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Birth and weaning weights of Awassi lambs raised in the GAP International Agricultural Research and Training Center

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Summary: In this study, the data were collected from 1271 heads of Awassi lambs raised in the GAP International Agricultural Research and Training Center in Diyarbakır, Turkey. Birth and weaning weight (at 90 days) of lambs were measured and average daily weight gain from birth to weaning was calculated. The effect of the years and season of lambing, age of dam, sex and birth type on birth weight (BWT), weaning weight (WWT) and average daily weight gain (ADWG) from birth to weaning were investigated. Overall means were 4.81±0.022 kg for BWT, 22.99±0.196 kg for WWT and 201.67±1.173 g for ADWG. The all tarits in the analyses were significantly ($P<0.05$) affected by all factors in the model. In addition, lambs born heavier grew faster and reached heavier WWT ($p<0.01$). Based on the single and multiple trait analyses, heritability estimates ranged from 0.21 to 0.25 for BWT, from 0.13 to 0.17 for WWT and from 0.13 to 0.17 for ADWG. Estimates of genetic correlations between BWT with WWT and ADWG were 0.61 and 0.61, respectively.

Keywords: Awassi sheep, environment, genetic parameters, lamb growth, phenotypic evaluation.

GAP Uluslararası Araştırma ve Eğitim Merkezi'nde yetiştirilen İvesi kuzularının doğum ve sütten kesim ağırlıkları

Özet: Bu çalışmada, Diyarbakır GAP Uluslararası Araştırma ve Eğitim Merkezi'nde yetiştirilen 1271 baş İvesi kuzularından elde edilen veriler kullanılmıştır. Çalışmada, kuzuların doğum ve sütten kesim ağırlığı (90-gün) ölçülmüş ve doğumdan sütten kesim ağırlığına kadar günlük canlı ağırlık artışı hesaplanmıştır. Kuzuların doğumdan sütten kesime kadar olan ortalama günlük canlı ağırlık artışı (ADWG), doğum ağırlığı (BWT) ve sütten kesim ağırlığı (WWT) üzerine kuzulama mevsimi, yıl, ana yaşı, cinsiyet ve doğum tipi etkileri araştırılmıştır. BWT, WWT ve ADWG özelliklerine ait genel ortalamalar sırasıyla, 4.81±0.022 kg, 22.99±0.196 kg ve 201.67±1.173 g olarak hesaplanmıştır. Analizdeki bütün özellikler, modelde dikkate alınan bütün faktörler tarafından önemli derecede etkilenmiştir ($P<0.05$). Bunlara ek olarak, daha ağır doğan kuzuların daha hızlı ağırlık kazandıkları ve sütten kesimde daha ağır oldukları gözlenmiştir ($p<0.01$). Tekli ve çoklu özellik analizleri temelinde, kalıtım derecesi kestirimleri BWT için 0.21 - 0.25, WWT için 0.13 - 0.17 ve ADWG için 0.13 - 0.17 aralığında bulunmuştur. BWT ile WWT ve ADWG arasındaki genetik korelasyonlar sırasıyla 0.61 ve 0.61 olarak tahmin edilmiştir.

Anahtar sözcükler: Çevre, fenotipik değerlendirme, genetik parametreler, İvesi koyunu, kuzu gelişimi.

Introduction

Sheep and sheep products have an economical importance in Turkey as is the case in other countries in the world. The importance of sheep is quite high to meet animal originated food requiements of humans. Changes in socioeconomic status, cultural development, increase in population size and some other factors have increased the human concern to protein need from animal origin and particularly to meat (8).

Major income is obtained from meat yield in the sheep production. Meat production means lambs production in sheep breeding. Therefore, sheep raising activities shifted to lamb meat production. There are many factors affecting live weight changes of lambs, such as season of birth, sex, birth type of lamb and age of dam. Another important factor is the genetic structure of animals causing differentiation among spices and breeds in terms of growth and maturing (9). Among the growth traits, birth weight is an important selection criteria because of its linear relationship with weaning weight and mature live weight in sheep (2, 12).

