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Effect of genotype and non-genetic factors on growth traits and survival rates in Turkish indigenous Hair goats and their first cross with Boer bucks

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ABSTRACT

The aim of this study was to determine the effects of genotype and non-genetic factors on the growth traits and survival rates of Turkish indigenous Hair goats (n=63) and their first crosses with Boer bucks (n=91), reared under a semi-intensive management system in the Van province of Turkey. The live weights of the kids at birth and on days 30, 60, 90, 120, 150, and 180 were determined to be 3.64, 8.89, 13.99, 18.97, 23.62, 27.22 and 30.44 kg, respectively. The average daily gains in the pre-weaning, post-weaning and overall periods were 171.09, 136.43 and 148.34 g, respectively. The multiple-birth kids had lower survival rates than the single-birth kids (P<0.01). As a result, it may be recommended to Hair goat breeders in the region to use Boer bucks in cross-breeding in order to ensure a better growth performance from the kids; to apply a sustainable selection program; and to improve management conditions. In addition, the data obtained from this study may be used as a model for designing policies on Hair goat breeding in this region.

Key words: Boer x Hair goat F_1 crossbred, Growth, Hair goat, Kids, Survival rate.

INTRODUCTION

Livestock serves an important role in rural regions of the world. Goats in these areas are raised for production of meat, milk, skin and hair, and they provide subsistence, economic benefits and livelihoods to their owners. Increasing human population, urbanization and incomes, coupled with changing consumer preferences, are creating more demand for these animals and their products. Goat breeders have started to search for breeds that are genetically predisposed to early development, rapid growth rates and good growth performance, which are associated with productivity and have significant roles in the income/expense relationship. The growth performance and characteristics of the animal are important features for genetic advancement in the context of goat breeding (Kosgey and Okeyo, 2007; Bedhane *et al.*, 2013; Singla *et al.*, 2014; Gupta, *et al.*, 2016). One of the methods applied to increase growth performance in goats is cross-breeding with breeds that have high genetic potentials. For this purpose, cross-breeding has been applied with Boer × Angora, Boer × Feral, Boer × Saanen, and Boer × local breeds (Criollis and Winderie) in previous studies (Dhanda *et al.*, 2003; Merlos-Brito *et al.*, 2008; Alemseged and Atkinson, 2015).

Boer goats are utilized worldwide due to their genetic potential for increasing the growth properties of local breeds. Boer goats are considered the best meat-type breed, with the feature of fast growth. In addition to their high genetic potential with regard to meat-type, Boer goats are disease-resistant and highly adaptable to high ambient temperatures, drought conditions, and various other environmental conditions (Urge *et al.*, 2004).

Goat breeding is widespread in Turkey due to the geographic-economic conditions of the country, the historical accumulation of agricultural experience, and the traditions and customs of the Turkish people. Although Hair goats (HGs) are considered a low-yield breed in terms of meat production, milk production and fertility, it is a local breed of Turkey that is adapted to harsh environmental conditions, including diseases, malnutrition, and extreme climatic conditions. HGs comprise ~97% of the goat population in Turkey, where the total population is 10.1 million. The goats are raised in intensive, semi-intensive and/or extensive management conditions, involving varying combinations of grazing, stall-feeding and housing, according to the season, geographical region, farm and climate. The main income for HG breeders in the country comes from sales of male kids of approximately 5-8 months-of-age (Atay and Gokdal, 2016).

In this study, HGs with low-yield properties were cross-bred with Boer bucks with inherent high-yield parameters in order to enhance growth performance and live weight. This study was conducted with the following aims:

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(1) to determine how crossbreeding of HG doe with Boer bucks affects kid traits; (2) to determine the effects of non-genetic factors on growth traits and survival rates in Turkish indigenous HGs and their first cross with Boer bucks (B×HGs); and (3) to present data that may be of benefit to goat producers in the country.

MATERIALS AND METHODS

All animal-use protocols were carried out in accordance with the Directive 2010/63/EU of the European Parliament and Council of 22 September 2010 on the protection of animals used for scientific purposes, as well as the Yuzuncu Yil University Local Ethics Committee on Animal Experiments guidelines on animal use (protocol number 2015/07).

