Dressing percentage	50.04±0.67	48.28±0.65
Untailed dressing percentage	40.47±0.56	43.37±0.67**
Cooling loss (%)	3.12±0.38	2.72±0.28
Weights of by-products and fat (kg)		
Head	2.10±0.06	2.33±0.05*
Feet	0.87±0.04	0.98±0.03*
Skin	3.78±0.25	4.79±0.16**
Heart+liver+lungs	1.54±0.05	1.97±0.04***
Testes	0.15±0.01	0.26±0.01***
Kidneys	0.12±0.01	0.12±0.01
Kidney+pelvic fat	0.05±0.01	0.18±0.03*
Internal fat	0.16±0.04	0.46±0.14
Tail fat	3.74±0.16***	2.18±0.08
Wholesale cuts of left half of carcass (kg)		
Leg (thigh) weight	2.92±0.14	3.48±0.12**
Back-loin weights	1.00±0.09	1.23±0.07
Forearm weight	1.44±0.07	1.80±0.03**
Shoulder weight	0.44±0.04	0.60±0.07
Neck weight	0.56±0.07	0.62±0.06
Flank-chest weights	0.92±0.12	1.39±0.12**
M. longissimus dorsi (MLD) area (cm^2)	12.49±0.73	14.24±0.38
Fat thickness over MLD (mm)	2.92±0.24	2.19±0.28

s.e.: standard error; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

As shown in Table 4.10, there were significant differences between the breeds in carcass by-product weights for all traits except kidney and internal fat weights. ASF x AK F_1 crossbred lambs had higher head and feet weights than Akkaraman lambs at $p<0.05$ significance level. Weights of skin, heart+liver+lungs, and testes were 3.78 kg and 4.79 kg ($p<0.01$), 1.54 kg and 1.97 kg ($p<0.001$), 0.15 and 0.26 kg ($p<0.001$) in Akkaraman and F_1 crossbred lambs, respectively.

ASF x AK F_1 carcasses had more kidney+pelvic fat than Akkaraman lambs ($P<0.05$). In contrast, the fat tail weight of Akkaraman lambs was significantly higher than that of the crossbred lambs. The tail weights of purebred and crossbred lambs were 3.74 and 2.18 kg respectively ($p<0.001$).

Table 4.10 also shows the wholesale cuts from the left half of the carcasses. ASF x AK F_1 crossbred lambs were found to have a higher leg weight (3.48 kg vs. 2.92 kg, $p<0.01$), forearm weight (1.80 kg vs. 1.44 kg, $p<0.01$) and flank-chest weights (1.39 kg vs. 0.92 kg, $p<0.01$) compared to Akkaraman lambs.

In addition, when examined in terms of MLD area, which is one of the carcass's most valuable sections, the MLD areas of pure Akkaraman lambs and ASF x AK F_1 crossbred lambs were determined as 12.49 cm^2 and 14.24 cm^2, respectively. Although the MLD area was determined to be higher in the crossbred genotype, it was found to be statistically insignificant. Fat thickness on the MLD area (2.92 mm and 2.19 mm) was found to be higher in purebred Akkaraman lambs but was determined to be statistically insignificant.

Table 4.11 shows the proportional yields of wholesale cuts, organs and fats in the carcass of Akkaraman and ASF x AK F_1 lambs. Head, feet, kidneys and internal fat percentages of both genotypes were found to be similar. In Akkaraman and crossbred F_1 lambs, skin percentage was 9.61% and 10.81% ($p<0.05$), respectively. The crossbred F_1 lambs also had significantly higher heart+liver+lungs ($p<0.01$), testes ($p<0.001$) and kidney+pelvic fat ($p<0.01$) percentages than Akkaraman lambs. However, tail fat percentage of Akkaraman lambs was significantly higher that of ASF x AK F_1 crossbred lambs ($p<0.001$). Although leg, forearm and neck percentages were higher in Akkaraman lambs than in crossbred F_1 lambs, the differences were not statistically significant. Flank-chest percentage of ASF x AK F_1 crossbred lambs was significantly higher than that of Akkaraman lambs ($p<0.01$).

Table 4.11 Proportional yields (%) (mean ± s.e.) of wholesale cuts, organs and fats in the carcass of Akkaraman and ASF x AK F_1 lambs

Traits	**Akkaraman (n=5)**	**ASF x AK F_1 (n=5)**
	$\bar{x} \pm S_{\bar{x}}$	$\bar{x} \pm S_{\bar{x}}$
Head	5.37±0.18	5.26±0.13
Feet	2.22±0.12	2.22±0.06
Skin	9.61±0.34	10.81±0.41*
Heart+liver+lungs	3.94±0.09	4.44±0.09**
Testes	0.74±0.05	1.18±0.07***
Kidneys	0.59±0.02	0.56±0.01
Kidney+pelvic fat	0.26±0.02	0.82±0.15**
Internal fat	0.77±0.19	2.08±0.64
Tail fat	19.11±0.67***	10.19±0.33
Leg	40.52±0.95	37.13±1.50
Back-loin	13.11±1.03	13.10±0.57
Forearm	20.03±0.97	19.26±0.63
Shoulder	6.15±0.63	6.35±0.67
Neck	7.76±0.93	6.50±0.55
Flank-chest	12.78±1.64	14.73±1.07**

s.e.: standard error; *: $p<0.05$; **: $p<0.01$; ***: $p<0.001$

5. DISCUSSION

5.1 Reproductive Performance Characteristics

Akkaraman ewes used the study had a 96% fertility rate, 1.03 fecundity rate, 1.07 litter size, 4% infertility rate, and 6.94% twinning rate (Table 4.1). Yıldız and Denk (2006) found the pregnancy rate and the average number of lambs per litter as 85.19% and 1.01, respectively, in Akkaraman ewes reared in Van region. The average lambing rate, twin birth rate, and litter size of Akkaraman ewes raised in Niğde province were 90.1%, 20.8%, and 1.12, respectively (Ceyhan et al., 2019). A higher litter size has been observed in flocks where crosses have been made between Akkaraman and Bafra (Chios x Karayaka B_1) sheep than in this study (Güngör and Ünal, 2020).

Şirin (2023), who investigated the reproductive characteristics of Akkaraman ewes in Tokat province between 2017 and 2021, reported that lambing rate varied between 74-89%, fecundity between 0.85-1.00, litter size between 0.86-1.15 and infertility rate between 11-26%. Tüfekci (2023) reported a lambing rate of 95.8%, 21.8% twin birth rate, 1.22 litter size in Akkaraman ewes under breeding conditions. The differences in the studies in which fertility characteristics of Akkaraman ewes were determined at flock level may be due to factors such as care, feeding, live weight, age, condition, effect of ram, season of birth and regional differences (Tüfekci, 2023).

On the other hand, in this study, fecundity and litter size of Akkaraman ewes were lower than Assaf ewes in the autumn season, whereas Awassi ewes had higher fecundity and similar litter size values (Zaher et al., 2020).

5.2 Live Weight of the Lambs at Different Periods

The mean of lamb's body weights at birth, weaning and 6-month-old were 3.87 kg, 22.11 kg and 32.02 kg for Akkaraman lambs and 3.79 kg, 22.09 kg and 35.67 kg for ASF x AK F_1 crossbred, respectively, (Table 4.2). In a study on the growth characteristics of different sheep genotypes; Güngör and Ünal (2020) reported the average weights of Bafra, Akkaraman, Bafra x Akkaraman F_1 and Bafra x Akkaraman B_1 lambs as 3.65 kg, 4.7 kg, 4.56 kg and 4.03 kg at birth, 23.51 kg, 31.39 kg, 30.00 kg

and 25.16 kg at weaning (90 days) and 33.62 kg, 45.49 kg, 43.33kg, 34.98 kg at 180 days weight, respectively. Also, Sakar and Erişek (2019) found that the average body weights of Akkaraman lambs at birth, 60, 90 and 120 days and were 4.264 kg, 22.114 kg, 30.147 kg, and 34.950 kg, respectively. Ünal et al. (2006a) recorded that the body weights of different period for Akkaraman, Kıvırcık x Akkaraman F_2, Kıvırcık x Akkaraman B_1, Chios x Akkaraman F_2 and Chios x Akkaraman B_1 lambs were 4.4 kg, 4.3 kg, 4.1 kg, 4.2 kg and 4.1 kg at birth, 21.1 kg, 20.3 kg, 19.6 kg, 20.3 kg and 19.9 kg at weaning (90 days), and 31.9 kg, 29.4 kg, 30.3 kg, 30.5 kg and 30.1 kg at 180 days weight, respectively.