Standardization of the individual traits based on effects of some environmental factors on the yield increases the breeding efficiency. On the breeding of any yield traits with selection, it is primarily essential to know the effect of environmental factors and adjustment of records on the basis of known factors (11).

Therefore, the objectives of this research were: 1) to investigate the influences of environmental factors on birth weight (BWT), weaning weight (WWT), average daily weight gain (ADWG) of lambs, and 2) to estimate genetic parameters of growth traits until weaning.

Materials and Methods

Material: In this study, BWT and WWT records belonging to 1271 Awassi lambs (from 575 ewes and 30 rams), raised in the GAP International Agricultural Research and Training Center in Diyarbakır, Turkey were used. The data used in this study belong to the first part of the "Genetic Improvement of Milk Yield in Awassi Sheep" project held by the genaral Directorate of Agricultural Research and Politics (TAGEM).

Hand mating system were applied and additional feeding including compound feed, lentil straw and dry clover (alfalfa) was given to ewes stayed on pasture most of the time during the years. Matings started in mid-July and ended at the end of August. After matings, a few rams kept in the flock in order to increase fertility rate. Lambings started generally in mid-December and lasted until the end of February. BWT of lambs were measured and recorded within 12 hours after lambing using weight device with 50-gr sensitivity and the lambs were ear tagged. Sex and birth type of lamb, dam and ram identification numbers were recorded, and live weight of lambs were taken every 30 days afterward. Lambs were weaned at about 90-days of age.

Statistical Analyses: Effects of the environmental factors on BWT, WWT, and ADWG from birth to weaning were investigated using least-square method by LSMEANS statement in GLM procedure in (16) a statistical package program. Tukey-Kremar multiple comparison method was used to test significance of differences among the group means. The model of analysis included the effect of year and season of birth, age of dam, birth type and sex of lamb. BWT was included in the model as a covariate in the analyses of WWT and ADWG.

MTDFREML programme (5) was used to obtain the estimates of variance-covariance components and genetic parameters. Five different animal models incorporating different combinations of direct genetic effect, maternal genetic effects, the correlation between direct and maternal genetic effects, and uncorrelated random effect of dam (permanent environment) were used.

The general description of the five models are as follows:

Model 1 (M1): $y = Xb + Z_1a + \beta(BWT) + e$

Model 2 (M2): $y = Xb + Z_1a + Z_2m + \beta(BWT) + e$ $\quad$ Cov (a, m) = 0

Model 3 (M3): $y = Xb + Z_1a + Z_2m + \beta(BWT) + e$ $\quad$ Cov (a, m) ≠ 0

Model 4 (M4): $y = Xb + Z_1a + Z_2m + Wpe + \beta(BWT) + e$ $\quad$ Cov (a, m) ≠ 0

Model 5 (M5): $y = Xb + Wpe + \beta(BWT) + e$

where **y** is a Nx1 vector of observation for the trait of interest, N stands for the number of records; **b** is the vector of fixed effects with incidence matrix X; **a** is the random vector of direct animal genetic effects with incidence matrix Z_1; **m** is the random vector of maternal genetic effects with incidence matrix Z_2; **pe** is the random vector of permanent environment effect of dam with incidence matrix W; **β** is regression coefficient of BWT on corresponding trait and it was excluded from the model when analyzing BWT; and **e** is the random vector of residual. Cov (a, m) is covariance between direct and maternal additive effect. The expectations and the variance-covariance structure for the effects in the model are assumed to be:

$$E(y) = Xb,\ E(a) = E(m) = E(pe) = E(e) = 0;$$

$$Var(a) = A\sigma_a^2 \quad Var(m) = A\sigma_m^2$$

$$Var(pe) = I\sigma_{pe}^2 \quad Var(e) = I\sigma_e^2$$

$$Cov(a,m) = A\sigma_{a,m}$$

$$Var(y) = Z_1AZ_1'\sigma_a^2 + Z_2AZ_2'\sigma_m^2 + Z_1AZ_2'\sigma_{a,m} + Z_2AZ_1'\sigma_{a,m} + I\sigma_{pe}^2 + I\sigma_e^2$$

where A, I, σ_a^2, σ_m^2, $\sigma_{a,m}$, σ_{pe}^2, σ_e^2 are the numerator relationship matrix, identity matrix, direct additive genetic variance, maternal additive genetic variance, covariance between direct and maternal additive effect, permanent environmental variance and residual variance, respectively. All remaining variances and covariances due to non-additive genetic effects were assumed to be zero.

