Turkish Journal of Veterinary and Animal Sciences

http://journals.tubitak.gov.tr/veterinary/

Research Article

Turk J Vet Anim Sci
(2022) 46: 755-763
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doi:10.55730/1300-0128.4250

Evaluation of genotype and nongenetic effects on some production traits: Comparison of Akkaraman and Bafra × Akkaraman B_1 sheep genotypes

Ömer Faruk GÜNGÖR[1,*], Ceyhan ÖZBEYAZ[2], Necmettin ÜNAL[2], Hilal ÇAPAR AKYÜZ[2], Rabia ARSLAN[3], Halil AKÇAPINAR[2]

[1]Department of Veterinary, Vocational School, Bolu Abant İzzet Baysal University, Bolu Turkey
[2]Department of Animal Breeding and Husbandry, Ankara University Faculty of Veterinary Medicine, Ankara, Turkey
[3]Graduate School of Health Sciences, Ankara University, Ankara, Turkey

Received: 16.05.2022 • **Accepted/Published Online:** 11.10.2022 • **Final Version:** 18.10.2022

Abstract: The purposes of this study were to evaluate genotype and some environmental effects on the reproductive and milk yield traits of sheep, and vitality and growth traits of lambs, and to compare the difference between Akkaraman (AKK) and Bafra × AKK B_1 (BA B_1: Bafra sires crossed BA F_1 ewes) genotypes in terms of these characters. Data were collected from 71 ewes for fertility traits and 37 ewes for milk yields in each genotype. Growth traits and survival rates of lambs were evaluated using 55 AKK and 56 BA B_1 lambs. AKK and BA B_1 ewes had 87.32% and 92.96% for lambing rate ($p > 0.05$), 125.35% and 161.97% for lamb production ($p = 0.005$), 1.45 and 1.74 for litter size ($p = 0.072$), respectively. Lactation milk yields and lactation lengths of those were determined as 109.46 ± 6.61 and 124.55 ± 7.26 kg ($p > 0.05$), and 155.76 ± 2.36 and 161.51 ± 2.43 days ($p > 0.05$), respectively. The survival rates and body weights of their lambs at weaning (90th day) were 87.27% and 87.50% ($p > 0.05$), and 27.77 ± 0.59 and 21.97 ± 0.59 kg ($p = 0.000$), respectively. In conclusion, the age of the dam affected the reproductive and milk yield traits, birth type affected the growth, and sex affected the survival rate and growth traits. Regarding the genotype effect, the BA B_1 genotype had better reproductive and lactation milk yield, lower growth performance than those of the AKK genotype, and a similar survival rate to the AKK genotype.

Key words: Crossbreeding, milk production, reproductive traits, survival rate, growth

1. Introduction

Many environmental factors, including the age of dam, lactation number, sex, and birth type, etc., affect the various production traits such as milk yield, reproductive traits, vitality, and growth. Identification of these effects and taking into account these effects in animal husbandry and breeding programs are important [1].

Milk is an important component of the human diet [2]. Milk production from sheep, however, accounts for little of the total volume of milk produced because sheep breeds for milk production are more prevalent in Asia, the Mediterranean, and Balkan countries than in others, and so this ratio can reach 90% only in these regions [3–5]. In addition, milk production traits of ewes are important for the vitality and growth of lambs [6]. Therefore, the milk yields of sheep reared on the farms affect farms' profitability at a high level. High milk yield is achieved by environmental and genetic developments. To improve the genetic merits of animals, there were two ways. The first of them is pure breeding and the second is crossbreeding. Pure breeding is a long and complicated process for more than one genetic trait. In addition, the success rate is poor for low heritability traits, so the second method is frequently chosen way for genetic improvement in the short term.