The average body weight of Assaf lambs at birth, weaning (60 days), and marketing ages (120 days) were 6.01 kg, 20.40 kg, 32.08 kg, respectively (Aljamaeen et al., 2023). Ocak and Cankaya (2013) reported the average birth and weaning weight (6 weeks) of Cukurova Assaf and Cukurova lambs and were 4.5 kg, 4.17 kg and 12.64 kg and 13.29 kg, respectively.

Breed (genotype) affects highly significantly all body weight of lambs with exception of weight at birth, weaning, 105 and 120 days (Table 4.2). The heavier body weights of lambs at different periods were recorded by ASF x AK F_1 crossbred lambs when compared with Akkaraman lambs.

Similarly, some investigators found that the breed of sheep had a significant effect on the weight of lambs at day of 15 (Akçapınar et al., 2000; Esen and Özbey 2001a, Mundan, 2003), 30 (Akçapınar et al., 2000; Esen and Özbey 2001a, Mundan, 2003), 45 (Odabaşıoğlu et al., 1995; Akçapınar et al., 2000; Esen and Özbey 2001a, Mundan, 2003), 60 (Odabaşıoğlu et al., 1995; Akçapınar et al., 2000; Esen and Özbey, 2001a; Mundan, 2003), 75 (Akçapınar et al., 2000; Esen and Özbey 2001a; Mundan, 2003), 135 (Esen and Elmaci, 2021), 150 (Çolakoğlu and Özbeyaz, 1999; Akçapınar et al., 2000; Mundan, 2003), and 180 days of old (Çolakoğlu and Özbeyaz, 1999; Akçapınar et al., 2000; Esen and Özbey 2001a; Mundan, 2003; Yakan et al., 2012; Güngör and Ünal 2020; Esen and Elmaci, 2021).

Whereas the non-significant differences in body weights of lambs at birth were reported by Akçapınar et al. (2000), Özbey and Akcan (2001), Yakan et al. (2012), Ocak and Cankaya (2013), Rosov and Gootwine (2013) and İlhan et al. (2020), and at weaning by Odabaşıoğlu et al. (1995), Özbey and Akcan (2001) and Yakan et al.

(2012). Variations in the genetic composition, the environment, and specific feeding practices could all contribute to this outcome.

Age of dam was found to have a significant effect on all body weights of lambs at different periods with exception of body weight at birth only (Table 4.2). These results agreed with the finding of other researcher had been reported that age effect on the lamb body weights at weaning in sheep (Alkass et al., 1996; Gökdal et al., 2004; Güngör and Ünal, 2020; Kramarenko et al., 2021; Aljamaeen et al., 2023). Also, this study was noticed that the highest body weight at different periods were attained from ewes 3 and 4 years old of age when compared the other ages of dam. This agreed to Aksoy et al. (2023) who found significantly affects and also higher body weight at 120 days obtained from ewes with 3 (33.08 kg) and 4 (33.87 kg) years old of age in Akkaraman sheep.

The non-significant differences in body weight of lambs at birth agreed with the results obtained by Özbey and Akcan (2001) in Morkaraman, Akkaraman and Awassi sheep, Mundan (2003) in Akkaraman, Kıvırcık x Akkaraman G_1 and Chios x Akkaraman G_1 ewes and Oramari (2009) of Karadi lambs in Iraq.

In this study, the lambs body weights at birth, weaning and 180 days old were 3.89 kg, 22.30 kg and 34.46 kg for males and 3.79 kg, 21.90 kg and 32.71 kg for female lambs, respectively (Tables 4.2). The result of birth weight was lower than the result reported by Ünal et al. (2006a) for both male (4.3 kg) and female (4.1 kg) lambs for Akkaraman, Kıvırcık x Akkaraman F_2, Kıvırcık x Akkaraman B_1, Chios x Akkaraman F_2 and Chios x Akkaraman B_1, while for the weaning weight was higher for both male and female lambs 21.3 kg and 19.2 kg, respectively.

Higher body weight at birth, weaning and 180 days were reported by Güngör and Ünal (2020) in Bafra, Akkaraman, Bafra x Akkaraman F_1, Bafra x Akkaraman B_1 for male lambs 4.39 kg, 29.50 kg, 42.62 kg, and 4.09 kg, 25.23 kg, 35.39 kg for female lambs, respectively.

Male lambs had significantly heavier weight than females at age 165 (32.04 kg vs 30.82 kg) and 180 days only (34.46 kg vs 32.71 kg), this result agreed with the finding of Güngör and Ünal (2020) for weight at 180 days (42.62 kg vs. 35.59 kg) of different sheep genotypes (Bafra, Akkaraman, Bafra x Akkaraman F_1, Bafra x Akkaraman B_1). Also, Akçapınar et al. (2000), Mundan (2003) and Yakan et al. (2012)

found a significantly effect of sex of lamb on the weight at 180 days old in Akkaraman, Chios x Akkaraman F_1 and Kıvırcık x Akkaraman F_1, Akkaraman, Akkaraman, Kıvırcık x Akkaraman G_1, Chios x Akkaraman G_1 and Awassi and Kıvırcık lambs, respectively.

In this study, the effect of lamb sex on weights at all periods except 165 and 180 days was found to be insignificant. In contrast, Alkass et al. (1996), Gökdal et al. (2004), Ünal et al. (2006a), Hermiz and Mohammed (2009), Ocak and Cankaya (2013), Rosov and Gootwine (2013), Güngör and Ünal (2020) reported a significantly effect of sex of lamb on the weight of lambs at birth and weaning. The non-significant difference between males and females in their weights at birth and weaning were in agreement to the findings reported by Panayotov et al. (2018); Sakar and Erişek (2019) and Aljamaeen et al. (2023) in Lacaune, Akkaraman and Assaf sheep breeds, respectively.

In the study, the mean birth, weaning, 120- and 180-days weights of single lambs were 3.90 kg, 22.78 kg, 26.29 kg and 34.52 kg, respectively, and for twin lambs were 3.44 kg, 17.53 kg, 21.42 kg and 28.44 kg, respectively. The weights of lambs at birth and at 120 days in this study were lower than those reported by Aksoy et al. (2023) for single lambs with an average 4.51 kg and 33.08 kg, and 3.82 kg and 31.18 kg for twin Akkaraman lambs in Türkiye, respectively. Also, the weight at birth in this work was lower than those recorded by Ocak and Cankaya (2013) for single (4.21 kg) and twin (3.95 kg) of Cukurova Assaf (CA) and Cukurova lambs.

The results showed that the type of birth had a highly significant effect on all live weight periods analyzed (Tables 4.2). Single born surpassed twin lambs and highly significant in their all-body weights at different periods. The significant differences in all lamb body weights due to their type of birth were in accordance with earlier studies on different breeds of sheep in Türkiye (Mundan, 2003; Gökdal et al., 2004; Ünal et al., 2006a; Ocak and Cankaya, 2013; Sakar and Erişek, 2019, Şireli, 2019; Güngör and Ünal, 2020).

5.3 Daily Live Weight Gains Between Various Periods

From Table 4.3, the mean daily live weight gains of Akkaraman and ASF x AK F_1 lambs at birth-30 days, birth-60 days, birth-90 days, birth-120 days, birth-150 days,

birth-180 days, and 90-180 days were 0.207 kg, 0.196 kg, 0.203 kg, 0.181 kg, 0.170 kg, 0.165 kg, and 0.136 kg, respectively.

Daily live weight gains in this study were higher than values recorded by Bingöl and Aygün (2014) for Karakaş lambs (133.82 and 146.25 g/day) for period of birth-90 (weaning age) and birth-180 days, respectively. While these averages were lower than the values of 297.5, 287.5, and 255.7 g/day reported by Sakar and Erişek (2019) for Akkaraman lambs from birth to the 60 (weaning age), 90, and 120 days, respectively.

Also, daily gain from birth to weaning (90 days) was lower than recorded by Kandemir (2013) for Ile de France x Akkaraman crossbred lambs (289.1 g/day) in Türkiye. In addition, Köseman et al. (2023) reported that the daily live weight gain of Bafra lambs (Chios × Karayaka) averaged 174.49 g/day from birth to the 30 days, 213.54 g/day from 30 to 60 days, 240.94 g/day from 60 to weaning (90 days), and 182.60 g/day from 90 to 120 days.

