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Evaluation of Some Reproductive Performance of Ewes, Livability and Growth Traits of Lambs of Akkaraman in Breeder Flocks in Niğde/Bor Province

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ABSTRACT

Conducted within the National Sheep and Goat Breeding "subproject: Akkaraman Sheep Breeding Project under farmer conditions in Nigde's Bor district" between 2018 and 2022, the current study evaluated the reproductive characteristics of ewes as well as the livability and growth traits of lambs. This study investigated some 'reproductive traits' of an average of 6000 ewes per year and 'growth performance and 'survival traits' of a total of 30051 head lambs. The birth weight (LBW), 60th-day body weight (BW60), 120th-day body weight (BW120), and 120th-day body weight gain (BWG120) of Akkaraman lambs during the study periods were 4.14±0.19 kg, 18.58±0.03 kg, 31.31±0.02 kg, and 246±2.23 g/lamb/day, respectively. In the study, among the factors affecting the growth characteristics of Akkaraman lambs, only the effect of gender on BWG120 and birth type on BW120 was found to be insignificant. In contrast, the other factors were found to be found to be statistically significant. In the study, it was determined that the number of lambs per Akkaraman ewe giving birth between 2018-2022 varied between 1.03-1.10. The highest livability in Akkaraman lambs was determined in 2018 (96.61%) and the lowest in 2020 (83.21%). As a result, it was found that liveability in Akkaraman lambs was dependent on birth year, the age of the ewe, gender, and birth type.

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Introduction

Sheep breeding has a significant role in the Turkish economy as well as all over the world (Küçük and Akçapınar, 1999; Özmen et al., 2015). Obtaining high-value-added products especially meat and milk from sheep increases the importance of sheep breeding every year (Yıldız and Denk, 2006a; Şireli, 2021). Among these products, lamb meat production constitutes the primary source of income for sheep breeders (Akçapınar et al., 2000; Yakan et al., 2012; Aksoy et al., 2023).

Turkiye's sheep population is around 44,687,888 heads. While 91,10% (40.728.954) of the sheep population is composed of indigenous sheep breeds, 8,90% (3.958.934) is composed of cross-breed Merino sheep. Sheep has a share of 22.32% in total red meat production among cattle, sheep, goat, and buffalo species (TurkStat, 2023). It is obvious that sheep contribute significantly to red meat production in Turkiye. However, when evaluating lamb carcass weight (approximate 13-22 kg), it is clear that Turkiye falls behind the average weight of many developed countries (about 21-27 kg) (Esen and Yıldız, 2000a; Kul and Akcan, 2002; Yarali et al., 2015; TurkStat, 2023).

From time to time, the red meat industry in Turkiye faces various challenges. Increasing the animal number for slaughter can be a short-term solution to the red meat problem. Despite the sufficient number of sheep to increase per capita red meat production in Turkiye, the productivity of local breeds which constitute a large part of the sheep population is low (Akçapınar et al., 2000). Therefore, to solve the problem in the long term, it is necessary to increase the carcass yield per animal in local breeds (Bingöl and Aygün, 2013; Turkyilmaz and Esenbuga, 2019; Türkyilmaz et al., 2021). Assuming that a 1 kg increase in lamb live weight will increase carcass yield by approximately 42-50% (for Akkaraman) (Boztepe, 2015;

Aksoy et al., 2018), lamb carcass weight will increase by roughly 420-500 g.