This research was conducted in two flocks (1st flock located latitude 38°34'33.0"N, longitude 43°17'15.1"E; and 2nd flock located latitude 38°05'29.1"N, longitude 43°06'46.6"E) in farm conditions between August 2011 and April 2014 in Van Province, where the altitude is 1600 meters. The climate is a dry-sub humid (C1) climate according to the Thornthwaite climate grading system (Eken *et al.*, 2008; Sensoy *et al.*, 2012). The average rainfall is 528.4 mm per annum. Maximum and minimum temperatures typically range from 4.3 to 33°C in the summer months, and -7.7 to 10.7°C in the winter months (TSMS, 2017).

This experiment was carried out with HG kids (n=63) and B×HG kids (n=91) raised in semi-intensive conditions. Kids were weighed and numbered with plastic ear tags within one day of birth. Afterwards, the live weights (LWs) of kids were recorded at monthly intervals, and the LWs of kids on days 30, 60, 90, 120 and 180 after birth were calculated by linear interpolation. The average daily gains (ADGs) of kids during the pre-weaning and post-weaning growth periods were calculated. In order to determine the survival rates, the number of kids alive at the time of weaning and on the 180th day were used.

The kids were kept with their mothers in the morning (06:00-08:00) and at night (18:00-20:00), and were given *ad libitum* alfalfa hay and kid-grower feed (approximately 100 g per kid per day) during the suckling period, until the 60th day after birth. The kids were weaned on day 60. After the suckling period, the kids began to graze in the rangelands, and 200 g concentrated feeds were given daily to the kids as additional nutrients.

The LWs and ADGs, as measures of growth performance of the kids, at different periods were analyzed using the GLM procedures of SAS Statistical Software (SAS, 2009). Duncan's multiple range tests were used for multiple comparisons in important subgroups. The Chi-square method in SPSS statistical software (SPSS, 2015) was utilized for comparing the survival rates of kids at weaning and day 180. The mathematical models followed fixed-effects models:

1) Genotype, farm, birth year, dam age, dam live weight at kidding, sex, birth type and random effects due to residual error for birth weight.
2) Genotype, farm, birth year, dam age, dam live weight at kidding, sex, birth type, fractional regression of birth weight and random effects due to residual error at different ages for live weights (except birth weight) and growth performance.

RESULTS AND DISCUSSION

The effects of genotype and non-genetic factors on the LWs in the pre- and post-weaning growth periods in Turkish indigenous HGs and their first cross with Boer goats are given in Tables 1, 2 and 3, with least squares means presented for birth weights, LWs and ADGs. In general, the LWs of the kids were 3.64, 8.89, 13.99, 18.97, 23.62, 27.22 and 30.44 kg at birth and at days 30, 60, 90, 120, 150, 180, respectively; and the ADGs were 171.09, 136.43 and 148.34 g in the pre-weaning, post-weaning and overall periods, respectively. These results were compared with previous studies conducted on HGs, and it was determined that these values were higher than those reported by Gökdal *et al.* (2013), and similar to those reported by Cemal *et al.*, (2013) and Atay and Gokdal (2016). The reasons for these variations may be the regions where the goats were breeding, the climatic and breeding conditions, and differences in genotype.

When compared with the HG kids, B×HG kids had higher birth weights and LWs in the different growth periods, as well as increased ADGs in the pre-weaning, post-weaning and overall periods ($P<0.001$). These results can be explained by the high heritability of growth and weight traits in Boer goat kids (Menezes *et al.*, 2016). One of the major effects on the growth of goats is the adult live weight of the mother and father goats. Generally, the kids of large-size breeds have higher the LWs and ADGs compared with kids from smaller breeds (Dhanda *et al.*, 2003).

The flock diversity and birth years did not affect the LWs and growth performances of the kids ($P>0.05$). The results of the study also revealed that flock diversity and year of birth did not affect the birth weight of goats, which has been suggested to indicate that the goats are well-adapted to the climatic variations of the region and can tolerate the variations (Raja, 2014). In this study, the lack of impact of flock variety and year on the LWs and growth performances could be regarded as an indication that the management conditions for semi-intensive conditions are uniform for the years in the study.

It was determined that the age of the dam had a significant effect on the birth weight, the LW on days 30, 60 and 90, and the ADGs in pre-weaning, post-weaning and overall periods ($P<0.05$). The highest birth weight was determined in the kids of 3-year-old dams, and the lowest birth weight was determined in the kids of 6-year-old dams

Table 1: Effect of genotype and non-genetic factors on live weights during pre-weaning growth periods in Turkish indigenous HGs and first crosses with Boer goats.

