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Analysis of the non-genetic factors affecting the growth traits of Balouchi sheep

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Abstract

A study was conducted to evaluate the effects of non-genetic factors on the growth behavior of Balouchi sheep breed. The data of growth traits, birth weight (BW), weaning weight (WW), weight at 6, 9 and 12 months of age (W6, W9 and W12, respectively) were taken from 1400 lambs belonging to historical data from Abbasabad Sheep Breeding Station located at the North-east of Iran during a period of five years. Statistical analyses were performed using a general linear model including non-genetic factors: lamb sex, birth year and litter size as main effects, the lamb's age when weighed as covariable, and the interactions between these factors. Results showed that all traits were significantly ($P < 0.001$) affected by all factors. However, the interaction between sex and litter size was not significant for BW, WW and W6. Environmental factors have very important roles in the development and growth of Balouchi sheep at different ages. Therefore, a correction is necessary to increase the accuracy of direct selection on lamb weight at different growth stages.

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Introduction

There were about 50 million heads of sheep in 2013 in Iran (FAO, 2016). The Balouchi breed is one of the famous meat-wool sheep breeds in this country. This breed is fat tailed and well adapted to harsh environmental condition of eastern and north-eastern area of Iran (Tahmoorespur and Sheikhloo, 2011). There are various production traits of this breed which suggest that there is a potential for improvement of economic traits. However, growth performances are preferred traits to improve due to low economic value of wool compared to meat production. The growth demonstrated as a change in volume, size or shape with the passing of time is a very important characteristic of living organisms, especially in meat sheep (Lupi *et al.*, 2015). Diversity in performance traits could be due to several genetic and environmental factors. Any selection program should be designed based on the genetic and environmental effects on the objective traits (Yazdi *et al.*, 1999). Non-genetic factors must be corrected before starting genetic analysis. Even when an attempt is made to provide a uniform environment, there are still unknown environmental differences between animals, known as residual error. An adjustment should be made for environmental and physiological sources of variation such as age, sex, birth type or litter size, years, seasons and such other environmental variables that can be evaluated (Babar *et al.*, 2004).The effect of non-genetic factors on growth performance in sheep has been investigated in several studies. These factors in different areas have their own specific effects regarding the environmental characteristics of related areas (Gbangboche *et al.*, 2006; Momoh *et al.*, 2013). Therefore, the present study was carried out to investigate the effect of sex of lamb, year of birth and litter size on body weight of Balouchi lambs at different ages.

Materials and methods

Animals and location of study area

The data on 1400 lambs born from 438 Balouchi ewes sired by 61 rams kept at the Abbasabad sheep breeding station located at a semi-arid area in the North-east of Iran during 2005-2009 were utilized to estimate the effect of environmental factors affecting BW, WW, W6, W9, and W12. The animals were raised in a closed system and fed with alfalfa, barley and straw. Sheep were supplemented in the last month of gestation and during lactation (usually barley), and births occurred mainly in April and May. Lambs were left with dams until age 90 days, from this age they were kept to fatten until reaching slaughter age.

Data and analyses

The data file contained information on individuals, sire and dam identification code, sex, litter size, birth date, date of weighing and measure of body weight. The data were analyzed to estimate the effect of year of birth, litter size and sex of lamb born on the lamb growth. The mathematical model assumed for the Least-Squares Analysis was:

$$Y_{ijklm} = \mu + S_i + A_j + L_k + (SA)_{ij} + b(Age - Age) + \varepsilon_{ijklm}$$

where Y_{ijklm} is the weight of a lamb; μ is the overall mean; S_i is the sex of lamb; A_j is the year of birth of a lamb; L_k is litter size; $(SA)_{ij}$ is the interaction between sex and year of birth; b is regression coefficient, Age is age of lamb at weighing time, ε_{ijklm} is residual error. A statistical analysis using the univariate general linear model from the statistical package Minitab v.16 was used to analyze the effect of the fixed factors and interaction between them on the total variance of the records.

The lamb's age at weighing time was used as covariate to correct the record of WW, W6, W9 and W12. Comparison of means was performed by Tukey test, setting $P < 0.05$ to identify significant differences between treatments.

Results and discussion

The data were used in the present study belonging to Abbasabad sheep breeding station that Balouchi breed is mainly kept over there. This sheep is a dual purpose breed, however, as wool is not a valuable product, meat is a more important trait in this breed.

As shown in Fig. 1, there was not such a big variation for BW and WW among different years, however, it was significant.