The fixed effects included in the models were year and season of birth, sex, birth type, age of dam and BWT as covariate when analyzing WWT and ADWG. Firstly, single trait analyses were carried out in order to identify the best model for the traits in the analyses, then identified models were used in the bivariate analyses to obtain the genetic correlations between the traits.

Results

Descriptive statistics of BWT, WWT and ADWG are given in Table 1. The structure of data for evaluating of the growth performance of Awassi sheep as well as the means, standard errors, minimum and maximum values, and coefficients of variations are given. In table 1 the result shows that Awassi lambs weighed 4.81 kg, 22.99 kg and 201.67 g for BWT, WWT and ADWG with variation coefficient variations of 16.4, 21.7 and 25.6%, respectively.

Least-square means and standard errors of BWT, WWT and ADWG by environmental factors are given in

Table 1. Descriptive statistics of BWT, WWT and ADWG
Tablo 1. Doğum Ağırlığı, Sütten Kesim Ağırlığı ve Ortalama Günlük Canlı Ağırlık Artışlarına ait Tanımlayıcı İstatistikler

	N	Mean	Std.Err.	Min	Max.	CV%
BWT (kg)	1271	4.81	0.022	1.94	7.55	16.4
WWT (kg)	874	22.99	0.196	7.80	39.27	21.7
ADWG (g)	874	201.67	1.173	54.89	362.22	25.6

Std.Err.: Standard error, Min: minimum, Max: maximum, CV%: coefficient of variation
Std.Err.: Standart hata; Min: En az, Max: En çok, CV%: VK %, varyasyon katsayısı

Table 2. Least square means and standard errors of BWT, WWT and ADWG of Awassi lambs by year, season, sex, type of birth and age of dam
Tablo 2. İvesi kuzularının doğum ağırlığı, sütten kesim ağırlığı ve ortalama günlük canlı ağırlık artışlarının doğum sezonu, cinsiyet, doğum tipi ve ana yaşı bakımından en küçük kareler ortalamaları ve standart hataları

	BWT (kg)		WWT (kg)		ADWG (g)	
	N	$\overline{X} \pm S_{\overline{X}}$	N	$\overline{X} \pm S_{\overline{X}}$	N	$\overline{X} \pm S_{\overline{X}}$
Year						
2005	288	4.55 ± 0.047^{a}	218	23.06 ± 0.321^{a}	218	202.44 ± 3.565^{a}
2006	297	4.49 ± 0.043^{a}	165	19.90 ± 0.328^{b}	165	167.35 ± 3.644^{b}
2007	363	4.76 ± 0.041^{b}	247	22.98 ± 0.273^{a}	247	201.47 ± 3.037^{a}
2008	323	4.72 ± 0.041^{b}	244	22.34 ± 0.266^{a}	244	194.39 ± 2.957^{a}
Season						
1	718	4.57 ± 0.030^{a}	571	23.29 ± 0.199^{a}	571	204.98 ± 2.208^{a}
2	553	4.69 ± 0.034^{b}	303	20.85 ± 0.255^{b}	303	177.84 ± 2.835^{b}
Sex						
Male	629	4.79 ± 0.031^{a}	387	22.85 ± 0.228^{a}	387	200.04 ± 2.528^{a}
Female	642	4.46 ± 0.030^{b}	487	21.29 ± 0.208^{b}	487	182.78 ± 2.307^{b}
Type of Birth						
Single	976	5.01 ± 0.024^{a}	690	22.85 ± 0.167^{a}	690	200.06 ± 1.860^{a}
Multiple	295	4.25 ± 0.041^{b}	184	21.29 ± 0.310^{b}	184	182.76 ± 3.350^{b}
Age of Ewe						
2	350	4.39 ± 0.043^{a}	239	22.14 ± 0.304^{ab}	239	192.21 ± 3.373^{ab}
3	279	4.67 ± 0.045^{b}	186	22.14 ± 0.306^{ab}	186	192.22 ± 3.396^{ab}
4	207	4.70 ± 0.051^{b}	152	22.65 ± 0.337^{a}	152	197.87 ± 3.747^{a}
5	205	4.68 ± 0.050^{b}	142	21.40 ± 0.334^{b}	142	183.92 ± 3.713^{b}
6≤	230	4.71 ± 0.046^{b}	155	22.02 ± 0.316^{ab}	155	190.83 ± 3.512^{ab}
β_{BWT}				$2.84 \pm 0.195^{**}$		$20.42 \pm 2.163^{**}$