Factors	n	Birth	n	30th day	n	60th day
Genotype						
B×HG	91	3.60±0.11	91	9.11±0.24	82	14.04±0.31
HG	63	3.03±0.11	63	6.88±0.26	58	10.75±0.33
P-value		<0.0001***		<0.0001***		<0.0001***
Farm						
1	66	3.37±0.16	66	7.99±0.36	64	12.37±0.46
2	88	3.26±0.15	88	7.99±0.33	76	12.42±0.42
P-value		0.6652^{ns}		0.9974^{ns}		0.9390^{ns}
Birth year						
2012	49	3.28±0.17	49	7.98±0.37	47	12.39±0.46
2013	29	3.44±0.15	29	8.38±0.34	28	12.72±0.43
2014	76	3.22±0.17	76	7.61±0.37	65	12.08±0.47
P-value		0.4622^{ns}		0.2082^{ns}		0.5065^{ns}
Age of dam, years						
2	22	3.27±0.19^{b}	22	8.21±0.38^{a}	19	12.37±0.49^{b}
3	20	3.45±0.16^{a}	20	8.65±0.37^{a}	17	13.29±0.48^{a}
4	27	3.37±0.17^{a}	27	8.32±0.43^{a}	25	11.54±0.33^{c}
5	53	3.24±0.11^{c}	53	7.39±0.25^{b}	49	13.48±0.57^{a}
≥6	32	3.23±0.17^{c}	32	7.39±0.38^{b}	30	11.31±0.48^{c}
P-value		0.0481*		0.0172*		0.0021**
Live weight of dam, kg						
30.0-35.0	27	3.03±0.18^{c}	27	6.84±0.40^{d}	23	10.30±0.53^{c}
35.1-40.0	13	3.23±0.21^{b}	13	7.57±0.47^{c}	12	11.56±0.60^{c}
40.1-45.0	40	3.20±0.14^{b}	40	8.05±0.31^{bc}	38	12.33±0.40^{b}
45.1-50.0	42	3.58±0.13^{a}	42	8.74±0.30^{a}	37	13.75±0.38^{a}
≥50.1	32	3.52±0.14^{a}	32	8.77±0.32^{a}	30	14.03±0.41^{a}
P-value		0.0406*		0.0035**		<0.0001***
Sex						
Female	78	3.01±0.10	78	7.50±0.23	69	11.84±0.29
Male	76	3.61±0.11	76	8.48±0.25	71	12.95±0.32
P		<0.0001***		0.0001***		0.0005***
Birth type						
Single	93	3.84±0.07^{a}	93	9.48±0.17^{a}	88	14.64±0.21^{a}
Twin	48	3.45±0.11^{b}	48	8.26±0.25^{b}	41	13.12±0.33^{b}
≥Triplet	13	2.65±0.21^{c}	13	6.24±0.48^{c}	11	9.43±0.63^{c}
P-value		<0.0001***		<0.0001***		<0.0001***
Linear regression						
Birth weight				2.12±0.12		2.78±0.18
P-value				<0.0001***		<0.0001***
General	154	3.64±0.07	154	8.89±0.17	140	13.99±0.24

$^{a, b, c, d}$: Means with different superscripts in the same column differ significantly (P<0.05); ^{ns}: non-significant (P>0.05). *: P<0.05. **: P<0.01. ***: P<0.001. Values represent least squares means ± standard errors.

(P<0.05). The reason for this may be the increased rate of multiple births with the increasing age of the goats, as multiple births cause the kids to have lower birth weights. Thus. the lighter birth weights of kids of 5- and 6-year-old dams was probably associated with the higher litter size of these HG dams at the time of kidding (Atay *et al.*, 2010). In addition, birth weight was affected by the nutritional intake of the dam during pregnancy. In fact, the maternal nutrition during this period plays an important role in the regulation of fetal and placental development.

It was determined that the kids of 5-year-old dams had higher the LWs at weaning compared with kids from dams of other age groups (P<0.01). The ADGs of the kids showed fluctuations dependent on the age of the dam in the pre-weaning, post-weaning and overall periods. It was also determined that, compared with kids from dams of other age groups, the kids of 5-year-old dams had higher ADGs in the pre-weaning period (P<0.01), and the overall period (P<0.05), the kids of 5-year-old dams had higher ADG in the post-weaning period (P<0.01). In the overall period, as

Table 2: Effect of genotype and non-genetic factors on live weight during post-weaning growth periods in Turkish indigenous HGs and their crosses with Boer goats.