AKK genotype having good livability and growth traits is the most reared sheep breed in Turkey [7,8]. The litter size and milk yield of AKK sheep, however, do not have a desirable level. Bafra having sufficient milk yield and high litter size is a native breed of Turkey. The min-max values of lactation milk yield and litter size reported for AKK ewes are 43.1–99.6 kg [9,10] and 1.0–1.36 [11,12], and these values were reported for Bafra ewes are 126.4–154.8 kg [5,9] and 1.42–1.78 [13,14], respectively. Bafra × AKK crossbreeding studies have been started in 2012 and up-and-coming results have been obtained. Lactation milk yield and litter size of Bafra × AKK F_1 genotypes were 112.5 kg and 1.89 [9,15].

BA B_1, obtained by crossbreeding between Bafra and AKK sheep breeds, was developed to use both pure breeding and commercial crossbreeding. The aim of the present study is to evaluate genotype and nongenetic

* Correspondence: gungorvet@gmail.com

effects on some production traits and to compare the fertility and milk yield of AKK and BA B_1 ewes, and the growth and livability traits of their lambs.

2. Materials and methods

The research protocol of the study was approved by Ankara University Animal Experiments Local Ethics Committee (file no. 2018-34, decision no. 2018-4-36). The study was carried out at Gözlü State Farm (Sarayönü district, Konya), which belongs to the General Directorate of Agricultural Enterprises, between 2018–2019 years. The farm has a steppe climate condition and locates at 38°29'N and 32°27'E, 1020 m of altitude. The animal materials were AKK and BA B_1 sheep, and their lambs were reared on this farm.

2.1. Animals

In this study, 71 sheep for reproductive traits and 37 sheep for milk yield traits were used from each AKK and BA B_1 genotypes. To evaluate the growth and survival characteristics of the lambs, 55 AKK and 56 BA B_1 lambs were followed up to the 120^{th} day.

Concentrated and roughage (alfalfa, wheat, and barley straw) feed produced in the Gözlü state farm were used for animal feeding. The same routine management and feeding program of Gözlü state farm were provided to all ewes and lambs. The ewes were offered 800 g concentrate feed (16 % CP and 2600 kcal/kg ME) in the last 6 weeks of gestation and continued until the rangeland period. This period started about 1 month later after lambing. Lambs suckled the dams every night, but lambs were kept indoors in the daytime. This time lambs had free access to good-quality hay and concentrate feed (2800 kcal/kg ME and 18% CP). However, 300 g/day concentrate feed per lamb (2500 kcal/kg ME and 16 % CP) was started within the rangeland period.

2.2. Reproductive traits

AKK × AKK and BA B_1 × BA B_1 mating were done between September 18^{th} and November 2^{nd}, 2018. The lambing period took place between 10^{th} February and 20^{th} March 2019. The numbers of the ewes exposed to ram and giving birth, and the number of the lambs born alive were determined for reproductive traits. Using these data, birth rate (the number of the ewes lambing/the number of ewes exposed ram), lamb production rate (the number of the lambs born alive/the number of the ewes exposed ram), and litter size (the number of the lambs born alive/the number of the ewes lambing) were calculated.

2.3. Milk yields traits

The ewes used to the determination of the milk yield performance were randomly selected among the ewes having similar birth types and similar beginning dates of lactation. Milk yield controls were started on the 20^{th} day after birth and repeated monthly until the milk yield fell below 100 g/day. Milking was done at 8 am and 6 pm. One day before the control days, the lambs were separated from their mothers around 8 pm and they stayed apart until the evening milking on the control day. Milking was done by machine (Most brand) (40 kPa, pulsation number 120, and pulsation ratio 60:40). Daily milk yields of ewes were calculated by the sum of morning and evening milk yields. Daily milk yields of 30, 60, 90, 120, and 150^{th} days were calculated by interpolation and extrapolation methods from milk yield records. Lactation milk yields of ewes were calculated according to the Trapeze II Method (Ünal et al., 2008) recommended by the International Committee for Animal Recording (ICAR) from these calculated data.