Two reasons are supposed for this result, first, the selection program is not suitable and second, environmental factors influence the traits.

The effects of sex, birth year and litter size are shown in the Tables one to three, respectively. All non-genetic factors that have been investigated in this study significantly influenced on lamb weights in all ages (P < 0.001). Male animals were heavier than females as shown in Table 1.

Table 1. Least square means (LSM) and standard error (SE) of lambs live weights according to sex of lambs.

Trait	Sex[1]	N[2]	LSM[3]	SE
BW	M	588	3.671^{a}	0.151
	F	534	3.440^{b}	0.152
WW	M	222	21.220^{a}	1.001
	F	212	18.890^{b}	1.000
W6	M	343	33.020^{a}	1.356
	F	287	29.630^{b}	1.360
W9	M	213	41.420^{a}	1.312
	F	148	35.800^{b}	1.342
W12	M	194	48.130^{a}	1.148
	F	169	41.680^{b}	1.170

1 Sex of lambs; M: male, F: female

2 Number of records

3 Column with different superscripts within subclass indicate significant differences (P < 0.001).

Table 2. Least square means (LSM) and standard error (SE) of lambs live weights according to year of birth of lambs.

Trait	**Birth year**	**N[1]**	**LSM[2]**	**SE**
BW	2005	176	3.410^{b}	0.156
	2006	209	3.638^{a}	0.155
	2007	239	3.526^{ab}	0.156
	2008	183	3.678^{a}	0.158
	2009	315	3.526^{ab}	0.154
WW	2005	151	17.190^{b}	1.030
	2006	188	21.070^{a}	1.024
	2007	95	21.900^{a}	1.051
W6	2005	136	30.980^{b}	1.389
	2006	176	32.810^{a}	1.378
	2007	159	28.110^{c}	1.409
	2008	159	33.400^{a}	1.398
W9	2005	103	37.470^{b}	1.351
	2006	129	39.070^{a}	1.353
	2007	129	39.300^{a}	1.346
W12	2005	114	46.650^{a}	1.174
	2006	90	43.940^{b}	1.211
	2007	159	44.130^{b}	1.175

1 Number of records

2 Column with different superscripts within subclass indicate significant differences (P < 0.001)

This fact has been reported in the other studies (McManus *et al.*, 2003; Babar *et al.*, 2004; Macedo and Arredondo, 2008; Baneh and Hafezian, 2009; Ulutas *et al.*, 2010; Gbangboche *et al.*, 2011; Momoh *et al.*, 2013; Lupi *et al.*, 2015). Differences in physiological functions in both sexes cause such a tendency in body weight. The nature of testosterone, a steroid hormone whose anabolic effects act as growth promoter, attributes in postnatal growth in males (Lupi *et al.*, 2015).

The variation in lamb weights at different ages observed in different years (Table 2) may be due to climate conditions (precipitation, humidity and temperature), environmental conditions and management as well as some environmental effects on the ewes during pregnancy.

Table 3. Least square means (LSM) and standard error (SE) of lambs live weights according to litter size.

Trait	Litter size	N[1]	LSM[2]	SE
BW	1	565	4.646[a]	0.029
	2	531	3.948[b]	0.030
	3	18	3.341[c]	0.160
	4	2	3.044[cd]	0.482
	5	5	2.373[d]	0.305
WW	1	243	23.780[a]	0.262
	2	182	20.080[b]	0.281
	3	10	15.200[c]	1.564
	4	2	15.170[c]	2.701
W6	1	353	34.050[a]	0.283
	2	264	30.630[b]	0.330
	3	6	27.440[bc]	1.672
	4	2	25.760[c]	3.754
W9	1	225	37.870[a]	0.287
	2	133	35.350[b]	0.384
	3	2	37.120[a]	3.011
W12	1	209	44.220[a]	0.276
	2	150	41.640[b]	0.335
	3	2	40.900[b]	2.274

1 Number of records

2 Column with different superscripts within subclass indicate significant differences ($P < 0.001$).

Table 4. Estimates of phenotypic correlation (below diagonal) and corresponded Pearson correlation *P*-value (above diagonal) between lambs live weights.

Trait	BW	WW	W6	W9	W12
BW		0.000	0.000	0.000	0.000
WW	0.401		0.000	0.000	0.000
W6	0.314	0.726		0.000	0.000
W9	0.224	0.574	0.747		0.000
W12	0.225	0.509	0.676	0.751	

The management includes farmer manager, his ability to supervise the staff, availability of financial resources and selection strategies. Climate and environmental changes affect the quality and quantity of pasture forages, which affect the provision of food (Baneh and Hafezian, 2009; Momoh *et al.*, 2013). Adequately fed ewes are expected to produce heavy lambs.