Breed had significantly affected on all growth periods of the exception of period birth-90 and birth-120 days of Akkaraman and ASF x AK F_1 crossbred lambs surpassed pure Akkaraman lambs. The significant difference of breed could be due to the heterosis (hybrid vigor) of crossbred lambs. These results were in accordance with earlier studies by several authors (Eyal et al., 1986; Altın et al., 2003; Kandemir, 2013; Rosov and Gootwine, 2013). On the other hand, non-significant effect of the breed on daily live weight gain of period birth-90 and birth-120 days of lambs reported by many authors (Esen and Yıldız, 2000a; Özbey and Akcan, 2003a; Gokdal et al., 2004; Aslan, 2013; Ocak and Cankaya, 2013).

Table 4.3 shows the age of dam had significantly affected on daily live weight gains of pure Akkaraman and ASF x AK F_1 crossbred lambs at different periods from birth to 150 days, ewes aged 3 and 4 years were significantly higher than those ewes aged 2, 5 and 6 years. This result was in accordance with those reported earlier in different periods of live weight and in different sheep breeds, Özbey and Akcan (2003) birth to weaning (105 days); Öztürk and Odabaşıoğlu (2011) (30-60 days), Ceyhan et al. (2010) and Alarslan (2018) (birth – 90 days). Whereas many authors such as Esen and Yıldız (2000a), Altın et al. (2003), Gokdal et al. (2004), Ağdacı (2013), Ceyhan et al. (2013), Kandemir (2013), Bingöl and Aygün (2014) reported that age of dam at lambing had no significant effect on daily live weight gain of lambs in different breeds of sheep.

The influence of sex of Lamb on daily live weight gains of Akkaraman and ASF x AK F_1 lambs was significant at birth-180 ($p<0.05$) and 90-180 days periods ($p<0.001$), whereas there were no significant effects on other live weight gains (Table 4.3). Male lambs were significantly heavier daily live weight gains than females at birth-180 days (0.170 vs 0.161 kg/day) and at 90-180 days (0.152 vs 0.124 kg/day). Many investigators reported that sex of lamb affected daily live weight gains significantly, and the males was higher daily live weight gains than female lambs (Altın et al., 2003; Özbey and Akcan, 2003; Gokdal et al., 2004; Kaymakçı et al., 2006; Ceyhan et al., 2010; Ağdacı, 2013; Ceyhan et al., 2013; Kandemir, 2013; Rosov and Gootwine, 2013). Also, Köseman et al. (2023) working on Bafra lambs and reported that male lambs had significantly ($p<0.01$) higher daily live weight gain than female lambs between period 60 and 90 days only, whereas this effect was non-significant between birth-30 days, 30-60 days, and 90-120 days. Alarslan (2018) on their study on Kıvırcık lambs, reported that the effect of sex was significant on live weight gain between birth-150 days, birth-180 days and 90-180 days, while such effect was non-significant on live weight gain between birth-90 days and 150-180 days.

On the other hand, other researchers found a non-significant effect of sex of lamb on daily live weight gains in many breeds of sheep (Esen and Yıldız, 2000a; Öztürk and Odabaşıoğlu, 2011; Aslan, 2013; Ocak and Cankaya, 2013; Bingöl and Aygün, 2014; Sakar and Erişek, 2019). The difference in weight gain during later stages could be due to variations in growth and development, stemming from the impact of sex hormones (Owen, 1976) and the higher levels of growth hormone secretion in male lambs compared to female lambs (Davis et al., 1977).

Type of birth was found to have a highly significant ($p<0.001$) effect on all daily live weight gains of Akkaraman and ASF x AK F_1 lambs at different periods, single born lambs surpassed twin lambs significantly in their all-daily live weight gains (Table 4.3). These results agreed to the several authors observed that single born lambs surpassed twins significantly in their daily live weight gains at different periods of lamb age (Özbey and Akcan, 2003; Gokdal et al., 2004; Kaymakçı et al., 2006; Ağdacı, 2013; Aslan, 2013; Ceyhan et al., 2013; Kandemir, 2013).

Köseman et al. (2023) reported that type of birth affects daily live weight gain of Bafra lambs significantly between birth-30 and 60-90 days (weaning age), while this

effect on daily live weight gain was found to be non-significant between period of 30-60 and 90-120 days of age of lambs. Öztürk and Odabaşıoğlu (2011) in their study on Hamdani lambs found that the type of birth had significant on daily live weight gains between day 30 and 60, while this effect was no significant on daily live weight gain between birth - 30, 60 – weaning (90 days), and birth - weaning (90 days).

Also, Altın et al. (2003) found a significant effect of type of birth on daily live weight gain of Kıvırcık, Chios x Kıvırcık F_1, and Kıvırcık x Karya F_1 crossbred lambs during the period between 47 to 61 days only. Significant differences in daily live weight gain of Kıvırcık lambs due to their type of birth was reported by Alarslan (2018) between birth-150 days, whereas a non-significant effect was recorded of type of birth on live weight gain between 90-180 days and 150-180 days.

Conversely, other researchers revealed a non-significant effect of type of birth on daily live weight gains of different breeds of sheep and for various periods of lambs age (Esen and Yıldız, 2000a; Ceyhan et al., 2010; Ocak and Cankaya, 2013; Bingöl and Aygün, 2014; Sakar and Erişek, 2019).

Such effects on birth weight could be attributed to decreasing weight and number of cotyledons with increasing the number of fetuses (Rhind et al., 1980; Black, 1983) and to growth competition between twins for a fixed amount of nutritive materials from their dams during pre-natal period (Aziz, 1986; Alkass et al., 1996; Solomon et al., 2006), whereas the differences in weaning weight might be due to the availability of milk during suckling period and to their weights at birth (Alkass et al., 1993).

5.4 Body Measurements

Table 4.4 shows the body measurements of Akkaraman and ASF x AK F_1 lambs at different periods of growth. At the 30^{th} day of the growth period, the measurements of the withers height, chest width, chest depth and chest girth of purebred and crossbred lambs were similar. On the other hand, the crossbred F_1 lambs had a longer body structure (43.98 cm vs. 42.15 cm, $p<0.001$) and a larger leg (thigh) circumference (27.69 cm vs. 24.32 cm, $p<0.001$) than the purebred lambs.

On the 60^{th} day, ASF x AK F_1 lambs were taller and longer in the body and wider in the chest than Akkaraman lambs. They also had a wider leg circumference. The

differences between crossbred F_1 and purebred lambs were found to be statistically significant in the values of withers height ($p<0.05$), body length ($p<0.001$), chest width ($p<0.01$), chest girth ($p<0.01$) and leg circumference ($p<0.001$). Obeidat et al. (2019) reported withers height between 53.84-59.23 cm, chest girth between 60.06-66.55 cm and chest width between 16.61-20.33 cm in Awassi and Chios x Awassi male and female lambs at 65 days of age. Similarly, Aljamaeen et al. (2023) reported that Assaf lambs in Jordan at 60 days of weaning age had a higher and longer body, deeper (and wider chest girth than ASF x AK F_1 and Akkaraman lambs in this study.

The chest width and depth measurements of purebred and crossbred lambs at 90 days were similar. On the other hand, withers height ($p<0.01$), body length ($p<0.001$), chest girth ($p<0.01$) and leg circumference ($p<0.001$) measurements of ASF x AK F_1 lambs were significantly higher than Akkaraman lambs. Akkaraman lambs (54.96 cm) in this study had similar values to those reported by Ünal et al. (2006a) for Akkaraman (55.4 cm), Kıvırcık x Akkaraman F_2 (54.8 cm) and Chios x Akkaraman F_2 (55.6 cm) lambs, but higher than Kıvırcık x Akkararaman B_1 (53.2 cm) lambs and lower than Chios x Akkaraman B_1 (57.0 cm) lambs. In contrast, the withers height of the ASF x AK F_1 lambs (56.91 cm) was similar to that of the Chios x Akkaraman B_1 lambs, but higher than that of the other genotypes. On the other hand, the values for 90-day body length and chest girth of the ASF x AK F_1 and Akkaraman lambs were lower than those found in the genotypes reported by Ünal et al. (2006a).