2.4. Survival rates and growth traits of lambs

The lambs were kept with the dam in an individual pen for 1–2 days after birth. During this time, iodine treatment of navel, injection of Vitamin E–Selenium, and ear tags were applied. The lambs' body weights have been taken at birth (10–18 h after birth) and 15 days after birth weighing sensitive to 5 g. Live weights (weighing sensitive to 50 g) and lamb mortalities were taken at 30-day intervals after birth until the 120^{th} day. Body weights of lambs at the age of 30, 60, 90, and 120^{th} days were calculated by interpolation and extrapolation method from these records. The survival rate of lambs at 30, 60, 90, and 120^{th} days (the number of live born lambs/the number of live lambs at the investigated day *100) was calculated based on live born lambs.

2.5. Statistical analysis

The statistical analysis of the data was done by the SPSS package program (SPSS 14.0 license number: 9869264). The differences in reproductive traits and survival rates were analyzed with the chi-square test. Pairwise comparison of the ewes' age and genotype groups for milk yield traits were done with t-test. The differences in growth traits were tested with the Least Squares Means Method. The math models were as follows:

$$y_{ijklm} = \mu + anim_i + Gj + AD_k + GN_l + BT_m + G_j xAD_k + Gj xGN_l + Gj xBT_m + AD_k xGN_l + AD_k xBT_m + GN_l xBT_m + Gj xAD_k xGN_l + Gj xAD_k xBT_m + AD_k xGN_l xBT_m + Gj xAD_k xGN_l xBT_m + e_{ijklm}$$

The y_{ijk} refers to each growth trait, μ the overall mean, $anim_i$ the random effect of the i^{th} animal, Gj the fixed effect of the j^{th} genoype (AKK and BA B_1), AD_k the fixed effect of the k^{th} age of dam (2 and 3), GN_l the fixed effect of the l^{th} sex (female and male), BT_m the fixed effect of the m^{th} birth type (twin and single) and e_{ijklm} the residual component of the model. A covariance matrix for the random effect of animals was assumed as a simple variance components structure and estimated using the restricted maximum likelihood method.

3. Results

3.1. Reproductive traits

Some reproductive traits of ewes according to the genotype and age of ewe were presented in Table 1. The effect of genotype (p = 0.005) and ewe's age (p = 0.028 and p = 0.059) on the lamb production rate was significant.

3.2. Milk yields traits

Mean daily milk yields of AKK and BA B_1 sheep on 15, 30, 60, 90, 120, and 150th days of lactation, and the entire lactation period are presented in Table 2. The effect of genotype on daily milk yield was significant on the 90th (p = 0.015) and 120th (p = 0.007) days. Daily milk yield differences between 1st and 2nd lactation of AKK ewes have been insignificant, but these differences have been significant in BA B_1 ewes at different levels (p = 0.045, p = 0.002, p = 0.000, and p = 0.053) except 15th day.

Additive partial milk yields on the different days of lactation according to the genotype and lactation number are given in Table 3. Differences between the 1st and 2nd lactation in terms of the additive partial milk yields on days 60, 90, 120, and 150th have been significant (p = 0.048, p = 0.010, p = 0.003 and p = 0.002) within the BA B_1 genotype.

Lactation milk yields and lengths according to the genotype and lactation number are presented in Table 4. The effect of lactation number on the lactation milk yield within the BA B_1 genotype has been significant (p = 0.001), and so lactation milk yields of ewes being 1st were lower than those of 2nd lactation. In addition, the difference between lactation lengths of genotypes has been close to the significance level (p = 0.094).

3.3. Survival rates and growth traits of lambs

The survival rates of the lambs according to the genotype, age of ewes, sex, and birth types are given in Table 5. The sex effect on the survival rates of the lambs has been significant (p = 0.040).

The growth traits of the lambs at birth, 30, 60, 90, and 120th days are given in Table 6. The effect of genotype, sex, and birth type on growth investigated time points has been determined significant at the different levels.