Akkaraman sheep, which is the subject of the research, has approximately 40-50% of the sheep population in Turkiye (Öztürk, 2000; Tufan and Akmaz, 2001; Arık et al., 2002; Yaranoğlu and Özbeyaz, 2019; Noyan and Ceyhan, 2021). Akkaraman sheep, which is resistant to harsh climatic conditions, is one of the local fat tail sheep breeds. Akkaraman sheep are bred across a wide geographical area that includes Central Anatolia and nearby provinces (Boztepe, 2015; Kaymakçı, 2016). Many researchers have reported the following results for Akkaraman sheep: live weight is 35-50 kg (Boztepe, 2015), milk yield is 40-99.57 kg (Esen and Özbey, 2002; Mundan and Özbeyaz, 2004; Özmen et al., 2015; Kaymakçı, 2016; Kahraman and Özkul, 2020), lactation length is 120-155.80 days (Kaymakçı et al., 2001; Esen and Özbey, 2002; Mundan and Özbeyaz, 2004; Sönmez et al., 2009; Özmen et al., 2015; Kahraman and Özkul, 2020), twinning rate is 4.00-20.80% (Akçapınar et al., 2000; Kaymakçı et al., 2001; Esen and Özbey, 2002; Özmen et al., 2015; Ceyhan et al., 2019), fleece yield is 1.5-2.87 kg (Arık et al., 2002; Yıldız and Denk, 2006b; Boztepe, 2015; Kaymakçı, 2016; Tuncer and Cengiz, 2018), birth rate is 0.69-0.94 (Akçapınar et al., 2000; Özbey and Akçan, 2000a; Esen and Özbey, 2002; Ünal et al., 2006; Yakan et al., 2012; Özmen et al., 2015; Güngör and Ünal, 2020; Türkmen and Çak, 2021; Aksoy et al., 2023), the number of lambs born per ram is 0.93-1.03 (Esen and Özbey, 2002; Ceyhan et al., 2019; Aksoy et al., 2023), litter size at birth is 1-1.39 (Akçapınar et al., 2000; Özbey and Akçan, 2000a; Ünal, 2002; Ünal et al., 2006; Yıldız and Denk, 2006a; Esen and Bozkurt, 2001; Yakan et al., 2012; Büyüktekin and Öztürk, 2018; Ceyhan et al., 2019; Türkmen and Çak, 2021), birth weight is 3.56-4.91 (Çolakoğlu and Özbeyaz, 1999; Özbey and Akcan 2000b; Yakan et al., 2012; Ceyhan et al., 2019; Güngör and Ünal, 2020; Sakar and Ünal, 2021; Türkmen and Çak, 2021; Aksoy et al., 2023), 60th day weight is 12.84-22.11 kg (Odabaşıoğlu et al., 1996; Akçapınar et al., 2000; Esen and Yıldız, 2000b; Kucuk and Erduran, 2009; Aktaş and Doğan, 2014; Özmen et al., 2015; Sakar and Erişek, 2019; Türkmen and Çak, 2021; Aksoy et al., 2023; Tüfekci, 2023), 120th day weight is 25.51-34.95 kg (Akçapınar et al., 2000; Kucuk and Eyduran, 2009; Yakan et al., 2012; Aktaş and Doğan, 2014; Aktaş et al., 2014; Özmen et al., 2015; Sakar and Erişek, 2019; Aksoy et al., 2023; Tüfekci, 2023). The survival rate from birth to weaning (up to the 120th day of age) is 88.80-100.00 (Mundan and Özbeyaz, 2004; Aktaş and Doğan, 2014; Aktaş et al., 2014; Özmen et al., 2015; Aksoy et al., 2023), daily live weights gains between the birth day and the 120th day of age is between 231-264 g lamb^{-1} day^{-1} (Aktaş et al., 2014; Sakar and Erişek, 2019; Aksoy et al., 2023).

Within the scope of National Sheep and Goat Breeding in Nigde, many scientific studies have been published on the determination of some reproductive characteristics of Akkaraman sheep and the livability and growth characteristics of lambs under breeder conditions in five-year periods (Ceyhan et al., 2019; Sekeroglu et al., 2019; Noyan and Ceyhan, 2021; Aksoy et al., 2023). This research aimed to evaluate some reproductive characteristics of Akkaraman sheep and the livability and growth characteristics of their lambs within the scope of the National Sheep and Goat Breeding Project (number of project: 51AKK2012-02) in the Bor district of Nigde between 2018 and 2022.

Materials and Methods

The study was conducted on sheep and lambs bred by the public in the Bor district of Nigde between 2018 and 2022 as part of a project that began in 2013. The data was collected annually from approximately 6000 head of Akkaraman sheep and their total 30051 head offspring. Although there are differences between the feeding methods in enterprises, sheep generally meet their nutrition requirements in pens during winter months. After winter, sheep feed on pasture from March to November (Ceyhan et al., 2019).