Factors	n	90th day	n	120th day	n	150th day	n	180th day
Genotype								
B×HG	78	18.90±0.39	77	23.80±0.47	76	27.75±0.55	76	31.22±0.64
HG	55	14.88±0.41	54	18.97±0.50	54	22.01±0.58	54	24.51±0.68
P-value		<0.0001***		<0.0001***		<0.0001***		<0.0001***
Farm								
1	61	16.50±0.57	59	21.05±0.70	58	24.72±0.81	58	28.19±0.94
2	72	17.28±0.54	72	21.72±0.66	72	25.04±0.76	72	27.55±0.89
P-value		0.3883^{ns}		0.5399^{ns}		0.8032^{ns}		0.6612^{ns}
Birth year								
2012	44	17.09±0.59	42	21.60±0.72	41	25.08±0.84	41	27.73±0.97
2013	26	17.35±0.53	26	21.91±0.65	26	25.30±0.75	26	28.02±0.87
2014	63	16.23±0.59	63	20.64±0.72	63	24.26±0.83	63	27.86±0.97
P-value		0.3405^{ns}		0.3957^{ns}		0.6283^{ns}		0.9566^{ns}
Age of dam, years								
2	16	$16.23±0.59^{bc}$	15	20.19±0.72	15	23.69±0.83	15	26.57±0.97
3	16	$17.95±0.62^{a}$	16	21.99±0.77	16	24.89±0.89	16	27.34±1.04
4	25	$16.20±0.40^{bc}$	25	21.03±0.49	25	24.52±0.57	25	27.81±0.66
5	47	$18.12±0.70^{a}$	47	22.93±0.85	46	26.55±0.98	46	29.45±1.14
≥6	29	$15.95±0.59^{c}$	28	20.78±0.72	28	24.76±0.84	28	28.16±0.97
P-value		0.0397*		0.1805^{ns}		0.2585^{ns}		0.2705^{ns}
Live weight of dam, kg								
30.0-35.0	21	$14.73±0.65^{c}$	20	$19.41±0.80^{c}$	20	22.95±0.93	20	26.27±1.08
35.1-40.0	12	$16.20±0.73^{ab}$	12	$20.83±0.88^{bc}$	12	24.13±1.02	12	27.03±1.19
40.1-45.0	36	$16.97±0.50^{ab}$	36	$21.35±0.60^{b}$	35	25.13±0.70	35	28.20±0.81
45.1-50.0	36	$18.29±0.46^{a}$	35	$22.69±0.57^{a}$	35	26.01±0.65	35	28.82±0.76
≥50.1	28	$18.26±0.51^{a}$	28	$22.63±0.62^{a}$	28	26.18±0.71	28	29.01±0.83
P-value		0.0004***		0.0144**		0.0786^{ns}		0.3285^{ns}
Sex								
Female	66	16.05±0.37	65	20.31±0.45	65	23.71±0.52	65	26.55±0.61
Male	67	17.73±0.40	66	22.46±0.49	65	26.05±0.57	65	29.18±0.66
P-value		<0.0001***		<0.0001***		<0.0001***		<0.0001***
Birth type								
Single	85	$19.83±0.26^{a}$	84	$24.46±0.31^{a}$	84	$27.89±0.36^{a}$	84	$30.76±0.42^{a}$
Twin	38	$17.87±0.40^{b}$	37	$22.31±0.50^{b}$	36	$25.72±0.58^{a}$	36	$28.91±0.68^{ab}$
≥Triplet	10	$12.98±0.79^{c}$	10	$17.38±0.96^{c}$	10	$21.03±1.11^{b}$	10	$23.94±1.29^{b}$
P-value		<0.0001***		<0.0001***		<.0001***		<0.0001***
Linear regression								
Birth weight		3.04±0.23		3.24±0.29		3.4±0.35		3.55±0.43
P-value		<0.0001***		<0.0001***		<0.0001***		<0.0001***
General	133	18.97±0.29	131	23.62±0.34	130	27.22±0.39	130	30.44±0.44

$^{a, b, c}$: Means with different superscripts in the same column differ significantly (P<0.05); ^{ns}: non-significant (P>0.05).
**: P<0.05. ***: P<0.001. Values represent least squares means ± standard errors.

the age of the dam increased (except for the 6-year-old dams), so did the ADGs of the kids. The differences between overall ADGs in kids were possibly due to a decreasing maternal effect and a growth compensation in the kids as the dams became older (Mabrouk *et al.*, 2010).