On the 120^{th} day of the growth period, withers height was 57.27 cm and 60.23 cm ($p<0.001$), body length was 52.45 cm and 56.78 cm ($p<0.001$), chest width was 13.27 cm and 13.68 cm ($p<0.05$), chest depth was 22.71 cm and 23.40 cm, chest girth was 63.65 cm and 65.53 cm ($p<0.05$), leg circumference was 31.18 cm and 36.18 cm ($p<0.001$) for purebred and crossbred lambs, respectively. These values were lower than the values of 61.46 cm withers height, 61.07 cm body length, 79.30 cm chest girth and 25.10 cm chest depth reported by Aljamaeen et al. (2023) for Assaf lambs at 120 days of age at marketing age.

On day 150, chest width of Akkaraman and ASF x AK F_1 lambs was found to be similar, while the withers height was 59.44 cm vs. 63.28 cm ($p<0.001$), body length was 54.61 cm vs. 59.83 cm ($p<0.001$), chest depth was 23.79 cm vs. 24.73 cm ($p<0.01$),

chest girth was 66.65 cm vs. 69.50 cm ($p<0.001$), leg circumference was 33.03 cm vs. 38.13 cm ($p<0.001$).

Similarly, at day 180, crossbred F_1 lambs showed superior values than purebred lambs in all measurements except chest width. Crossbred lambs were 4.08 cm taller than purebred bred lambs ($p<0.001$). While the withers height determined as 61.68 cm in Akkaraman lambs was similar to the value of 61.1 cm reported by Ünal et al. (2006a) for Kıvırcık x Akkaraman B_1 genotype, it was lower than the values determined in other genotypes. On the other hand, the withers height of ASF x AK F_1 lambs was 65.76 cm, which was similar to the value of 65.2 cm reported by Ünal et al. (2006a) for the Chios x Akkaraman B_1 genotype, but higher than the values obtained for the other genotypes.

The body lengths of Akkaraman and ASF x AK F_1 lambs, 56.40 cm and 62.48 cm respectively, were lower than those reported by Ünal et al. (2006a) for the genotypes he studied, which ranged from 63.6 to 67.9 cm.

Crossbred F_1 lambs had a deeper (25.88 cm vs. 24.85 cm, $p<0.01$) and wider (73.35 cm vs. 69.45 cm, $p<0.001$) chest than purebred lambs. On the other hand, Ünal et al. (2006a) reported that Kıvırcık x Akkaraman and Chios x Akkaraman crosses had a larger chest girth. The difference between the leg circumference trait of Akkaraman and ASF x AK F_1 lambs was very significant at $p<0.001$ level in favor of crossbred F_1 lambs.

In general, ASF x AK F_1 lambs were found to have a taller and longer body structure than Akkaraman lambs when body measurements were compared during the growth. Towards the end of the growth period, ASF x AK F_1 lambs were better at defining meat type due to their wide and round chest circumference and plump thigh structure.

The withers height, body length, chest girth and depth of 6–18-month-old female and male Assaf lambs reared in Southern Sinaiin Egypt were reported to be 74.80 cm and 71.70 cm, 93.30 cm and 84.50 cm, 105.40 cm and 101.00 cm and 38.30 cm and 40.00 cm respectively (Abd-Allah et al., 2018).

5.5 Survivability

In sheep farming, survivability, which measures environmental adaptability, is related to profitability (Aksoy et al., 2023). Since the lambs were sold after weaning in the farm where the study was carried out, the survivability up to the 3-month weaning period was calculated. Within the first three months of life, the survival rates for Akkaraman lambs were 96.12%, 93.20% and 90.29%, and for ASF x AK F_1 lambs were 98.04%, 96.08% and 90.20%.

The survival rate of Akkaraman lambs up to one month of age was greater than the values reported for Akkaraman (95.3%), Chios x Akkaraman F_2 (88.3%), and Chios x Akkaraman B_1 (94.6%) by Ünal et al. (2006). It was also lower than the value reported for Kıvırcık x Akkaraman F_2, which was 98.7% (Ünal et al., 2006). On the other hand, the first month survival of ASF x AK F_1 lambs was similar to the 98.7% reported by Ünal et al. (2006) for Kıvırcık x Akkaraman F_2 and had a higher survival rate than the other genotypes. Akkaraman and ASF x AK F_1 lambs had higher survival than Awassi (92.6%) and Kıvırcık (95.5%) lambs but lower than Akkaraman (100%) lambs at 1st month.

The survival rate of Akkaraman and ASF x AK F_1 lambs at 3 months of age was found to be lower than other genotypes except Chios x Akkaraman F_2 (Ünal et al., 2006a). On the other hand, purebred and crossbred lambs showed higher survival rate than Awassi lambs, similar to Kıvırcık lambs and lower than Akkaraman lambs up to 3 months of age (Yakan et al., 2012).

5.6 Testis Characteristics of Male Lambs

Testicular characteristics of Akkaraman and ASF x AK F_1 lambs were measured at 3 and 6 months. At 3 months of age, the testicular diameter of purebred and crossbred F_1 lambs was 2.68 cm and 2.77 cm, respectively, and the testicular length was 5.21 cm and 5.80 cm, respectively. The values of testicular diameter and length of both genotypes were higher than those found by Aygün and Karaca (2000) in Karakaş male lambs of Akkaraman variety at 90 days and lower than those found by Yılmaz and

Cengiz (2006) in Norduz lambs and by Erdoğan Ataç and Kaymakçı (2021) in Chios lambs.

It was reported that as the scrotal circumference increased, sperm output also increased, therefore, scrotal circumference could be used as an index for sperm production in rams (Kridli et al., 2006). ASF x AK F_1 lambs had a scrotum circumference of 17.37 cm and a scrotum length of 12.40 cm, while Akkaraman lambs had a scrotum circumference and length of 14.40 cm and 7.75 cm, respectively. The differences were found to be significant at the $p<0.01$ level. These values were higher than those reported for Karakaş lambs of the same age (Aygün and Karaca, 2000), but lower than those reported for Chios lambs (Erdoğan Ataç and Kaymakçı, 2021). At the same time, lambs from Awassi and Redkaraman sheep and their reciprocal crosses had a lower scrotum circumference than Akkaraman and ASF x AK F_1 lambs (Emsen, 2005).

There are reports that testicular volume decreases more sharply with increasing malnourishment. Testis volume at 3 months of age was significantly higher in ASF x AK F_1 lambs than in Akkaraman lambs (73.07 vs. 51.00 cm^3, $p<0.001$), but lower than the values reported for Norduz lambs (Yılmaz and Cengiz, 2006) and Chios lambs (Erdoğan Ataç and Kaymakçı, 2021).

It has been reported that protein supplementation above a moderate level would not be necessary to achieve maximum testicular growth in mature Assaf rams (Fernandez et al., 2004). The purebred and crossbred F_1 lambs' testicular diameters at 6 months were measured to be 3.60 cm and 4.35 cm, respectively ($p<0.05$). Al-Doski (2022) determined higher testicular diameter in Awassi lambs fed diets containing 14% and 15% protein. However, the testicular length of Akkaraman and ASF x AK F_1 lambs at 6 months was greater than that of Awassi in all the diet groups reported by Al-Doski (2022). Contrary to the results of the study, higher testicular diameter and length were reported in Norduz (Yılmaz and Cengiz, 2006) and Chios lambs (Erdoğan Ataç and Kaymakçı, 2021).

ASF x AK F_1 lambs had a greater scrotum circumference and length than Akkaraman lambs, but only the difference in the scrotum length was statistically significant ($p<0.01$). At six months, Akkaraman and ASF x AK F_1 lambs had larger scrotums than Karakaş lambs (Aygün and Karaca, 2000) and Awassi lambs (Emsen, 2005), but smaller scrotums than Norduz (Yılmaz and Cengiz, 2006) and Chios lambs

(Erdoğan Ataç and Kaymakçı, 2021). The testicular volume determined as 120.37 cm^3 and 127.82 cm^3 in Akkaraman and ASF x AK F_1 lambs were lower than the values reported by Yılmaz and Cengiz (2006), Erdoğan Ataç and Kaymakçı (2021).

5.7 Fattening Performance

Live weight, daily live weight gain and feed intake values of Akkaraman and crossbred F_1 lambs at various periods during intensive fattening are given in Table 4.8. The live weights of Akkaraman and crossbred lambs at the beginning of fattening were 23.89 kg and 23.77 kg, respectively. Fattening starting weights in this study were higher than the values of 14.3-14.4 kg reported by Rodriguez et al. (2011) for Assaf and Merino x Assaf crossbred lambs, 20.06 kg and 21.58 kg for Akkaraman and Awassi lambs reported by Khadre and Karabacak (2018). In addition, the initial weights of the lambs in this study were higher than those reported by Yaralı (2020) for different genotypes bred in Türkiye, which ranged between 19.70-22.50 kg, but lower than the 28.3-29.1 kg reported by Mateo et al. (2023) for Spanish Assaf lambs.