Ram mating in the study was between August and September. It was planned at one ram per 30 ewes (class mating) in elite flocks and one ram per 25 ewes (free mating) in base flocks. . In the herds covered by the project, ram mating was limited to 45 days. Once the lambs were born, breeders recorded their birth date, birth type, gender, ewe's age, and birth weight (LBW). Besides LBW, the study has examined the growth characteristics of lambs: 60th-day weight (BW60), 120th-day weight (BW120), and lamb's daily weight gain (BWG120) between birth and 120th day. The growth characteristics of the lambs were examined by evaluating the birth records in the two months following the birthday. The live weights of lambs BW60 and BW120 were adjusted using the interpolation method (Aksoy et al., 2023).

The research investigated some reproductive performance traits according to mating, lambing and weaning results in Akkaraman ewes. Table 1 shows the formulas that determine the fertility characteristics of Akkaraman lambs discussed in the study (Kaymakçı, 2016; Aksoy et al., 2023).

In the research, the 120-day-Akkaraman lambs' livability (SR120) = Number of lambs born / Number of lambs weighted on the 120th day × 100) was determined according to the year of lamb birth (2018, 2019, 2020, 2021, and 2022), the age of the ewe (2, 3, 4, 5, 6, and 7 years old and above), gender (male and female), and the type of birth (single and twin).

The following general linear model was used to determine the environmental factors affecting LBW, BW60, BW120, and BWG120 (Model 1).

Table 1. Equations used in calculation of some reproductive performance traits according to mating, lambing and weaning results in Akkaraman ewes

Mating and lambing results	Equality for calculation
Litter size at birth (n)	Number of lambs born / Number of ewes lambing
Weaning results	
Litter size at weaning (n)	Number of lambs at weaning / Number of ewes lambing

Table 2. The least squares means (LSM) and standard errors (kg) of birth (LBW) and 60th day weight (BW60) of Akkaraman lambs

Factor	N	LBW		N	BW60	
		LSM	SE		LSM	SE
Birth year		P<0.01			P<0.01	
2018	5228	4.33a	0.011	5061	17.60c	0.060
2019	6420	3.95d	0.012	5940	19.52b	0.067
2020	5881	4.13b	0.010	5349	17.38d	0.060
2021	5971	4.30a	0.094	5632	21.68a	0.014
2022	6551	4.06c	0.085	6282	16.71e	0.013
Ewe's age		P<0.01			P<0.01	
2	4332	4.14b	0.082	3924	18.11b	0.018
3	4519	4.15b	0.074	4293	18.24b	0.012
4	3688	4.22a	0.071	3469	19.94a	0.011
5	6811	4.21a	0.094	6538	18.28b	0.015
6	5428	4.00c	0.077	5117	19.14a	0.013
7 and more	5273	4.16b	0.083	4923	18.10b	0.013
Gender		NS			P<0.01	
Male	14759	4.17	0.136	13684	18.72	0.021
Female	15292	4.12	0.140	14580	18.45	0.022
Birth type		P<0.01			P<0.01	
Single	26527	4.28	0.198	24940	18.74	0.028
Twin	3524	3.11	0.092	3324	17.34	0.011
Overall mean	30051	4.14	0.195	28264	18.58	0.030

LBW: Lamb birth weight; BW60: Live weight of lamb at day 60; SE: Standard error of the mean; a, b, c, d, e: The observed differences between the mean denoted by different letters in the same column are significant (P<0.01); NS: Nonsignificant

yijklm = μ + Ai + Bj + Ck + Dl + interactions between factors + eijklm Model 1

In the model;

yijklm = Individual yield record of m^{th} lamb in i^{th} lambing year, j^{th} ewe-age, k^{th} birth-type, and l^{th} gender

μ = Overall mean of population

Ai = The effect of the lambing year (in five categories: 2018, 2019, 2020, 2021, and 2022)

Bj = The effect of ewe's age at lambing (in six categories: 2, 3, 4, 5, 6, and 7+ years old)

Ck = The effect of lamb's birth type (in two categories: twin and single)

Dl = The effect of lamb's gender (in two categories: female and male)

eijklm = Random error

In this study, Duncan multiple comparison tests were used to determine the differences between more than two subgroups in Akkaraman lambs (Düzgüneş et al., 1983). In this current study on the factors affecting lamb survival, Chi-square (X^2) test was used to determine the dependence on these factors (breeding age, gender, type of birth and year of birth) and SPSS (2015) package programme was used for all data analyses.