Litter size (single or multiple) had significant effects on living weight at different ages of lambs, single born lambs were heavier than multiple born lambs (Table 3). This result is according to the earlier studies (Dimsoski *et al.*, 1999; Rodríguez *et al.*, 1999; Hernández, 2004; Hinojosa-Cuéllar *et al.*, 2012; Gavojdian *et al.*, 2013). This could be due to competition for nutrient and uterine space and the limited capacity of ewes to provide more nourishment for the development of multiples fetuses and more milk for lambs (Gbangboche *et al.*, 2006; Momoh *et al.*, 2013). However, the multiple born lambs may demonstrate compensatory growth after weaning. There was no variation in weaning weights among lambs from different birth types (Quesada *et al.*, 2002) and also, González *et al.* (2002) concluded that lambs from multiple births reach daily weight gains after weaning, that are higher than those of single birth lambs. Therefore, there are differences between breeds in term of the effect of litter size on live weight. In addition, the interaction between sex and litter size was significant ($P < 0.01$) for w9 and w12 that shows it should be considered in genetic analyses.

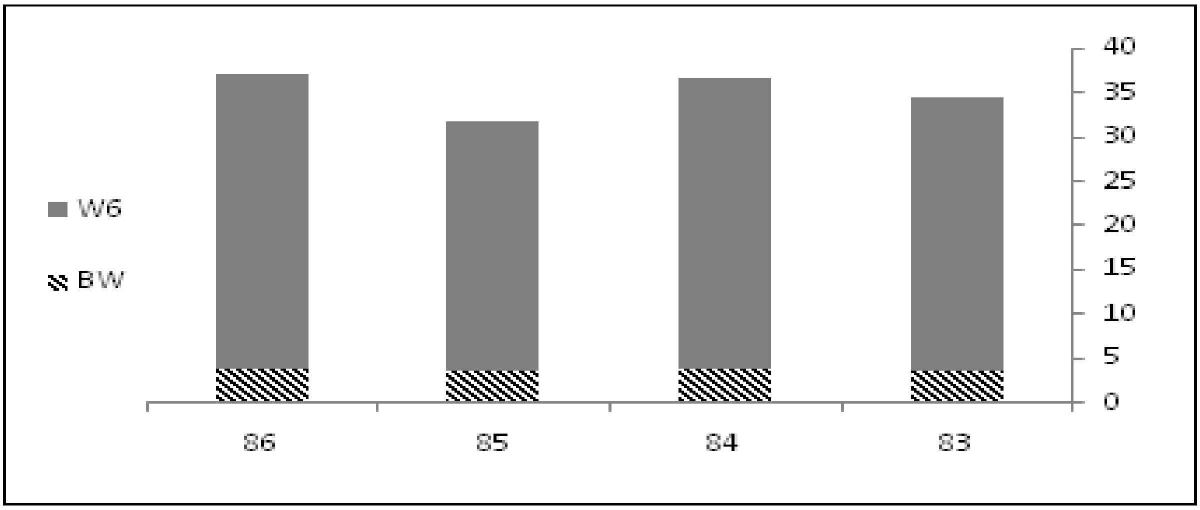

Fig. 1. Least square means of BW and W6 according to year of birth of lambs.

Table 4 presents the coefficients of phenotypic correlation between body weights and corresponded Pearson correlation *P*-value. Although, all correlation coefficients are significant, the correlation between WW, W6, W9 and W12 are higher than correlation between BW and the other traits. Similar results were observed in previous studies for the Sabi sheep of Zymbawe, Iran-Black and Lori-Bakhtiari sheep (Matika *et al.*, 2001; Rashidi, 2013; Vatankhah, 2013, respectively). Phenotypic correlation between two traits includes both the genetic and environmental correlations. With appropriate design, the genetic correlation can be separated from the environmental correlation (Momoh, 2013). Therefore, in this study the environmental correlation between WW and post-weaning weights may be higher than pre-weaning weights.

Conclusion

The results obtained in the present study revealed that environmental factors cause differences in live weight of Balouchi sheep from birth to 12 months of age.

A breeding program needs to adjust records according to non-genetic effects to estimate breeding values of animals accurately. Sex of lamb, year of birth and litter size influenced body weight of Balouchi lambs. Hence, the effect of these factors should be considered in mixed model approaches to find pure genetic values of animals.

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