*Means with different superscript in a column within factor is significantly different (P<0.05). *P<0.05, **P<0.01,
season 1: December-January, season 2: February-March, β_{BWT}: regression coefficient of BWT on corresponding trait.
Aynı sütunda farklı harflerle gösterilen ortalamalar arasındaki farklılıklar önemlidir(P<0.05). *P<0.05, **P<0.01,
sezon 1: Kasım-Ocak, sezon 2: Şubat-Mart,
β_{BWT}: Doğum ağırlığına ait regresyon katsayısı

Table 2. There were significantly the effects of year, season, sex, birth type and age of dam (p<0.05) on BWT, WWT and ADWG. Over the years from 2005 to 2008, there was a constant increase (p<0.05) in BWT while ADWG and WWT did not change significantly. The lambs born from the ewes older than 2 years old, males and single borns are more weight at birth (BWT) than the lambs born in the second season and born from ewes younger than 3 years old, females and multiple borns, respectively. Similar patterns were observed in ADWG and WWT (p<0.05) for the season of birth, sex and birth type whereas ADWG and WWT were fluctuated among dam ages. BWT was included in the analyses models of WWT and ADWG and found that every 1 kg deviation from the mean BWT resulted in 2.84 kg and 20.42 g/day differences in mean WWT and ADWG (p<0.01), respectively.

The results of the univariate analysis under the five different models are presented in Table 3. The direct heritability (h_a^2) estimates for BWT under the different

Table 3. Estimates of genetic parameters for growth traits from single trait animal models
Tablo 3. Tek özellik hayvan modeline göre genetik parametreler tahminleri

		h^2	m^2	$r_{a,m}$	e^2	pe^2	-2Log(L)
BWT							
	Model 1	0.57±0.073			0.43±0.073		292.69
	Model 2	0.22±0.081	0.18±0.043		0.60±0.063		283.10
	Model 3	0.21±0.075	0.09±0.061	0.72±0.602	0.60±0.060		281.03
	Model 4	0.21±0.075	0.09±0.086	0.72±0.644	0.60±0.061	0.00±0.067	281.03
	Model 5	0.37±0.102			0.52±0.078	0.11±0.044	287.59
WWT							
	Model 1	0.13±0.073			0.87±0.073		3176.97
	Model 2	0.02±0.049	0.15±0.046		0.83±0.051		3158.65
	Model 3	0.02±0.042	0.17±0.086	-0.34±1.179	0.83±0.052		3158.58
	Model 4	0.02±0.042	0.03±0.143	0.42±4.068	0.82±0.053	0.12±0.115	3157.55
	Model 5	0.02±0.041			0.82±0.053	0.15±0.047	3165.57
DWG							
	Model 1	0.13±0.073			0.87±0.073		7294.56
	Model 2	0.02±0.049	0.15±0.046		0.83±0.051		7266.60
	Model 3	0.02±0.042	0.17±0.086	-0.34±1.179	0.83±0.052		7266.53
	Model 4	0.02±0.042	0.03±0.143	0.42±3.969	0.82±0.053	0.12±0.115	7265.51
	Model 5	0.02±0.041			0.82±0.053	0.15±0.047	7283.16