Up to day 42 of intensive fattening, there was no statistically significant difference between the live weights of purebred and crossbred lambs. However, the 56^{th} day live weight was significantly higher in crossbred F_1 lambs than in Akkaraman lambs (41.01 kg vs. 38.12 kg, $p<0.01$).

There was a statistically significant difference of 3.01 kg between the lambs from Akkaraman and ASF x AK F_1 with final live weights of 41.02 kg and 44.03 kg respectively ($P<0.01$). While lower fattening live weights were determined in Bafra, Akkaraman and Bafra x Akkaraman F_1 lambs with a slaughter weight of 34 kg, higher values were reported in Akkaraman and Bafra x Akkaraman F_1 lambs with a slaughter weight of 42 kg (Yaranoğlu and Özbeyaz, 2019). Jawasreh et al. (2019) reported higher end-of-fattening live weights for first generation callipyge Rambouillet x Awassi lambs at the end of 74 days of fattening, but similar end-of-fattening live weights for Awassi lambs to ASF x AK F_1 lambs. Saro et al. (2020) also reported higher final live weights ranging from 45.0-50.7 kg for heavy fattening Assaf lambs.

By the end of fattening on day 70, the total live weight of the purebred and crossbred lambs had increased by 17.14 kg and 20.26 kg respectively ($p<0.01$). Abo

Omar and Abdallah (2019) stated that after 80 days of feeding on two upgraded agricultural wastes, the Assaf lambs gained a total of 17.9-19.5 kg of weight.

The average daily weight gain of the Akkaraman and ASF x AK F_1 lambs did not differ significantly. Crossbred lambs gained an average of 0.289 kg per day, compared to 0.245 kg for Akkaraman lambs. Higher daily weight gains were reported by Rodriguez et al. (2011) in Merino x Assaf crossbred male lambs (0.326 kg), Jawasreh et al. (2019) in first‐generation callipyge Rambouillet‐Awassi male lambs (0.360 kg) and by Yaranoğlu and Özbeyaz (2019) in Akkaraman lambs (0.356 kg). The average daily weight gain of Akkaraman and ASF x AK F_1 lambs was similar to the values determined by Saro et al. (2020) in Assaf lambs, ranging from 221-297 g. On the other hand, it was higher than the values ranging between 122.42-161.93 g obtained in the 56-day fattening of Eşme Kıvırcık, Bursa Kıvırcık, Çine Çaparı and Karya lambs (Yaralı, 2020).

Since feed is the most important expense in fattening, it is essential to achieve the highest live weight gain with the least amount of feed in the shortest possible time. For this reason, a high nutritional level of the rations to be fed to lambs in fattening will increase the live weight gain and feed conversion ratio of the lambs. During the fattening period, daily concentrate feed consumption was 1.15 kg in Akkaraman and 1.20 kg in ASF x AK F_1 lambs. Similar daily concentrate feed consumption was reported for Akkaraman and Bafra x Akkaraman B_1 crossbred lambs in intensive fattening (Güngör et al., 2022).

When the values related to feed consumption per 1 kg of live weight gain were examined, the feed conversion coefficients of Akkaraman and crossbred F_1 lambs at the end of intensive fattening were 4.70 kg and 4.15 kg, respectively. Feed conversion ratios for Akkaraman and Awassi lambs were reported as 4.93 and 4.61 (Khadre and Karabacak, 2018). The feed conversion values obtained in this study were higher than values reported by Rodriguez et al. (2011), Jawasreh et al. (2019), and Güngör et al. (2022). In contrast, Saro et al. (2020), Yaralı (2020) and Koyuncu et al. (2021) reported higher feed conversion rates.

The breed, sex, birth type, age at start of fattening (days), duration of fattening, amount and nutrient content of the rations used are important factors influencing fattening performance. Therefore, it can be assumed that the wide variation observed in

the literature results in terms of live weight and daily live weight gain, which determine the meat production ability of lambs, is due to the combination of all these factors.

5.8 Body Measurements of the Lambs at Fattening

As can be seen from the Table 4.9, the mean values of withers height, body length, chest width, chest depth, chest girth and leg circumference at the beginning of the fattening were measured as 57.20 cm, 53.60 cm, 12.90 cm, 22.60 cm, 65.50 cm, 33.20 cm in Akkaraman lambs. The same measurements were determined as 59.78 cm, 56.33 cm, 13.00 cm, 23.11 cm, 65.89 cm, and 33.56 cm in ASF x AK F_1 lambs, respectively. ASF x AK F_1 lambs were found to have greater withers height ($P<0.01$) and body length ($P<0.01$) than Akkaraman lambs at the start of the fattening period (day 0). These differences were statistically significant. Crossbred lambs maintained their statistical superiority for withers height and body length traits throughout the entire fattening period. Body measurements of Akkaraman and ASF x AK F_1 lambs at the beginning of fattening were higher than the values reported for Awassi lambs (Kutan and Keskin, 2022).

Akkaraman lambs had higher chest width values than the crossbred F_1 lambs from the 28^{th} day until the end of fattening. At 28^{th}, 42^{nd} and 56^{th} days, the differences in chest width between the breeds were found to be statistically significant at $P<0.05$ level in favor of Akkaraman lambs. Throughout the fattening period, the chest depth measurements for the two breeds were similar.

Crossbred F_1 lambs measured greater in the chest girth at 56 and 70 days compared to Akkaraman lambs. The chest girths of Akkaraman and crossbred lambs were 75.10 cm and 78.22 cm ($P<0.05$) on day 56 and 77.50 cm and 80.11 cm ($P<0.05$) on day 70, respectively.

There were no significant differences between breeds for leg circumference between days 0-28. As opposed to this, the leg circumferences of Akkaraman and ASF x AK F_1 lambs were 38.10 cm and 40.56 cm ($P<0.01$) on day 42, 39.10 cm and 46.22 cm ($P<0.01$) on day 56, 42.30 cm and 49.33 cm ($P<0.01$) on day 70.

The values of the fattening body measurements in Akkaraman and ASF x AK F_1 lambs were similar to the withers height, chest girth and chest width measurements

determined by Khadre and Karabacak (2018) in Akkaraman and Awassi lambs. On the other hand, the research material lambs exhibited a longer body length, a deeper chest, and a smaller leg circumference.

5.9 Slaughter and Carcass Characteristics

The slaughter weight of 44.34 kg for ASF x AK F_1 lambs was significantly higher than 39.22 kg for Akkaraman lambs ($p<0.05$). Similar to the findings of this study, Shaker et al. (2002) and Khadre and Karabacak (2018) found that breed had a significant effect on slaughter weight. The slaughter weight of ASF x AK F_1 lambs was higher than Awassi and Awassi x Charollais lambs and lower than Awassi x Romanov crossbred lambs (Shaker et al., 2002). Mateo et al. (2023) reported that Spanish Assaf suckling lambs with lower daily live weights were slaughtered at lower live weights and lambs with higher birth weights tended to have higher slaughter live weights.

There was no difference in hot carcass weight between Akkaraman and ASF x AK F_1 lambs, but cold carcass weight of crossbred F_1 lambs was significantly different from that of purebred lambs ($p<0.05$). Obeidat et al. (2019), who determined that breed had a significant effect on both hot and cold carcass weight, reported that crossbred F_1 lambs (Chios x Awassi) had higher weights than purebred (Awassi) lambs, similar to the study findings. The lambs used in this study had higher hot and cold carcass weights in fattening studies on various purebred and crossbred lambs (Rodriguez et al., 2008; 2011; Obeidat et al., 2019; Güngör et al., 2022).

After the tail was removed, the cold carcass weight for Akkaraman and ASF x AK F_1 lambs was 15.86 kg and 19.22 kg, respectively ($p<0.01$). These values were higher than those reported by Bingöl et al. (2006) for Norduz lambs. On the other hand, the values reported by Karakuş (2007) for Karakaş and (Ile de France x Akkaraman G_1) x Karakaş F_1 lambs were higher than Akkaraman lambs and lower than ASF x AK F_1 lambs.