Results

Table 2 shows the least squares mean (LSM) and standard errors for the LBW and BW60 weights of lambs. In this study, LBW in Akkaraman lambs in 2018, 2019, 2020, 2021, and 2022 were 4.33±0.01, 3.95±0.01, 4.13±0.01, 4.30±0.09, and 4.06±0.08 kg, respectively. In terms of ewe's age, the highest LBW was in lambs born to 4-year-old mothers (4.22±0.07 kg), and the lowest LBW was in lambs born with a maternal age of six (4.00±0.07 kg). Although the LBWs of males and females in Akkaraman lambs were similar (P>0.05), the difference of 1.17 kg observed between singleton and twin lambs was significant (P<0.01).

All environmental factors considered in this study had a significant effect on BW60 (Table 2; P<0.01). In Akkaraman lambs, BW60 varied between 16.71±0.01 and 21.68±0.01 kg (LSM = 18.58±0.03 kg) between 2018-2022. In Akkaraman lambs, the highest BW60 was determined in males (18.72±0.02 kg), single-born (18.74±0.02 kg) with ewe ages 4 (19.94±0.01 kg) and birth years in 2021 (21.68±0.01 kg).

The gender, age of the ewe, and year of birth affected the BW120 of the lambs (P<0.01). BWG120 were higher in male lambs (249±0.58 g day^{-1} $lamb^{-1}$) compared to female lambs (243±0.54 g day^{-1} $lamb^{-1}$) (P>0.05), and in single lambs (246±0.42 g day^{-1} $lamb^{-1}$) compared to twins (242±1.12 g day^{-1} $lamb^{-1}$) (Table 3; P<0.01).

Litter size at weaning (LSW) and litter size at birth (LSB) was 0.95 and 1.06, respectively (Table 4). The year 2022 had the highest LSB (1.10), and the lowest was in 2021 (1.03). SR120 had the lowest value (86.56%) in lambs born to 2-year-old ewes and the highest value (95.34%) in lambs born to 5-year-old ewes. The current study concluded that SR120 (mean = 91.88%) was dependent on the environmental factors examined (P<0.01).

Discussion and Conclusion

Birth Weight

Birth weight is also a significant criterion in evaluating the growth characteristics of lambs. Since the heritability of lamb birth weight is medium and high (h^2 = 0.33-0.77), it is a criterion for improving the growth characteristics of

lambs through selection. Many researchers reported that birth weight generally had a positive relationship between a lamb's livability and future growth characteristics (Assan et al., 2002; Hatcher et al., 2009; Everett-Hincks et al., 2014; Ptáček et al., 2017; Juengel et al., 2018).

In Akkaraman lambs, the birth weight of male lambs was higher than that of female lambs. Previous studies have explained this situation with a higher number of cotyledons of ewes giving birth to male lambs than that of ewes giving birth to female lambs. It has also been reported that male lambs secrete growth hormone at an earlier stage, thus possibly increasing their birth weight. In addition, some studies have reported that birth weight in female lambs is lower than in males due to the estrogen hormone weakening bone development in female lambs (Rashidi et al., 2008; Jawasreh et al., 2009; Bancheva et al., 2022). Babar et al. (2004) reported that male lambs generally had higher birth weights because they stayed in the uterus longer than female lambs.