σ^2_P =total phenotypic variance; σ^2_a =direct additive genetic variance; σ_{am}=covariance between direct additive genetic effect and maternal genetic effect; σ^2_m =maternal genetic variance; σ^2_{pe} = variance of maternal permanent environmental effect; σ^2_e =environmental variance; r_{am}=correlation between direct additive genetic effect and maternal additive genetic effect; pe^2=proportion of maternal permanent environmental variance on total phenotypic variance; e^2=proportion of environmental variance on total phenotypic variance; m^2=maternal heritability; h^2=direct heritability

σ^2_P =toplam fenotipik varyans; σ^2_a =doğrudan eklemeli genetik varyans ; σ_{am} = doğrudan genetik etki ile anasal eklemeli genetik etki arasındaki kovaryans, σ^2_m =anasal genetik varyansı; σ^2_{pe} = anasal sabit çevre varyansı; σ^2_e = hata varyansı; r_{am} = doğrudan eklemeli genetik etki ile anasal eklemeli genetik etki arasındaki korelasyon; pe^2= toplam fenotipik varyanta anasal sabit çevre varyansının payı; e^2= toplam fenotipik varyanta hata varyansının payı; m^2= anasal kalıtım derecesi; h^2= kalıtım derecesi

models ranged from 0.21 to 0.57 while the maternal heritabilities (h^2_m) were ranged from 0.09 to 0.18. On the other hand, estimates of h^2_a for WWT and ADWG were the same (as expected) and in the range of 0.02 and 0.13. Maternal heritability estimates ranged from 0.03 to 0.17 for ADWG and WWT, and the correlation between direct and maternal additive effect was in the range of -0.34 and 0.42.

On the basis of the results of unvariate analysis presented in Table 3, among the five models, the Model 3 (M3) for BWT and the Model 1 (M1) for ADWG and WWT were the most appropriate models accounting for the variation in the trait of interest. This results could be seen more clearly by examining -2Log(L) value, the standard errors of the parameter estimates. For BWT, the smallest -2Log(L) was produced by the models M3 and M4, however, the estimates of permanent environmental variance under M4 was zero. In addition, the estimates of parameters and their standard errors under M3 were reasonable. Thus, M3 was chosen for further analysis of BWT in bivariate analyses to obtain the estimates of genetic correlation. For ADWG and WWT, the estimates of standard errors are larger than the estimates of direct and maternal heritability, and genetic correlation between direct and maternal additive effect for ADWG and WWT although -2Log(L) and error variances are larger than those for the other models. This makes the estimates of parameters meaningless, therefore, the models from M2 to M5 are not appropriate for the analyses of ADWG and WWT. Thus, M1 was chosen for bivariate analyses of ADWG and WWT to obtain the estimates of genetic correlation.

The estimates of genetic correlations among growth traits and heritability estimates from the bivariate analyses are presented in Table 4. It was observed that the bivariate analyses for a trait with each of the other traits caused a little increase in the direct and total heritability estimates for all traits. However, for BWT, small decreases were observed in the estimates of genetic correlation between the direct and maternal additive effect, but maternal heritabilities were very similar in comparison to those from unvariate analyses.

Table 4. Estimates of genetic parameters for early growth traits from bivariate analysis (bold-black typing is from single trait analyses)
Tablo 4. Erken büyüme özelliklerine ait genetik parametre tahminleri (Koyu biçimde yazılanlar tek özellik analizinden)

	h^2	m^2	$r_{a1,a2}$	$r_{a1,m1}$	e^2	h_t^2
BWT	0.21±0.075	0.09±0.061		0.72±0.602	0.60±0.060	0.40
WWT	0.25	0.08	0.61	0.67	0.58	0.43
ADWG	0.25	0.08	0.61	0.67	0.58	0.42
WWT	0.13±0.073				0.87±0.073	0.13
BWT	0.17		0.61		0.83	0.17
ADWG	0.15		1.00		0.85	0.15
ADWG	0.13±0.073				0.87±0.073	0.13
BWT	0.17		0.61		0.83	0.17
WWT	0.14		1.00		0.86	0.14