ASF x AK F_1 lambs had significantly higher the left carcass weight than Akkaraman lambs ($p<0.001$). In this study, the left half carcass weight of Akkaraman lambs was 7.20 kg, which was lower than the values reported by Khadre and Karabacak (2018) for Akkaraman and Awassi lambs. In contrast, the left half carcass weight of

ASF x AK F_1 lambs (9.41 kg) was similar to that of Akkaraman lambs (9.26 kg) and higher than that of Awassi lambs (8.47 kg) (Khadre and Karabacak, 2018).

There was no significant difference in the dressing percentage between Akkaraman and crossbred F_1 lambs (50.04% against 48.28%). Although Obeidat et al. (2019) reported that the effect of breed on dressing percentage was significant, lower dressing percentages were determined in Awassi and Chios x Awassi lambs. Lower dressing percentage values were reported in Assaf, Merino x Assaf, Akkaraman and Bafra x Akkaraman B_1 lambs (Rodriguez et al., 2011; Güngör et al., 2022). Ünal et al. (2006b) reported dressing percentage ranging between 48.25-50.52% in Akkaraman and crossbred male lambs and found no difference between the breeds.

For Akkaraman and ASF x AK F_1 lambs, the untailed dressing percentages were 40.47% and 43.37%, respectively ($p<0.01$). Norduz lambs were reported to have lower untailed dressing percentage (Bingöl et al., 2006). Similar to the findings of the study, crossbred lambs were reported to have significantly higher untailed dressing percentages than purebred lambs (Karakuş, 2007).

Cooling loss was found to be 3.12% and 2.72% in Akkaraman and ASF x AK F_1 lambs, respectively. Rodriguez et al. (2011) reported lower values for Assaf ewe and male lambs, but Merino x Assaf cross ewe and male lambs had lower cooling loss values than Akkaraman lambs and similar to ASF x AK F_1 lambs.

Carcass by-products such as head ($p<0.05$), feet ($p<0.05$), skin ($p<0.01$), heart+liver+lungs ($p<0.001$), testes ($p<0.001$), kidney+pelvic fat ($p<0.05$) were statistically higher in ASF x AK F_1 lambs than in Akkaraman lambs. Ünal et al. (2006b) reported no significant differences between purebred and crossbred genotypes for head, feet, skin, heart+lungs+liver, kidney and testis weight, but found a significant effect of breed for omental fat ($p<0.01$) and kidney+pelvic fat weights ($p<0.01$).

The weight of kidney+pelvic fat, which is one of the important auxiliary traits in determining carcass fat percentage, was 0.05 kg and 0.18 kg for Akkaraman and ASF x AK F_1 lambs, respectively ($p<0.05$). The weight of kidney+pelvic fat in genotypes obtained from crosses between Akkaraman and Kıvırcık and Chios breeds was reported to vary between 0.134-0.289 kg (Ünal et al., 2006). It was found that while the raising method had no significant impact on carcass and non-carcass fat stores, naturally grown

Assaf lambs had higher levels of fat stores than lambs raised artificially (Landa et al., 2004).

In the study, Akkaraman lambs had tail weights of 3.74 kg, while crossbred F_1 lambs had tail weights of 2.18 kg ($p<0.001$). Khadre and Karabacak (2018) determined a tail weight of 3.17 kg and 2.31 kg ($p<0.05$) in Akkaraman and Awassi lambs, respectively. Shaker et al. (2002) found tail weights of Awassi, Awassi x Charollais and Awassi x Romanov crossbred lambs as 2.74 kg, 0.56 kg and 0.43 kg ($p<0.001$), respectively. It was revealed that the tail fat weight of Akkaraman breed could be reduced by crossbreeding with different breeds (Ünal et al., 2006b).

In the study, left half carcasses were divided into six parts as leg, back-loin, forearm, shoulder, neck, and flank-chest according to the standard carcass dissection method and the weight of each part was determined. Rodriguez et al. (2011) stated that legs, ribs, and fore-ribs were the higher-priced joints, shoulders were the medium-priced joints, and the lower-priced joints included breasts, necks, and tails.

ASF x AK F_1 crossbred lambs had significantly higher leg ($p<0.01$), forearm ($p<0.01$) and flank-chest weights ($p<0.01$) than Akkaraman lambs. Although back-loin, shoulder and neck weights were slightly higher in ASF x AK F_1 lambs, there were no significant differences with Akkaraman lambs. Khadre and Karabacak (2018) found that Akkaraman lambs had significantly higher leg ($p<0.05$), fore ribs ($p<0.05$) and flank ($p<0.05$) weights than Awassi lambs. Obeidat et al. (2019) reported that Chios x Awassi lambs had significantly higher shoulder and legs weights than Awassi lambs ($p<0.05$).

Musculus longissimus dorsi is the largest and longest muscle in the body, which is important as it is a reliable measure of carcass conformation (Karakuş, 2007). The MLD area was measured as 12.49 cm^2 and 14.24 cm^2 in Akkaraman and ASF x AK F_1 lambs, respectively. Ünal et al. (2006b) determined MLD areas ranging between 12.78-14.67 cm^2 in lamb carcasses of Akkaraman and different crossbred genotypes, similar to the findings of this study. Obediat et al. (2019) found the effect of breed to be significant, although they found lower MLD area in Awassi and Chios x Awassi genotypes. Güngör et al. (2022) also measured lower MLD area in Akkaraman and Bafra x Akkaraman B_1 lamb carcasses. However, Jawasreh et al. (2019) and Saro et al. (2020) reported higher MLD areas.

There was not a significant difference between Akkaraman (2.92 mm) and ASF x AK F_1 (2.19 mm) lambs in terms of fat thickness measured on MLD. Higher fat thickness was determined in lambs of different purebred and crossbred genotypes (Ünal et al., 2006; Koyuncu et al., 2021).

When the proportional yields (%) of wholesale cuts, organs and fats in the carcass were analyzed, the percentages of head, feet and kidneys were similar in both genotypes. However, skin ($p<0.05$), heart+liver+lungs ($p<0.01$) and testicular weights ($p<0.001$) of ASF x AK F_1 lambs were significantly higher than Akkaraman lambs.

The crossbred F_1 lambs had significantly higher kidney+pelvic fat (0.82% vs. 0.26%, $p<0.01$) percentages than Akkaraman lambs. Although internal fat percentage of the carcass was higher in crossbred F_1 (2.08%) lambs than Akkaraman (0.77%) lambs, it was not statistically significant. However, the tail fat percentage of ASF x AK F_1 lambs was considerably lower ($p<0.001$) than that of Akkaraman lambs. Shaker et al. (2002) reported lower tail fat content in Awassi, Awassi x Charollais and Awassi x Romanov crossbred lambs and in agreement with the results of this study, tail fat percentage was lower in crossbred lambs.

Although the percentages of the leg, forearm, and neck of Akkaraman lambs were higher than those of crossbred F_1 lambs, the differences were not statistically significant. The ASF x AK F_1 lambs had a considerably larger percentage of flank-chest compared to the Akkaraman lambs ($p<0.01$). According to Ünal et al. (2006b), among the desirable carcass portions, breed only significantly affected the loin percentage, where Akkaraman crosses outperformed pure lambs. It was reported that breed did not have a significant effect on the proportions of the three commercial cut categories (Rodriguez et al., 2011). On the other hand, significant effects of breed on the proportion of valuable carcass parts were found in different genotypes (Yaralı, 2020). Saro et al. (2020) found the proportions of high-priced carcass cuts to be 52.6-52.9%, medium-priced cuts 518.2-18.3%, and low-priced cuts 26.5-27.0% in Asaf lambs.

6. CONCLUSIONS AND RECOMMENDATIONS

Nowadays, it is essential to improve the quality of output in addition to the quantity of sheep products obtained. However, it is known that the yields obtained from domestic sheep breeds are not at the desired levels. Increasing the quality and quantity in production is possible through studies on improving the genetic structure as well as improving management conditions. For this reason, for the improvement of domestic sheep breeds especially in terms of meat yield, crossbreeding with high meat-yielding, prolific culture breeds should be carried out by making use of crossbreeding programs together with pure breeding and selection.

Within the scope of this study, ASF x AK F_1 lambs obtained by crossing Akkaraman ewes with pure Assaf rams had better growth-development, fattening performance, testicular and slaughter-carcass characteristics than pure Akkaraman lambs. When body measurements were examined during the growth and fattening periods, ASF x AK F_1 lambs had a longer and taller body structure than Akkaraman lambs. At the same time, ASF x AK F_1 lambs were superior in defining meat type due to their broad and rounded chest circumference and well-developed leg structure.