Table 3. The least squares means (LSM) and standard errors of live weights (BW120) and daily live weight gains (BWG120) of Akkaraman lambs at 120 days

Factor	N	BW120 (kg)		BWG120 (g day^{-1})	
		LSM	SE	LSM	SE
Birth year		P<0.01		P<0.01	
2018	5051	28.78d	0.087	240d	0.730
2019	5754	33.11b	0.112	276a	0.940
2020	4894	30.36c	0.103	253c	0.860
2021	5632	35.54a	0.107	260b	0.890
2022	6282	28.67d	0.080	205e	0.670
Ewe's age		P<0.01		P<0.01	
2	3750	30.26c	0.121	239d	1.010
3	4236	31.24b	0.116	239d	0.990
4	3401	32.96a	0.140	256b	1.130
5	6494	30.10c	0.089	238d	0.750
6	4990	32.46a	0.118	262a	1.030
7 and more	4742	31.38b	0.115	244c	0.970
Gender		P<0.01		NS	
Male	13397	31.69	0.069	249	0.580
Female	14216	30.96	0.064	243	0.540
Birth type		NS		P<0.01	
Single	24416	31.43	0.050	246	0.420
Twin	3197	30.45	0.134	242	1.120
Overall mean	27613	31.31	0.021	246	2.230

BW120: Live weight of lamb at day 120, BWG120: Daily live weight gains of lambs between birth and 120 days of age; SE: Standard error of the mean; a, b, c, d, e: The observed differences between the mean denoted by different letters in the same column are significant (P<0.01); NS: Nonsignificant

Table 4. Livability of Akkaraman lambs at 120-days postpartum (SR120) and some reproductive traits

Factor	Livability					Reproductive traits	
	NB (n)	NB120 (n)	SR120 (%)	X2 Value	P	LSB (n)	LSW (n)
Birth year				982.3	0.000		
2018	5228	5051	96.61			1.04	1.01
2019	6420	5754	89.62			1.08	0.97
2020	5881	4894	83.21			1.05	0.88
2021	5971	5632	94.32			1.03	0.97
2022	6551	6282	95.89			1.10	0.95
Ewe's age				322.2	0.000		
2	4332	3750	86.56				
3	4519	4236	93.73				
4	3688	3401	92.21				
5	6811	6494	95.34				
6	5428	4990	91.93				
7 and more	5273	4742	89.92				
Gender				48.4	0.000		
Male	14759	13397	90.77				
Female	15292	14216	92.96				
Birth type				7.2	0.007		
Single	26527	24416	92.04				
Twin	3524	3197	90.72				
Overall mean	30051	27613	91.88			1.06	0.95

NB: The number of live-born lambs, NB120: The number of lambs that survived to 120 days of age; SR120: The livability of lambs at 120 days of age; LSB: Litter size at birth; LSW: Litter size at weaning

The birth weight of single-born lambs was higher than that of twin lambs. A previous study reported that the birth weight of lambs in multiple births is lower than in single-born lambs due to the finite capacity of the uterine space of sheep giving birth to multiples and the limited nutrition of the lambs during the gestation period (single-born lambs have no competition for nutrition) (Bancheva et al., 2022).

Although the effect of the age factor decreases until 8 ages, some researchers reported that the birth weight of older sheep was higher than that of two-year-old sheep. Previous studies attribute this to the fact that older ewes can transfer their energy to productivity as they have completed their development and produce heavier lambs. In addition, many researchers report that with increasing age, the weight of the placenta, uterus, and the amount of nutrients transferred from the mother to the lamb cause an increase in lamb birth weight (Babar et al., 2004; Wu et al., 2006; Jawasreh et al., 2009; Bancheva et al., 2022). In this study, lowest birth weight was detected in born lambs from 6-year-old ewes (4.00 kg). The differences observed in Akkaraman lambs in birth weight in 2-year-old (4.14 kg), 3-year-old (4.15 kg), and 7-year and more (4.16 kg) lambs were insignificant (Table 2).