σ_P^2 =total phenotypic variance; σ_a^2 =direct additive genetic variance; σ_{am} =covariance between direct additive genetic effect and maternal genetic effect; σ_m^2 =maternal genetic variance; σ_{pe}^2 =variance of maternal permanent environmental effect; σ_e^2 =environmental variance; r_{am}=correlation between direct additive genetic effect and maternal genetic effect; pe^2=proportion of maternal permanent environmental variance on total phenotypic variance; e^2=proportion of environmental variance on total phenotypic variance; m^2=maternal heritability; h^2=direct heritability; h_t^2 =total heritability $= h_t^2 = (\sigma_a^2 + 1.5\sigma_{am} + 0.5\sigma_m^2)/\sigma_P^2$ (Willham, 1972)

σ_P^2 =toplam fenotipik varyans; σ_a^2 =doğrudan eklemeli genetik varyans ; σ_{am} = doğrudan genetik etki ile anasal eklemeli genetik etki arasındaki kovaryans, σ_m^2 =anasal genetik varyansı; σ_{pe}^2 = anasal sabit çevre varyansı; σ_e^2 = hata varyansı; r_{am} = doğrudan eklemeli genetik etki ile anasal eklemeli genetik etki arasındaki korelasyon; pe^2 = toplam fenotipik varyanta anasal sabit çevre varyansının payı; e^2 = toplam fenotipik varyanta hata varyansının payı; m^2 = anasal kalıtım derecesi; h^2 = kalıtım derecesi; h_t^2 = toplam kalıtım derecesi = $h_t^2 = (\sigma_a^2 + 1.5\sigma_{am} + 0.5\sigma_m^2)/\sigma_P^2$ (Willham, 1972)

Discussion and Conclusion

Birth Weight (BWT): The mean BWT in year 2007 was the highest valve followed by 2008, 2005 and 2006, respectively. This might be attributable to fluctation in management conditions from yaer to year. These results were similar to reports in the previous studies carried out on different breeds of sheep (3, 4, 6, 11, 14, 17, 19). The mean BWT was higher in male lambs than female lambs ($p<0.05$) and similar to those reported previously (4, 10-12, 14, 18, 19). On the contrary, non-significant effect of sex on BWT was reported in a study on Anadolu Merino sheep (2). The effect of birth type on BWT was significant ($p<0.05$) and similar to the findings reported in some studies carried out on various pure and crossbred sheep (3, 6, 10-12, 14, 18, 19). In regards to the effect of age of dam, it was observed that the differences in means of age of dam groups was insignificant, except for two years old dam, this might be explained as the ewes produce lighter lambs in their first experience of lambing. Insignificant effect of age of dam on BWT was also reported in the previous researches (3, 4, 10).

Weaning Weight (WWT): Least square means and standard errors of WWT are presented in Table 2. According to the results of the analysis, the average WWT of Awassi lambs was 22.99±0.196 kg. The differences among the years, except results in 2006, were significant ($p<0.05$). The highest WWT was obtained in 2005 followed by 2007, 2008 and 2006, respectively. There have been a large number of studies carried out by various rescarchers conducted on sheep to investigate the effect of year on WWT. The most of them reported significant effect of year on WWT (4, 12, 19) while the results obtained in some other studies reported non-significant effect of year (3, 10). This could also be explained by that environmental and managemental conditions have not been stable, and fluctation from year to year.

The effects of sex on WWT were significant ($p<0.05$) and male lambs were more weight at weaning than females. This result is in agreement with some of previous studies (3, 4, 6, 7, 10, 12, 14, 18, 19). The effect of type of birth on WWT was significant ($P<0.05$) and in agreement with those reported in the studies carried out on Karacabey Merino, Akkaraman, Awassi, Konya Merino, Anadolu Merino and Zom sheep (3, 4, 6, 10, 14, 19). The effect of age of dam on WWT was insignificant, except for 4 and 5 years old dams, and corresponds with some previous reports (3, 4, 19).