4. Discussion

Sheep breeding can be done in many parts of the world, but it has special importance for some regions that have arid or semiarid climate conditions and wide grazing lands because it is the most profitable livestock branch for these areas. Sheep mostly feed on rangeland. It has a special place to evaluate the plants on the stubbles, and along the edges of the garden and cropland. Sheep are resistant to harsh environmental conditions and have easy to manage, low cost, and highly profitable in terms of production [1].

When Turkey is evaluated in terms of the geographical, climatic, and socio-economic conditions it is understood that sheep breeding has an important role to increase meat and milk production. Genotypes suitable for both pure breeding and crossbreeding should be developed, and these genotypes should be convenient for the regional conditions. Bafra × AKK crossbreeding has been started for this purpose. Determination of reproductive, milk yield, growth, and survival characteristics of the new genotype and comparison of these with the AKK is important for the evaluation of crossbreeding.

4.1. Reproductive traits

Birth rates of AKK and BA B_1 ewes were similar, but BA B_1 ewes had higher lamb production rate and litter size values than AKK ewes. This result indicates that the Bafra, a prolific breed, positively affects the reproductive traits in the crossbreeding study.

If the effects of ewes' age on the birth rate, lamb production rate, and litter size are evaluated, it is understood that the reproductive traits and the age of the ewe increase together in both genotypes. The improvement of reproductive performance with increasing age is consistent with literature reports [16,17].

The birth rate of AKK ewes in this study (87.32%) was consistent with many studies' results (90.30%, 88.10%,

Table 1. Reproductive traits according to the genotypes and age of ewes.

	AKK			BA B_1			Genotype		
Age of ewes (years)	2	3	p	2	3	p	AKK	BA B_1	p
Ewes exposed to ram	51	20		51	20		71	71	
Ewes giving birth	44	18		47	19		62	66	
Lambing rate %	86.27	90.00	0.671	92.16	95.00	0.674	87.32	92.96	0.260
Number of lambs	59	30		75	40		89	115	
Lamb production %	115.69	150.00	**0.028**	147.06	200.00	**0.059**	125.35	161.97	**0.005**
Litter size	1.34	1.67	0.157	1.60	2.11	0.117	1.45	1.74	0.072

AKK: Akkaraman; BA B_1: The backcrossing of the BA (Bafra × AKK) F_1 dams to the Bafra sire line.

Table 2. Means (± SEM) of daily milk yields (g) according to the genotype and lactation number.

Control days of lactation		15	30	60	90	120	150	Entire lactation period
AKK	p	0.682	0.931	0.554	0.351	0.186	0.523	0.822
1st lactation (n: 24)	$\bar{x} \pm S_{\bar{x}}$	816.88 ± 90.28	1034.58 ± 91.27	947.92 ± 71.40	645.42 ± 50.84	336.67 ± 34.40	169.00 ± 8.62	693.94 ± 55.58
	Min	200	350	280	160	50	120	229
	Max	2050	2400	1780	1240	700	200	1347
	CV %	54.14	43.22	36.90	38.59	50.05	16.13	39.24
2nd lactation (n: 13)	$\bar{x} \pm S_{\bar{x}}$	876.54 ± 102.83	1046.92 ± 91.82	1013.85 ± 70.63	723.08 ± 60.19	415.38 ± 47.40	149.17 ± 28.98	713.40 ± 54.91
	Min	305	460	550	380	50	20	405
	Max	1660	1710	1380	1020	660	320	1126
	CV %	42.30	31.62	25.12	30.01	41.15	67.31	27.75
BA B_1	p	0.144	**0.045**	**0.002**	**0.000**	**0.000**	**0.053**	**0.004**
1st lactation (n: 20)	$\bar{x} \pm S_{\bar{x}}$	741.00 ± 85.44	923.50 ± 79.27	941.50 ± 60.84	662.50 ± 42.61	371.00 ± 28.70	160.83 ± 8.74	659.58 ± 49.25
	Min	255	420	615	430	140	120	386
	Max	1800	1900	1500	1060	600	200	1252
	CV %	51.56	38.39	28.90	28.76	34.59	18.83	33.39
2nd lactation (n: 17)	$\bar{x} \pm S_{\bar{x}}$	939.97 ± 103.60	1195.59 ± 106.98	1316.47 ± 94.69	1013.53 ± 61.54	640.00 ± 56.06	249.29 ± 40.89	907.31 ± 63.57
	Min	180	330	610	630	350	30	416
	Max	1940	2080	2280	1580	1200	600	1378
	CV %	45.44	36.89	29.66	25.04	36.12	61.37	28.89
Genotypes	p	0.955	0.920	**0.083**	**0.015**	**0.007**	**0.098**	0.229
AKK (n: 37)	$\bar{x} \pm S_{\bar{x}}$	837.84 ± 68.11	1038.92 ± 66.64	971.08 ± 52.20	672.70 ± 39.16	364.32 ± 28.16	158.18 ± 16.10	700.77 ± 40.45
	Min	200	350	280	160	50	20	229
	Max	2050	2400	1780	1240	700	320	1347
	CV %	49.45	39.01	32.70	35.41	47.01	47.73	35.11
BA B_1 (n: 37)	$\bar{x} \pm S_{\bar{x}}$	832.42 ± 67.43	1048.51 ± 68.12	1113.78 ± 62.10	823.78 ± 46.27	494.59 ± 37.09	208.46 ± 23.69	773.40 ± 44.05
	Min	180	330	610	430	140	30	386
	Max	1940	2080	2280	1580	1200	600	1378
	CV %	49.28	39.52	33.92	34.17	45.62	57.96	34.65