These results can be considered positive in terms of crossbreeding between Akkaraman and Assaf breeds. Although F_1 crossbred lambs had higher values than purebred Akkaraman lambs in many traits, it is expected that heterosis and uniformity in F_1 progeny play a role in this difference. ASF x AK F_1 lambs can be recommended for commercial production.

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EXTENDED TURKISH SUMMARY

(GENİŞLETİLMİŞ TÜRKÇE ÖZET)

YETİŞTİRİCİ KOŞULLARINDA AKKARAMAN VE ASAF x AKKARAMAN (F_1) MELEZ KUZULARININ BÜYÜME, BESİ PERFORMANSI VE KARKAS ÖZELLİKLERİNİN BELİRLENMESİ

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Ağustos 2024, 121 sayfa

ÖZET

Bu tez çalışmasının amacı, Türkiye yerli koyun ırkları arasında sayı bakımından en fazla olan Akkaraman koyunlarını anaç materyal olarak kullanarak et verim özelliklerinin ıslahında Assaf ırkından yararlanma olanaklarının araştırılmasıdır. Böylece bu çalışmada, köy koşullarında yetiştirilen Akkaraman koyunları ile Asaf koçlarının melezlenmesiyle elde edilen saf ve melez F_1 kuzuların büyüme hızı, besi performansı ve karkas özelliklerini ortaya koymak amaçlanmıştır. Çalışmanın hayvan materyalini 150 baş Akkaraman koyunu, 2-6 yaş arası 5 baş Akkaraman koçu ve 2 baş safkan Asaf koçu (2 ve 3 yaş) ile bunların çiftleştirilmesinden elde edilen kuzular oluşturmuştur.

Aşım döneminde tüm koyunlar tek bir sürü halinde gün boyunca merada tutulmuş; üreme organları ve bel bölgesi pamuklu bir bezle örtülü olan arama koçlarıyla kızgınlık tespiti yapılmıştır. İlk gözlem, sürü sabah saat 10:00'da çiftliğe dönene kadar merada, ikinci gözlem ise sürünün saat 14:00'te meraya döndüğü akşam saatlerinde yapılmıştır.

Arama koçları tarafından kızgınlıkta olduğu belirlenen koyunlar ayrılmıştır. Saf Akkaraman kuzularını elde etmek amacıyla Akkaraman koyun ve koçlarına merada serbest aşım uygulanmıştır. Yarı yağlı kuyruklu Asaf koçlarının yağlı kuyruklu Akkaraman koyunları ile çiftleşme zorluğu nedeniyle melez kuzuları elde etmek için Akkaraman koyunlarının kuyruk bölgesi kaldırılarak Asaf koçlarının elde aşım yapması sağlanmıştır. Gebe olmayan koyunları tespit etmek amacıyla arama koçlarıyla merada 2

ay süreyle kızgınlık taramalarına devam edilmiş ve kızgınlıkta olduğu belirlenen koyunların tekrar çiftleştirilmesi sağlanmıştır.

Akkaraman koyunlarının döl verimi özelliklerini belirlemek amacıyla kuzulayan koyun sayısı, koçaltı koyun başına doğan kuzu sayısı, doğuran koyun başına doğan kuzu sayısı, kısırlık oranı ve ikizlik oranı kaydedilmiştir.

Ocak-Nisan aylarını kapsayan doğum mevsiminde doğumu yaklaşan gebe koyunlar doğum bölmesine alınmıştır. Yenidoğan kuzular doğumdan sonraki 12 saat içerisinde 10 grama duyarlı teraziyle tartılmıştır. Her kuzunun doğum ağırlığı, doğum tarihi, genotipi, cinsiyeti, doğum tipi, annenin kulak numarası, annenin yaşı ve annenin doğumdaki ağırlığı kaydedilmiştir.

Kuzular yaklaşık 5-7 gün boyunca anneleriyle beraber tutulmuş, daha sonra annelerinden ayrılmış ve günde iki kez emzirilmiştir. Kuzular kapalı alanda barındırılmış ve 600 g yonca samanı ve 800 g/kuzu/gün arpa ile beslenmiştir. Nisan ayından sonra koyunlar merada otlatılmış, günde bir kez sağılmış ve kuzular sütten kesilene kadar (3 ay) anneleriyle beraber barındırılmıştır. Sütten kesilen kuzular annelerinden ayrılarak ayrı sürü halinde meraya götürülmüş ve ortalama 7 ay boyunca burada kalmışlardır.

Kuzularda büyüme ve gelişmeyi izlemek amacıyla ortalama 6 aylık yaşa kadar 14 günlük aralıklarla bireysel tartımlar yapılmıştır. Kuzuların çeşitli vücut ölçüleri, doğumdan sonra 30 günlük aralıklarla tespit edilmiştir. Vücut ölçülerinin belirlenmesinde ölçü bastonu yardımıyla cidago yüksekliği, vücut uzunluğu, kürekler arkası göğüs genişliği ve göğüs derinliği ölçüleri belirlenirken, ölçme şeridiyle göğüs çevresi ve but çevresi ölçüleri kaydedilmiştir.

Yaşama gücünün belirlenmesi amacıyla büyüme dönemlerindeki canlı kuzu sayısı, canlı doğmuş kuzu sayısına oranlanmıştır. Çalışmada ayrıca erkek kuzuların testis özelliklerinin belirlenmesi amacıyla 3 ve 6 aylık yaşta testis çapı, testis uzunluğu, skrotum çevresi ve skrotum uzunluğu ölçümleri yapılmıştır. Testis çapı ve testis uzunluğu elektronik kumpas yardımıyla, skrotum çevresi ve skrotum uzunluğu ise ölçme şeridi ile ölçülmüştür. Testis hacmi formülasyon yoluyla belirlenmiştir.

Saf ve melez kuzuların besi performansını belirlemek amacıyla aralarında en fazla 1 aylık yaş farkı bulunan 10 baş Akkaraman ve 9 baş ASF x AK F_1 melezi tek doğan erkek kuzu rastgele seçilmiştir. Kuzular 3 aylık yaşta sütten kesildikten sonra

gruplara göre iki ayrı besi bölmesine alınmış ve iç parazit tedavisi yapılmıştır. Yetmiş gün süren besi denemesi başlamadan önce besi yemlerine alışmalarını sağlamak amacıyla kuzulara 7 günlük bir adaptasyon süreci uygulanmıştır. Kuzu başına günde 100 g yonca otu ve ad libitum konsantre besi yemi verilmiştir. Kuzuların önünde besi süresince temiz içme suyu ve mineralli yalama taşı bulundurulmuştur. Besi performansını belirlemek amacıyla 12 saat öncesinden aç bırakılan kuzuların iki haftada bir canlı ağırlık denetimleri yapılmış ve aynı denetim günlerinde vücut ölçüleri alınmıştır.

Besi süresinin sonunda her genotipten 5'er erkek kuzunun kesim ve karkas özellikleri belirlenmiştir. Kesim öncesinde erkek kuzular suya erişim sağlayacak şekilde 18 saat aç bırakılmış ve kesimden hemen önce tartılmışlardır. Daha sonra kesim ve karkas parçalama işlemlerinin gerçekleştirilmesi için özel bir mezbahaya nakledilmişlerdir. Kesimden sonra baş, dört ayak, post, yürek+ciğer (takım), iç yağı ve sıcak karkas ağırlıkları 10 g'a duyarlı teraziyle belirlenmiştir. Karkaslar +4°C'deki soğuk hava deposunda 24 saat süreyle bekletilmiş ve daha sonra soğuk karkas, böbrek, testis, böbrek-leğen yağları ile kuyruk ağırlıklarının belirlenmesi amacıyla tartılmıştır. Omurga boyunca iki simetrik parçaya ayrılan kuyruksuz karkasların sol yarımı tartılmış ve parçalama işlemlerinin tümü sol yarım karkaslarda yapılmıştır. Standart karkas parçalama yöntemine göre sol yarım karkaslar but, sırt-bel, omuzbaşı, boyun, kol ve etek olmak üzere 6 parçaya ayrılmış ve her bir değerli parçanın ağırlığı belirlenmiştir. Sol yarım karkasların 12-13. omurlar arasındaki bölgesinden alınan *Musculus longissimus dorsi* (göz kası) alanları aydınger kağıdına çizilerek dijital planimetre ile alan ölçümü yapılmıştır. Aynı zamanda, göz kası alanının hemen üzerindeki kabuk yağı kalınlığı, elektronik kumpas yardımıyla belirlenmiştir. Çalışmada elde edilen sonuçlar aşağıda başlıklar halinde sunulmuştur.