Various studies report that lamb birth weight is affected by the following factors: genetic factors (heterosis effect and breed) (Bancheva et al., 2022), non-genetic factors (production year (Kleemann et al., 1990; Mellado et al., 2016; Sudan et al., 2018; Sveinbjörnsson et al., 2021), lamb birth type (Sudan et al., 2018; Bancheva et al., 2022), weight and body condition of ewes (Kleemann et al. 1990; Bancheva et al., 2022), lamb gender (Mellado et al., 2016; Sudan et al., 2018; Bancheva et al., 2022), litter size (Hinch et al., 1985; Kleemann et al., 1990; Mellado et al., 2016) weight of ewes at pairing (Hinch et al., 1985), inbreeding (Alsheikh, 2005), Ewes' feeding (Bancheva et al., 2022), herd (Baneh and Hafezian, 2009), season of lambing (Mellado et al., 2016). Similar to many studies in Akkaraman sheep, this study found that environmental factors such as ewe's age (Aktaş et al., 2014; Noyan and Ceyhan, 2021; Aksoy et al., 2023), birth type (Aktaş and Doğan, 2014; Aktaş et al., 2014; Ceyhan et al., 2019; Sakar and Erişek, 2019; Noyan and Ceyhan, 2021; Sakar and Ünal, 2021; Aksoy et al., 2023; Tüfekci, 2023), and birth year (Ceyhan et al., 2019; Behrem, 2021; Noyan and Ceyhan, 2021; Aksoy et al., 2023; Tüfekci, 2023) significantly affected birth weight in Akkaraman lambs.

The direct effect of lamb birth weight on lamb survival has been reported in previous studies. Therefore, researchers have announced that the ideal birth weight of lambs is between 3.5 and 6.0 kg, but for maximum lamb survival, it should be approximately 4.50 kg (Oldham et al., 2011).

The birth weight value determined by this study for Akkaraman lambs (4.14 kg) was lower than the values found by Çolakoğlu and Özbeyaz (1999), Kucuk and Eyduran (2009), Yakan et al. (2012), Ceyhan et al. (2019), and Aksoy et al. (2023) (4.23-4.91 kg). Akkaraman birth weight values documented by the previous studies were as follows: Özbey and Akcan (2000b) 3.57 kg, Tüfekci (2023) 3.71 kg, Esen and Yıldız (2000b) 3.73 kg, Özmen et al. (2015) 3.74 kg, Yıldız and Denk (2006b) 3.81 kg. The birth weight value of Akkaraman lambs in this study was compatible with the reports of Aktaş and Doğan (2014) and Behrem (2021). Past studies conducted on the Akkaraman male and female lambs in Nigde province found birth weight values as 4.44 and 4.28 kg (Aksoy et al., 2023); 4.32 and 4.14 kg (Ceyhan et al., 2019); 4.10 and 4.04 kg (Noyan and Ceyhan, 2021), respectively. Besides, the birth weight in singleton and twin lambs were 4.51 and 3.82 kg (Aksoy et al., 2023), 4.44 and 4.02 kg (Ceyhan et al., 2019), 4.26 and 3.11 kg (Noyan and Ceyhan, 2021), respectively. In this study, the birth weight determined for male and singleton lambs (4.17 and 4.28 kg, respectively) was higher than the value reported by Noyan and Ceyhan (2021) and lower than the value reported by Ceyhan et al. (2019) and Aksoy et al. (2023). The birth weight value determined by this study in Akkaraman twin lambs in Nigde province was similar to the value stated by Noyan and Ceyhan (2021).

The differences observed between the results of this research and previous studies in terms of birth weight in Akkaraman sheep may be due to the ram effect, pasture vegetation status of the growing region, climatic conditions, sheep's genetic capacity and breeding system, and the herds' regeneration level.

Body weights of lambs at 60 days

The BW60 value determined for Akkaraman lambs in the study was higher than the value reported Esen and Yıldız (2020b), Türkmen and Çak (2021), Aksoy et al. (2023), and Tüfekci (2023) (12.84-18.43 kg), similar to the value announced by Akçapınar et al. (2000) (18.51 kg), and lower than the value documented by Sakar and Erişek (2019) (22.11 kg). In the study, the effects of lamb gender, ewe's age, birth year, and type on BW60 were significant. This finding was consistent with the reports of Aksoy et al. (2023). In an earlier study conducted under breeder conditions in Yozgat, similar to the research findings, the effect of birth year on BW60 was significant; however, the effects of birth type and gender were insignificant (Tüfekci, 2023). In another study conducted under breeder conditions in Çankırı province, the impact of gender on BW60 in Akkaraman lambs was negligible, but the birth type was significant (Sakar and Erişek (2019). In their study on Akkaraman sheep in Van, Türkmen and Çak (2021) found the differences as influential in male and female lambs and singleton and twin lambs in terms of BW60. On the BW60 of Akkaraman lambs bred in Konya, Aktaş and Doğan (2014) reported a significant effect of lamb birth type and gender and an insignificant impact of the ewe's age.