AKK: Akkaraman; BA B_1: The backcrossing of the BA (Bafra × AKK) F_1 dams to the Bafra sire line; CV: Coefficient of variation; $S_{\bar{x}}$: SEM (Standard error of the means)

Table 3. Means (± SEM) of additive partial milk yields (kg) according to the genotypes and lactation numbers.

Lactation days		**30**	**60**	**90**	**120**	**150**
AKK	p	0.759	0.769	0.666	0.578	0.570
1st lactation (n: 24)	$\bar{x} \pm S_{\bar{x}}$	27.88 ± 3.07	58.89 ± 5.25	82.79 ± 6.93	97.68 ± 8.04	104.99 ± 8.71
	Min	7.13	20.10	26.70	29.98	30.50
	Max	70.12	126.86	172.16	201.39	214.7
	CV %	0.54	0.44	0.41	0.40	0.41
2nd lactation (n: 13)	$\bar{x} \pm S_{\bar{x}}$	29.46 ± 3.96	61.34 ± 5.65	87.50 ± 7.15	104.74 ± 8.37	112.83 ± 9.22
	Min	10.31	32.76	50.46	59.52	62.96
	Max	64.40	110.75	146.75	172.12	186.65
	CV %	0.48	0.33	0.29	0.29	0.29
BA B_1	p	0.162	**0.048**	**0.010**	**0.003**	**0.002**
1st lactation (n: 20)	$\bar{x} \pm S_{\bar{x}}$	24.97 ± 0.15	54.25 ± 4.94	78.31 ± 6.25	93.97 ± 7.10	102.07 ± 7.54
	Min	9.19	25.73	41.93	50.99	53.98
	Max	62.93	113.3	150.23	172.88	187.73
	CV %	0.56	0.41	0.36	0.34	0.33
2nd lactation (n: 17)	$\bar{x} \pm S_{\bar{x}}$	31.58 ± 3.39	70.34 ± 6.24	105.62 ± 8.12	130.58 ± 9.44	143.79 ± 10.24
	Min	6.53	20.63	41.42	58.40	68.27
	Max	59.25	117.53	163.38	196.08	215.33
	CV %	0.44	0.37	0.32	0.30	0.29
Genotypes	p	0.898	0.739	0.394	0.230	0.163
AKK (n: 37)	$\bar{x} \pm S_{\bar{x}}$	28.43 ± 2.40	59.75 ± 3.90	84.45 ± 5.10	100.16 ± 5.95	107.75 ± 6.47
	Min	7.13	20.10	26.70	29.98	30.50
	Max	70.12	126.83	172.13	201.39	214.73
	CV %	0.51	0.40	0.37	0.36	0.36
BA B_1 (n: 37)	$\bar{x} \pm S_{\bar{x}}$	28.00 ± 2.34	61.64 ± 4.09	90.86 ± 5.46	110.79 ± 6.47	121.24 ± 7.05
	Min	6.53	20.63	41.42	50.92	53.98
	Max	62.93	117.53	163.38	196.08	215.33
	CV %	0.51	0.40	0.37	0.36	0.35