It was determined that the live weight of dam had a significant effect on birth weight, the LWs of kids on days 30, 60, 90 and 120, and on the pre-weaning ADG (P<0.05). It was also observed that, as the dam live weight increased, so did the birth weights (P<0.05), weaning weights (P<0.001) and ADGs of the kids in the pre-weaning periods (P<0.001). The birth weights of the kids are related to the body conformation and the size of their parents. It was determined that the live weight of the dam had a significant effect on the LW of the kid at early ages; however, it did not have a significant effect on the live weights in older animals. Additionally, the motherhood instincts (such as care of kids, and suckling behaviors) of the heavier dams were more developed compared with the mothers with lower weights, and the heavier dams gave birth to kids with higher birth weights. Therefore, goat breeders in the region must pay attention to the motherhood abilities of the dams in order to

Table 3: Effect of genotype and non-genetic factors on daily live weight gain during pre-weaning (days 1 to 60), post-weaning (days 61 to 180) and overall (days 1 to 180) growth periods in Turkish indigenous HGs and their crosses with Boer goats.

Factors	Pre-weaning growth rate	Post-weaning growth rate	Overall growth rate
Genotype			
B×HG	173.85±4.41	144.01±4.95	153.53±3.51
HG	128.98±4.78	114.32±5.23	119.46±3.71
P-value	<0.0001***	<0.0001***	<0.0001***
Farm			
1	149.96±6.58	132.68±7.25	138.19±5.14
2	152.87±6.08	125.66±6.88	134.81±4.88
P-value	0.7740^{ns}	0.5354^{ns}	0.6734^{ns}
Birth year			
2012	152.62±6.66	127.81±7.53	136.09±5.34
2013	155.67±6.13	127.83±6.72	136.84±4.76
2014	145.96±6.81	131.86±7.47	136.57±5.29
P-value	0.5238^{ns}	0.9195^{ns}	0.9908^{ns}
Age of dam, years			
2	149.67 ± 6.97^{bc}	120.19 ± 7.51^{bc}	129.01 ± 5.32^{c}
3	164.45 ± 6.88^{a}	116.93 ± 8.05^{c}	132.33 ± 5.70^{c}
4	138.00 ± 4.67^{c}	136.99 ± 5.14^{ab}	136.59 ± 3.64^{b}
5	170.69 ± 8.15^{a}	133.29 ± 8.84^{ab}	145.63 ± 6.26^{a}
≥6	135.27 ± 6.95^{c}	140.45 ± 7.54^{a}	138.92 ± 5.34^{ab}
P-value	0.0011**	0.0068**	0.0385*
Live weight of dam, kg			
30.0-35.0	122.36 ± 7.53^{d}	133.43±8.36	129.83±5.93
35.1-40.0	139.53 ± 8.56^{cd}	130.57±9.22	132.79±6.54
40.1-45.0	153.23 ± 5.78^{bc}	132.34±6.30	139.24±4.47
45.1-50.0	168.47 ± 5.43^{ab}	124.27±5.89	139.79±4.18
≥50.1	173.49 ± 5.83^{a}	125.23±6.42	140.84±4.55
P-value	<0.0001***	0.8025^{ns}	0.6141^{ns}
Sex			
Female	146.82±4.22	123.77±4.70	130.79±3.34
Male	156.01±4.62	134.57±5.14	142.20±3.65
P-value	0.0420*	0.0320*	0.0016**
Birth type			
Single	179.58 ± 2.99^{a}	133.18±3.26	149.27 ± 2.31^{a}
Twin	160.32 ± 4.68^{b}	131.19±5.24	141.25 ± 3.71^{b}
≥Triplet	114.35 ± 9.08^{c}	123.13±9.96	118.97 ± 7.06^{c}
P-value	<0.0001***	0.6156^{ns}	0.0002***
Linear regression			
Birth weight	29.72±3.05	6.38±3.08	14.16±2.39
P-value	<0.0001***	0.0401*	<0.0001***
General	171.09±3.22	136.43±2.6	148.34±2.24

$^{a, b, c}$: Means with different superscripts in the same column differ significantly (P<0.05); ^{ns}: non-significant (P>0.05).
*: P<0.05. ***: P<0.001. Values represent least squares means ± standard errors.

increase birth weight, weaning weight, and pre-weaning ADG.

Male kids had higher birth weights than the female kids (P<0.001). This variation might be associated with the faster development of male fetuses compared with female fetuses in the prenatal period; and with the slightly prolonged pregnancy period of dams pregnant with male kids than those pregnant with female kids (1-2 days) (Afzal *et al.*, 2004).