Döl Verim Özellikleri

Çalışmada koçaltı koyun sayısı 150 olurken doğuran koyun sayısı 144 olarak tespit edilmiştir. Koyunların 10'u ikiz kuzu ve 134'ü tek kuzu doğurmuştur. Çalışma kapsamında toplam 154 kuzu elde edilmiştir. Sonuç olarak Akkaraman koyunlarında

döl verimi %96, koçaltı koyun başına doğan kuzu sayısı 1.03, doğuran koyun başına doğan kuzu sayısı 1.07, kısırlık oranı %4 ve ikizlik oranı %6.94 olarak belirlenmiştir.

Kuzularda Büyüme-Gelişme

Akkaraman ve ASF x AK F_1 melezi kuzuların doğum, 30, 60, 90, 120, 150 ve 180. günlerdeki canlı ağırlıkları sırasıyla 3.87 ve 3.79 kg, 9.79 ve 10.59 kg ($p<0.01$), 14.98 ve 16.82 kg ($p<0.001$), 22.11 ve 22.09 kg, 25.17 ve 25.84 kg, 28.72 ve 30.44 kg ($p<0.001$), 32.02 ve 35.67 kg ($p<0.001$) olarak belirlenmiştir. Doğum ağırlığı hariç tüm büyüme dönemlerinde ana yaşının istatistiki olarak önemli etkileri olmuştur ($p<0.05$, $p<0.01$, $p<0.001$). Erkek kuzular yalnızca 165 ($p<0.05$) ve 180. ($p<0.01$) günlerde dişilerden önemli derecede ağır gelmiştir. İncelenen tüm büyüme dönemlerinde doğum tipinin önemli etkileri belirlenmiş ve tek doğan kuzular ikizlerden daha fazla canlı ağırlığa ulaşmıştır ($p<0.01$, $p<0.001$).

Çeşitli dönemler arasındaki günlük canlı ağırlık artışları incelendiğinde, doğum ile 30, 60, 150 ve 180. günler arası ve 90-180. günler arası canlı ağırlık artışı melez kuzularda Akkaraman kuzularından önemli derecede yüksek olmuştur ($p<0.05$, $p<0.01$, $p<0.001$). Doğum-180 ve 90-180. günler arası hariç diğer dönemlerde ana yaşının önemli etkileri bulunmuştur. Buna karşılık cinsiyetin etkisi yalnızca söz konusu dönemlerde önemli bulunmuş ve erkek kuzular dişilerden daha fazla günlük canlı ağırlık artışı sağlamıştır ($p<0.05$, $p<0.001$). Yine tüm dönemlerde tek doğan kuzular ikizlerden daha fazla günlük canlı ağırlık kazancı sağlamıştır ($p<0.001$). Akkaraman ve melez F_1 kuzularda 3 aylık yaştaki sütten kesime kadar yaşama gücü oranları sırasıyla %90.29 ve %90.20 olarak belirlenmiştir.

Testis Özellikleri

Üç aylık yaşta ölçülen testis özelliklerinden testis çapı ve uzunluğu Akkaraman ve ASSxAK F_1 kuzularında benzer bulunmuştur. Öte yandan, skrotum çevresi, skrotum uzunluğu ve testis hacmi Akkaraman kuzularda sırasıyla 14.40 cm, 7.75 cm ve 51.00 cm^3, ASF x AK F_1 kuzularda ise 17.37 cm, 12.40 cm ve 73.07 cm^3 olarak bulunmuş ve farklılıklar $p<0.01$ düzeyinde önemli bulunmuştur.

Altıncı ayda ölçülen testis çapı saf ve melez F_1 kuzularda sırasıyla 3.60 cm ve 4.35 cm olarak bulunmuştur ($p<0.05$). Aynı zamanda ASF x AK F_1 melez kuzuları, Akkaraman kuzularından daha yüksek skrotum uzunluğuna sahip olmuştur ($p<0.01$).

Besi Performansı ve Kesim-Karkas Özellikleri

Akkaraman ve ASF x AK F_1 melezi kuzularda sırasıyla besi başı canlı ağırlığı 23.89 ve 23.77 kg, besi sonu canlı ağırlığı 41.02 ve 44.03 kg ($p<0.01$), toplam canlı ağırlık artışı 17.14 ve 20.26 kg ($p<0.01$), günlük ortalama canlı ağırlık artışı 0.245 ve 0.289 kg, 1 kg canlı ağırlık artışı için yem tüketimi 4.70 ve 4.15 kg olarak belirlenmiştir.

Kesim ve karkas özellikleri arasında kesimhane ağırlığı, soğuk karkas ağırlığı, kuyruksuz soğuk karkas ağırlığı, sol yarım karkas ağırlığı, karkas randımanı ve *Longssimus dorsi* kas alanı Akkaraman ve ASF x AK F_1 melezi kuzularda sırasıyla 39.22 ve 44.34 kg ($p<0.05$), 19.60 ve 21.40 kg ($p<0.05$), 15.86 ve 19.22 kg ($p<0.01$), 7.20 ve 9.41 kg ($p<0.001$), %50.04 ve %48.28, 12.49 ve 14.24 cm^2 olarak tespit edilmiştir.

Değerli karkas parçalarından but ağırlığı, kol ağırlığı ve etek ağırlığı Akkaraman ve ASF xAK F_1 melezi kuzularda sırasıyla 2.92 ve 3.48 kg ($p<0.01$), 1.44 ve 1.80 kg ($p<0.01$), 0.92 ve 1.39 kg ($p<0.01$) olarak bulunmuştur.

Sonuç

Bu çalışma kapsamında Akkaraman koyunlarının saf Asaf koçları ile melezlenmesi sonucu elde edilen ASF x AK F_1 kuzuları, saf Akkaraman kuzularına göre daha iyi büyüme-gelişme, besi performansı, testis ve kesim-karkas özelliklerine sahip olmuştur. Büyüme ve besi dönemlerinde vücut ölçüleri incelendiğinde ASF x AK F_1 kuzuların Akkaraman kuzulara göre daha uzun ve daha iri vücut yapısına sahip olduğu görülmüştür. Aynı zamanda ASF x AK F_1 kuzular geniş ve yuvarlak göğüs çevreleri ve iyi gelişmiş bacak yapıları nedeniyle et tipi tanımlamada üstünlük göstermişlerdir.

Bu sonuçlar Akkaraman ve Asaf ırkları arasındaki melezleme açısından olumlu olarak değerlendirilebilir. Birinci generasyon F_1 melezi kuzular birçok özellikte safkan Akkaraman kuzulardan daha yüksek değerlere sahip olmasına rağmen, bu farklılıkta F_1 döllerindeki heterosis ve üniformitenin rol oynaması beklenmektedir. ASF x AK F_1 kuzuları ticari üretim için önerilebilir.

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Al-Barwari, I.I.I., Turan, M., Karakuş, F. 2022. Determination of factors affecting red meat consumption habits in Duhok Province (Northern Iraq). 6th International Anatolian Agriculture, Food, Environment and Biology Congress, 7-9 Ekim 2022, Kütahya, Türkiye, ss.1032 (Oral Presentation)

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ARAŞTIRMA KESİN SONUÇ ONAY BELGESİ

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ANIMAL RESEARCHES LOCAL ETHIC COMMITTEE
RESEARCH FINAL REPORT APPROVAL CERTIFICATE

AraştırmanınAdı *Research Title*	Yetiştirici Koşullarında Akkaraman ve Asaf x Akkaraman (F_1) Melez Kuzularının Büyüme, Besi Performansı ve Karkas Özelliklerinin Belirlenmesi Determination of Growth, Fattening Performance and Carcass Characteristics of Akkaraman and Assaf x Akkaraman (F_1) Crossbred Lambs in Breeder Conditions	
Araştırıcı(lar) *Investigator(s)*	**Yürütücü** / *Chief investigator :*	Doç. Dr. Ferda KARAKUŞ
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Final report of the research project detailed above was approved by Van Yuzuncu Yil University Animal Researches Local Ethic Committee in the session held on ... / ... / ... (decision number .../...).

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