AKK: Akkaraman; BA B_1: The backcrossing of the BA (Bafra × AKK) F_1 dams to the Bafra sire line; CV: Coefficient of variation; $S_{\bar{x}}$: SEM (Standard error of the means).

and 85.71%) conducted with AKK [11,18,19]. Lamb production rate of AKK ewes (125.35%) in this study was about similar to the results of some studies conducted with AKK (123.25% and 119.10%) [11,18], but it was higher than the results of some studies conducted with AKK (112.72%, 93.87%, and 82.71%) [12,20,21]. The litter size result of AKK (1.45) was higher than the results of many studies (1.27, 1.20, 1.12, and 1.01) [12,15,20,21] conducted on the same breed. It can be said that Gözlü AKK sheep are at a good level among the local breeds in terms of litter size.

The lambing rate (92.16%), lamb production rate (161.97%), and litter size (1.74) values obtained from BA B_1 ewes were generally similar to the reported lambing rate (91.40%, 93.70%, and 93.10%), lamb production rate (152.64%, 167.20%, and 155.60%), and litter size (1.52, 1.78, and 1.67) values obtained from Bafra ewes [14,16,22].

The reproductive results obtained from BA B_1 ewes were compared with the results obtained from BA F_1 ewes, BA B_1 ewes had a higher lambing rate (92.16% vs. 64.91%) and lamb production rate (161.97% vs. 121.81%), and lower litter size (1.74 vs. 1.89) [15].

4.2. Milk yield traits

Daily milk yield of BA B_1 ewes (832.42, 1048.51, 1113.78, 823.78, 494.59, 208.46, and 773.40 g) at the different days of lactation (15, 30, 60, 90, 120, 150th days) and entire lactation

Table 4. Means (± SEM) of lactation milk yields (kg) and lengths (day).

Items	AKK				BA B_1				
	n	$\bar{x} \pm S_{\bar{x}}$	Min	Max	n	$\bar{x} \pm S_{\bar{x}}$	Min	Max	p
Lactation milk yields (kg)	p	0.508			p	**0.001**			
1st lactation	24	106.18 ± 8.79	30.50	216.92	20	104.08 ± 7.49	53.98	104.08	
2nd lactation	13	115.50 ± 9.74	63.20	193.69	17	148.64 ± 10.63	74.86	148.64	
Means	37	109.46 ± 6.61	30.50	216.92	37	124.55 ± 7.26	53.98	148.64	0.129
Lactation lengths (day)	p	0.063			p	0.249			
1st lactation	24	152.54 ± 2.83	129	175	20	158.90 ± 3.47	135	180	
2nd lactation	13	161.69 ± 3.83	125	180	17	164.59 ± 3.31	142	180	
Means	37	155.76 ± 2.36	125	180	37	161.51 ± 2.43	135	180	0.094

AKK: Akkaraman; BA B_1: The backcrossing of the BA (Bafra × AKK) F_1 dams to the Bafra sire line; $S_{\bar{x}}$ SEM (Standard error of the means).

Table 5. Survival rates of lambs (%).