The effect of season of lambing was significant on WWT ($p<0.05$). Lambs born in the first season (December-January) were more weight at weaning than those born in second season (February-March) although the lambs born in the first season was less weight than those born in the second season in terms of BWT. This could be due to the reason that lambs born earlier stayed with their mother longer and received more care until weaning and consumed more milk than the lambs born later time.

Average Daily Weight Gain (ADWG): The least square means and standard errors of the average daily weight gain (ADWG) from birth to weaning and the effects of the factors in the model are presented Table 2. All the factors in this study were significant on ADWG ($p<0.05$). The significant effect of year was also reported in some studies (4). In this study, the effect sex on ADWG was significant ($p<0.05$) and similar to the results reported in the previous studies (3, 4, 10, 15). The effect of type of birth on ADWG was significant ($p<0.05$) and in agreement with some studies (3, 10, 12). On the other hand, the effect of age of dam on ADWG was insignificant, except for 4 and 5 years old dams, and similar to those reported in some previous studies (3, 4).

Genetic Parameters: In this study, h_a^2, h_m^2 and h_t^2 estimates for BWT were in the ranges of 0.21 to 0.25, 0.08 to 0.09, and 0.40 to 0.43, respectively. These findings are directly comparable to those reported in earlier studies conducted on Awassi lambs. Heritability estimates for BWT were higher than those found by (21-24), and lower than those found by (25, 26).

Estimates of heritabilities for WWT adjusted to 90 days of age was found to be lower in comparison to the findings in (24). However, it seemed to be higher than those found by (21, 22, 26-28).

The heritability estimate for ADWG was found lower than those found in the other studies (24, 26, 29). BWT had a moderate genetic correlations (0.62) with WWT and ADWG whereas it was found to be unity (1.00) between the latter traits and was in agreement with the report earlier (24). However, (26) reported that genetic correlations of BWT were 0.11 and -0.05 with WWT and ADWG, respectively, and it was 0.03 between WWT and ADWG contradicting the finding (1.00) in this study and in (24) (0.99).

Heritability estimates were larger than those reported in the literature for Romanov (0.07) (13), Ramlıç (0.14) and Dağlıç (0.18) (20), and for Scottish Blackfaced sheep (0.15) (15), but smaller than those reported for Horro sheep (1). For WWT, heritability estimates were ranged ranges from 0.13 to 0.17, and were similar to the previous report for Scottish Blackface sheep (0.14) (15), for Horro sheep (0.10 to 0.26) (1), but smaller than the finding for Romanov (0.24) (13). In addition, the additive genetic correlation between BWT and WWT was larger than 0.45 reported for Horro sheep (1).

In this study, single born and male lambs were more weight in terms of BWT and WWT, and grew faster daily up until weaning. However, the lambs born earlier in lambing season were lighter in terms of BWT but grew faster until weaning and ended up with heavier WWT. The results of the present study revealed that the enviromental factors beside management and feeding regime cause differences in the expression of economically important trait such as birth and weaning weight in sheep breeding and farming. In this study, year, sex, type and season of birth had significant effect on birth weight, weaning weight and daily growth from birth to weaning, on the other hand, the age of dam effect on the stated traits was insignificant.

Medium direct and high total heritability estimates obtained in this study and suggest that Awassi ewes showed a good mothering ability in terms of pre-natal care for their lamb(s), and would be effective in terms of genetic improvement for BWT. However, it should be paid attention that the increasing BWT would increase difficulty in lambing. Lack of maternal genetic and environmental variance for WWT might be the result of the structure of the data such that this flock was formed by means of buying ewes and rams from different flocks at the beginning. Thus, the pedigree might not be complete enough for animal model to take the advantages of using numerator relationship matrix. In future evaluations with more data and more complete pedigree, the use of the models including maternal additive and maternal environmental effect may produce more reliable and usable parameters for WWT.

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