It was determined that the LWs and ADGs of the male kids in the pre- and post-weaning periods were higher than those of the female kids (P<0.05). Differences in the possible positions of the growth-related genes in the sex chromosomes, differences in physiological characteristics, and also differences in the endocrine system (especially the type and level of the sex hormones) can cause variations in the growth of male and female kids. For example, the limiting effect of estrogen hormone on the growth of bones in female

Table 4: Survival rates of kids at different growth periods (%).

Factors	Weaning	180th day
Genotype		
B×HG	90.11	83.52
HG	92.06	85.71
Chi-Square	0.1719	0.1366
P-value	0.6784^{ns}	0.7115^{ns}
Farm		
1	96.97	87.88
2	86.36	81.82
Chi-Square	3.9302	1.0529
P-value	0.0524^{ns}	0.3048^{ns}
Birth year		
2012	95.92	83.67
2013	96.55	89.66
2014	85.53	82.89
Chi-Square	5.2695	0.7593
P-value	0.0717^{ns}	0.6841^{ns}
Age of dam, years		
2	86.36	68.18
3	85.00	80.00
4	92.59	92.59
5	92.45	86.79
e”6	93.75	87.50
Chi-Square	1.9529	6.5347
P-value	0.7444^{ns}	0.1626^{ns}
Dam live weight, kg		
30.0-35.0	85.19	74.07
35.1-40.0	92.31	92.31
40.1-45.0	95.00	87.50
45.1-50.0	88.10	83.33
≥50.1	93.75	87.50
Chi-Square	2.6260	3.3685
P-value	0.6222^{ns}	0.4982^{ns}
Sex		
Female	88.46	83.33
Male	93.42	85.53
Chi-Square	0.6241	0.1407
P-value	0.4295^{ns}	0.7076^{ns}
Birth type		
Single	94.62	90.32^{a}
Twin	85.42	75.00^{b}
≥Triplet	84.62	76.92^{b}
Chi-Square	3.9278	6.2560
P-value	0.1403^{ns}	0.0438*
General	90.91	84.42

$^{a, b}$: Means with different superscripts in the same column differ significantly ($P<0.05$); ^{ns}: non-significant ($P>0.05$).
*: $P<0.05$.

individuals may cause females to have lower the LWs compared with males, and to have smaller body structures than males (Rashidi *et al.*, 2008).

In this study, it was determined that, as the litter size increased, birth weights decreased ($P<0.001$). This might have stemmed from the effect of the birth type, or from the increase or decrease in the number of contact points between the trophoblast and endometrium in the uterus during the embryonic implantation stage; as the litter size increases, the number of contact points between the uterus and the embryo, as well as the volume of the void in the uterus, decreases. Thus, the increased growth performance of single-birth kids compared with multiple-birth kids may result from the excess of nutrient availability from the mother during the pregnancy period (Merlos-Brito *et al.*, 2008).

The ADGs of the single-birth kids were also higher than those of the multiple-birth kids in the pre-weaning period ($P>0.001$). The first possible reason for this is the limitation of the uterine environment (such as space availability and connections between the fetus and uterus) for multiple-birth kids compared with single-birth kids. The second reason might be the reduced availability of milk from the dams birthing multiple kids when compared with those birthing single kids (Merlos-Brito *et al.*, 2008). To circumvent this, goat breeders may apply special feeding methods such as creep feeding in order to increase the growth performances of the multiple-birth kids.

When birth weight was analyzed by linear-regression, it was determined that the increase in birth weight had a significant effect on the LW and growth performance at various ages ($P<0.001$).

In the present study, the type of birth significantly affected the 180-day survival rates of the kids ($P<0.01$); it was determined that the multiple-birth kids had lower survival rates than the single-birth kids (Table 4). Single-birth kids consume more colostrum than kids from litters of two or three, therefore increasing their consumption of immunoglobulin. This may pose an advantage for single-birth kids in terms of disease resistance.

CONCLUSION

In conclusion, it was determined that the genotype, age of dam, live weight of dam at kidding, sex, birth type and birth weight have a significant influence on the LW and ADG of kids. It was also demonstrated that the highest growth parameters occurred in crossbred kids, in kids born from 4-year-old goats, in kids born from goats whose live weight was ≥50.1 kg, in male kids, and in single-birth male kids. Additionally, it was determined that the survival rate was higher in single-birth kids. It may be recommended to HG breeders in the region to use Boer bucks in cross-breeding to achieve better growth performances in the kids, to apply a sustainable selection program, and to improve management of environmental conditions and maintenance of the animals. In addition, the data obtained in this study may be used as a model for designing regional policies for HG breeding in the area.

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