	The number of live lambs (control days)						Survival rate % (control days)			
Items	Birth	30	60	90	120		30	60	90	120
Genotype						p	0.563	0.794	0.971	0.810
AKK	55	50	49	48	48		90.91	89.09	87.27	87.27
BA B_1	56	49	49	49	48		87.50	87.50	87.50	85.71
Age of dam						p	0.563	0.794	0.59	0.810
2 years	56	49	49	48	48		87.50	87.50	85.71	85.71
3 years	55	50	49	49	48		90.91	89.09	89.09	87.27
Sex						p	0.235	0.136	0.075	**0.040**
Female	64	59	59	59	59		92.19	92.19	92.19	92.19
Male	47	40	39	38	37		85.11	82.98	80.85	78.72
Birth type						p	0.513	0.424	0.787	0.675
Twin	84	74	73	73	72		88.10	86.90	86.90	85.71
Single	27	25	25	24	24		92.59	92.59	88.89	88.89

AKK: Akkaraman; BA B_1: The backcrossing of the BA (Bafra × AKK) F_1 dams to the Bafra sire line.

period were higher than AKK ewes (837.84, 1038.92, 971.08, 672.70, 364.32, 158.18 and 700.77 g). These findings are expected and positive results for the crossbreeding because BA B_1 genotype has ¼ AKK and ¾ Bafra genotype having higher milk yield than those of AKK genotype.

Daily milk yield of AKK and BA B_1 ewes have increased up to day 30th and 60th, respectively. However, there is a high variation in both genotypes in terms of daily milk yield because high yield variation in the native and crossbreed genotypes is expected.

Daily milk yield during the entire lactation period (700.77 g) of AKK ewes has been higher than the reported values (340, 345, 360, 282 g) for AKK sheep [10,21,23,24]. In addition, this result has been slightly higher than the result of a previous study (683 g) conducted on AKK ewes at Gözlü state farm [9].

Table 6. Means (± SEM) of lamb body weights (kg).

Items	n	Birth	30. day	60. day	90. day	120. day
Genotype	p	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
AKK	55	4.64 ± 0.14	12.92 ± 0.31	21.63 ± 0.49	27.77 ± 0.59	32.98 ± 0.73
BA B_1	56	3.87 ± 0.13	10.17 ± 0.31	17.31 ± 0.49	21.97 ± 0.59	25.45 ± 0.72
Age of dam	p	0.205	0.134	0.184	0.195	0.473
2 years	56	4.13 ± 0.10	11.21 ± 0.24	19.01 ± 0.38	24.33 ± 0.46	28.85 ± 0.56
3 years	55	4.37 ± 0.16	11.88 ± 0.37	19.93 ± 0.58	25.42 ± 0.70	29.58 ± 0.85
Sex	p	**0.064**	**0.002**	**0.002**	**0.000**	**0.000**
Female	64	4.07 ± 0.12	10.84 ± 0.27	18.35 ± 0.43	23.28 ± 0.52	27.21 ± 0.63
Male	47	4.43 ± 0.15	12.24 ± 0.34	20.59 ± 0.54	26.47 ± 0.66	31.21 ± 0.80
Birth type	p	**0.000**	**0.006**	**0.002**	**0.002**	**0.016**
Twin	84	3.87 ± 0.08	10.93 ± 0.20	18.35 ± 0.31	23.53 ± 0.37	27.96 ± 0.46
Single	27	4.64 ± 0.17	12.16 ± 0.39	20.58 ± 0.62	26.22 ± 0.75	30.47 ± 0.91

AKK: Akkaraman; BA B_1: The backcrossing of the BA (Bafra × AKK) F_1 dams to the Bafra sire line; SEM: Standard error of the means.

Daily milk yield during the entire lactation period (773.40 g) of BA B_1 genotype has been lower than the results obtained from Bafra ewes (1051 and 850 g) and has been slightly higher than the results (753 g) obtained from BA F_1 ewes [5,9]. It should be also stated that the lactation length of the BA B_1 genotype (161.51 days) has been longer than the reported lactation length for the BA F_1 genotype (133 days) [9].