Body weights of lambs at 120 days

In this research, the BW120 value detected in the male (31.69 kg) and singleton (31.43 kg) Akkaraman lambs was similar to the value reported by Özmen et al. (2015). The BW120 value reported by Özmen et al. (2015) (30.76 kg) for Akkaraman lambs under Elazığ conditions was lower than the value found in this study. In the study conducted in Konya, the values reported by Aktaş et al. (2014) for Akkaraman ewes and twin lambs are compatible with the findings of this study. The value reported by the same researcher for male and twin lambs was higher than our

research findings. The BW120 value reported by Yakan et al. (2012) for Akkaraman lambs (30.38 kg) was similar to the value found in this study in twin lambs (30.45 kg). In this study, the BW120 value was lower than the value reported by Sakar and Erişek (2019) and Aksoy et al. (2023) (34.95 and 32.62 kg, respectively). The BW120 value reported by Tüfekci (2023) (31.08 kg) for Akkaraman lambs in Yozgat breeder conditions was similar to the effect of lamb gender, year of birth, and ewe's age on BW120 as significant. This result is compatible with Aktaş et al. (2014) and Aksoy et al. (2023) for Akkaraman lambs. Unlike the research findings, Sakar and Erişek (2019) and Tüfekci (2023) reported that the effect of gender and birth type on BW120 in Akkaraman lambs was negligible.

Live weight gain at 120 days

Aktaş et al. (2014) determined BWG120 in Akkaraman lambs as 218 and 244 g day^{-1} lamb^{-1} in female and male lambs and 220 and 241 g day^{-1} lamb^{-1} (LSM = 231 g day^{-1} lamb^{-1}) in twin and single-born lambs. Aksoy et al. (2023) reported BWG120 in Akkaraman lambs in Nigde as 255 and 275 g day^{-1} lamb^{-1} in female and male lambs and 253 and 268 (LSM = 264 g day^{-1} lamb^{-1}) in twin and singleton lambs. In this study, the BWG120 value detected in Akkaraman male and female and singleton and twin lambs was higher than that reported by Aktaş et al. (2014) and lower than that reported by Aksoy et al. (2023). A study conducted in Çankırı determined the daily weight gain in Akkaraman lambs from birth to the 90th day and from birth to the 120th day as 287 and 255 g day^{-1} lamb^{-1}, respectively (Sakar and Erişek, 2019). Ceyhan et al. (2019) reported daily live weight gains between birth and 90 days in Akkaraman lambs as 208 g day^{-1} lamb^{-1}; Türkmen and Çak (2021) reported 171 and 170 g day^{-1} lamb^{-1} in male and female lambs, respectively; Noyan and Ceyhan (2021) found it to be 225 and 222 g day^{-1} lamb $^{-1}$ (LSM = 222 g day^{-1} lamb^{-1}) in singletons and twins, respectively, and Odabaşıoğlu et al. (1996) found it to be 226 g day^{-1} lamb^{-1}. In this study, the BWG120 value detected in Akkaraman lambs was lower than the value reported by Sakar and Erişek (2019) at the same age.

Similar to the research findings, Aksoy et al. (2023) reported that the effect of ewe's age, birth type, and year on BWG120 was significant in Akkaraman lambs. The study by Aktaş et al. (2014) on Akkaraman sheep in Konya revealed similar results to this research on the powerful effect of birth year and lamb birth type on BWG120. Unlike the research findings, Sakar and Erişek (2019) reported that the BWG120 in Akkaraman, singleton and twin lambs were similar.