Additive partial milk yields on the 60th day of the lactation period for AKK and BA B_1 genotypes have been 56% and 51%, respectively. The remaining about 50% have been obtained within the other 90 days of the lactation period. This rate has been higher for AKK ewes than those of BA B_1 ewes because AKK genotype had higher daily milk yield in the first days of the lactation period and the shorter lactation period. Lactation number had a significant effect on the additive partial milk yields for BA B_1 genotype and this result was in accordance with the daily milk yield and lactation milk yield results for the BA B_1 genotype.

If the lactation milk yields (109.46 and 124.55 kg) and lactation length (155.76 and 161.51 days) of AKK and BA B_1 ewes are evaluated, it is understood lactation milk yield and lactation length of BA B_1 ewes have been higher than those of AKK ewes. Higher lactation milk yield was an expected result due to the BA B_1 genotype consisting of the 75% Bafra genotype having better milk yield compared to AKK.

When the lactation milk yield and length (109.46 kg and 155.76 days) of AKK ewes are compared with the results of previous studies on the AKK, the lactation milk yield of this study has been higher than the results of previous studies (50, 52, 50, 57, 43, 100, and 74 kg), but the lactation length of this study has been similar to the results of previous studies (144, 148, 130, 158, 156, 133, and 147 days) [9,10,21,23,24,25]. It can be said that Gözlü AKK sheep have a satisfactory milk yield compared to other native breeds.

The lactation milk yield of BA B_1 sheep (124.55 kg) was similar to the lactation milk yield of Bafra sheep (126 kg) reared on the Gözlü state farm and higher than the milk yield of BA F_1 (1112 kg) and Chios × AKK B_1 (73 and 75 kg) genotypes [9,10,26]. The lactation length of BA B_1 sheep (161.51 days) was higher than those of BA F_1 sheep (133 days) [9] and similar to the Chios × AKK B_1 genotype (178 and 166 days) [10,26].

4.3. Survival rates and growth traits of lambs

Vitality and reproduction are important factors for lamb production and these traits can be affected by genetic and nongenetic factors. The survival rates, however, were not affected by age of ewe and birth type in this study, and this result was in agreement with some previous studies [13,17]. These positive findings could be regarding from good rearing of lambs and management of the farm. The effect of sex on survival rate has been significant on the 120th day. This finding was in agreement with Akçapınar et al.'s results [20]. The survival rates of AKK and BA B_1 have been close to each other at the weaning (90th day) and on other days. This can be considered as a good result for BA B_1 because AKK genotype has high vitality.

As expected, the growth trait of lambs was affected by sex and birth type, and these results have been in accordance with previous study results [27,28]. Body weights of BA B_1 lambs determined all time points were lower than AKK lambs. AKK is a heavier breed than Bafra, so this is to be expected. BA B_1 lambs born from BA B_1 have 21.97 kg body weight at the weaning (90th day) in this study. This result was higher than some studies' results conducted on Bafra lambs (12 and 16 kg) [16,27] and similar to some reported studies on Bafra sheep (23 and 20 kg) [14,16]. However, this finding was lower than one study's results (25.2 kg) on BA B_1 lambs born from BA F_1 ewes [15]. This difference could be due to the heterosis and maternal effect because BA B_1 lambs were born from BA B_1 ewes in this study.

5. Conclusion

The effect of ewe's age on the reproductive performance, lactation number on the milk yield traits, birth type on the growth, and sex on the survival rate and growth traits have been significant in this study. When the genotype difference is evaluated, BA B_1 genotype has had better reproductive and milk yield performance compared to AKK genotype. It has been determined that the BA B_1 genotype may have important potential for both pure breeding and commercial crossbreeding. It has also been revealed that the BA B_1 ewes can be utilized for milk yield. Moreover, Gözlü AKK sheep had better performance than the normal values of this breed. This shows that AKK has important potential for pure breeding.

Acknowledgment
Ankara University Scientific Research Projects Coordination Unit supported this project (64299502-604.01.02-E.84290).

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