Livability of lambs

Lamb livability has an impact on farm profitability through changes in the number of lambs that are retained after weaning. (Ünal et al., 2006; Aktaş and Doğan, 2014). In this study, the lowest survival rate was in the lambs born from 2-year-old mothers (86.56%). Similar to this research finding, Aktaş and Doğan (2014) found the lowest SR120 value in Akkaraman lambs born from 2-year-old ewes (87.00%). This situation can reveal the low maternal abilities of 2-year-old mothers, low milk yield, and hypothermia occurring in lambs due to low lamb birth weight. The current study has found SR120 as 91.88%. Özmen et al. (2015) determined the SR120 value in Akkaraman lambs in Elazığ as 87.83 and 92.36% in male and female lambs and 90.82 and 92.59% (mean = 90.06%) in singleton and twin lambs. This study found the SR120 value determined in Akkaraman male and singleton lambs to be higher than the value reported by Özmen et al. (2015) for the same breed. In their study conducted on Akkaraman lambs in Nigde, Aksoy et al. (2023) announced that females (93.93%) and singletons (93.75%) had higher SR120 survival rates than males and (93.27%) and twins (93.10%) (mean = 93.60%). In the current study, similar to the report of Aksoy et al. (2023), SR120 in Akkaraman lambs was higher in female lambs than in male lambs. Aktaş et al. (2014) found an average of 91.40% of SR120 in Akkaraman sheep raised under breeding conditions in Konya in 2007 (88.30%), 2008 (89.00%), 2009 (94.50%) and 2010 (93.70%). In the study conducted in the same province, Aktaş and Doğan (2014) reported that SR120 in lambs born from 2, 3, 4, 5, and 6+ year-old sheep varied between 87.00-90.60% (mean = 88.80%). This research revealed that the SR120 value in Akkaraman lambs was compatible with the value reported by Aktaş et al. (2014) and higher than that reported by Aktaş and Doğan (2014). Çolakoğlu and Özbeyaz (1999) determined the survival rate of Akkaraman sheep on the 105th day (at weaning) as 97.67%, 96.05%, 97.06% and 96.50% in 1992, 1993, 1994, and 1995, respectively. Again, the 90th-day survival rate in Akkaraman lambs was determined as 89.52% by Akçapınar et al. (2000), 95.92% by Türkmen and Çak (2021), and 91.02% by Ünal et al. (2006). This research found the SR120 value for Akkaraman lambs to be lower than the value reported by Türkmen and Çak (2021). This difference can be explained by the higher age of the lamb in the study.

Some Reproductive Traits of Ewes

The litter size and the number of lambs reaching marketing age measure sheep productivity. In the study, while the LSB varied between 1.03-1.10 (mean = 1.06), the LSW was between 0.88-1.01 (mean = 0.95). A study conducted in Nigde found that the LSB was 1.13, and the LSW was 1.05 (Aksoy et al., 2023). In the study, both fertility traits were lower than the value reported by Aksoy et al. (2023). The current study found the number of Akkaraman lambs per birthing ewe lower (1.12-1.39) than many studies conducted on the same breed in the past (Akçapınar et al., 2000; Özbey and Akçan, 2000a; Yakan et al., 2012; Büyüktekin and Öztürk, 2018; Ceyhan et al., 2019). Although the number of Akkaraman lambs per birthing ewe determined in the study was similar to the value reported by Esen and Bozkurt (2001) (1.06), it was higher than the values reported by Türkmen and Çak (2021) (1.03) and Yıldız and Denk (2006a) (1-1.02) for Akkaraman sheep raised in Van.

In conclusion, in this study, the growth characteristics, survival and litter size of Akkaraman ewes raised in Bor district of Nigde were analysed , within the scope of the National Sheep and Goat Breeding Project. This research found the highest BW60 and BW120 in male and single lambs born to 4-year-old ewes in 2021. The birth weight, one of the growth characteristics considered in the study, was lower or higher than the value reported by many

previous researchers. This research found the birth weight slightly lower than in two studies but higher than in one study conducted within the scope of the same project in Nigde. This research found that BW60 and BW120 among the growth characteristics of lambs were similar or higher than most studies. In the study, among the factors whose effects were examined on the growth performance of Akkaraman lambs, only the impacts of gender on BWG120 and birth type on BW120 were insignificant. It could be concluded that adequate care, nutrition and routine health and protection measures during the gestation and calving season in Akkaraman ewes could improve the yield traits examined in the study within the next five years in Nigde.

We foresee that adequate care, nutrition and routine health and protection measures during the gestation and parturition season in Akkaraman ewes can improve the productivity traits examined in the study over the next five years in Nigde.

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