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Heritability estimates for some growth traits and Kleiber ratios in Karakul sheep

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ABSTRACT

Data and pedigree information obtained from 1491 birth records of Karakul sheep collected from the Agricultural Office, Darab, were analyzed. The objective was to evaluate the performance and to estimate the heritability of Karakul sheep. The mean of BW, WW, W_6, ADG_1, ADG_2, $WW^{0.75}$, $W_6^{0.75}$, KR_1 and KR_2 were 4.20 kg, 16.50kg, 24.90 kg, 0.136 g/d, 0.114 g/d, 8.20 kg, 11.11 kg, 0.016 and 0.010, respectively. The heritability estimates (uncorrected and corrected) for BW, WW, W_6, ADG_1, ADG_2, $WW^{0.75}$, $W_6^{0.75}$, KR_1 and KR_2 were (0.340, 0.288), (0.350, 0.307), (0.462, 0.173), (0.402, 0.410), (0.418, 0.170), (0.334, 0.288), (0.442, 0.153), (0.552, 0.606) and (0.482), respectively. The environmental factors were significant sources of variation on growth traits that play an important role in expression of genetic potential. The findings from this study exhibit that weight at 6 month are the most important trait to consider for enhancing productivity in Karakul sheep.

Key words: Heritability, Karakul sheep, Kleiber ratio

The research on native/local breeds and getting information is important not only for genotype conservation but also for breeding programmes. A slow growth rate, resulting in a low market weight of sheep, was identified to be one of the factors limiting profitability throughout the world (Mukasa-Mugerwa and Lahlou-Kassi 1995). The efficiency of sheep production enterprises can be improved by enhancing litter size, lamb weight, milk yield, and wool quantity and quality (Yazdi *et al*. 1997). The significant resources were spent to have improved management information systems for animal populations; and the accurate estimates of the genetic parameters as these are vital for prediction of breeding value and selection response.

The body condition score (BCS), and some indices such as Kleiber ratio (KR; Kleiber 1947, Scholtz and Roux 1988) which developed as an alternative ratio for breeding purpose are used to select animals for breeding (Arthur *et al*. 2001). The Kleiber ratio (KR) is recommend to be a useful indicator of feed conversion and an important selection criterion for efficiency of growth (Köster *et al*. 1994). This ratio is a measurement for efficiency, independent of body size (Kleiber 1961). The Kleiber ratio, defined as growth rate/ body mass$^{0.75}$, was suggested for measuring growth efficiency (Kleiber 1947). Arthur *et al*. (2001) exhibited that the KR is highly negatively correlated (r=–0.81) with feed conversion efficiency in beef cattle. Bergh (1994) indicated that Kleiber ratio (KR) is highly heritable ($h^2 = 0.50$) in beef cattle, which suggests that herd feed conversion could be improved through a selection process. The selection for Kleiber ratio (KR) has fewer negative results than selection for average daily gain (ADG), since it has a lower correlation with other traits, such as birth weight, final weight, average daily gain per day of age, shoulder height and body length (Bergh 1994).

The purpose of this study was to obtain heritability estimates for the some growth traits and Kleiber ratio at different stages of growth.

MATERIALS AND METHODS

Animal resource: The data and pedigree information on Karakul sheep were collected by Agricultural Office in Darab, during 1996 to 2001. These records included pedigree information (animal, sire and dam number), birth information (date of birth, lamb sex, birth type), performance records (birth weight (BW), weaning weight (WW), and weight at months 6 (W_6)) and calculated records (average daily gain from birth to weaning (ADG_1), average daily gain from weaning to weight at month 6 (ADG_2), metabolical weight at weaning ($WW^{0.75}$), metabolical weight at month 6 ($W_6^{0.75}$), Kleiber ratio from birth to weaning (KR_1), Kleiber ratio from weaning to month 6 (KR_2)). The number of records and mean per each trait are shown in Table 1.

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Statistical analysis

The corrected weaning weight (i), ADG_1 (ii), ADG_2 (iii), (iv) KR_1 and (v) KR_2 were computed by the following formula:

(i) Corrected weaning weight at day 90 = ((uncorrected weaning weight – birth weight)/lamb age at weaning) × 90 + birth weight

(ii) ADG_1 = (WW – BW)/no. of day from birth to weaning

(iii) $ADG_2 = (W_6 – WW)$/no. of day from weaning to month 6

(iv) $KR_1 = ADG_1/WW^{0.75}$

(v) $KR_2 = ADG_2/W_6^{0.75}$

The analysis of variance (General Linear Model/GLM procedure) and regression coefficient were estimated using the SAS (2004) and Harvey software's respectively. The statistical models for corrected (1) (using environmental effects including sex, birth type, dam age, year) and uncorrected (2) regression coefficient were:

(1) $Y_{ijklm} = \mu + S_i + T_j + D_k + P_l + b\ (X_{ijiklm} – X) + e_{ijklm}$

(2) $Y_{im} = \mu + b\ (X_m – X) + e_{im}$

where, Y_{ijklm}, the records on the i^{th} sex, j^{th} birth type, k^{th} birth year and l^{th} dam age of offspring; Y_{im}, the records on the i^{th} offspring; μ, population mean; S_i, i^{th} sex effect; T_j, j^{th} birth type effect; D_k, k^{th} birth year effect; P_l, l^{th} dam age effect; b, regression coefficient; X_m, the records on the m^{th} dam; X, the explanatory variable; and e_{ijklm} and e_{im}, random error.

The heritability estimate (h^2) for all traits in this research was calculated by the following formulae:

$$h^2 = 2b_{OD}$$

where, b_{OD}, regression coefficient between progeny per dam.

The standard error for heritability was estimated by the following formulae:

$S_b^2 = [\text{“}z^2 – (xz)^2/\text{”}x^2]/N\text{-}2$

$S.E.(b) = \text{“}s_b^2/\text{”}x^2$

$S.E(h^2) = 2S.E(b)$

where

N, number of progeny-dam; X, dam record; Z, progeny mean.

RESULTS AND DISCUSSION

Environmental effects

Mean of birth weight (BW), weaning weight (WW), weight at month 6 (W_6), average daily gain from birth to weaning (ADG_1), average daily gain from weaning to weight at month 6 (ADG_2), metabolical weight at weaning ($WW^{0.75}$), metabolical weight at month 6 ($W_6^{0.75}$), Kleiber ratio from birth to weaning (KR_1) and Kleiber ratio from weaning to month 6 (KR_2) are given in Table 1. The analysis of variance results and least squares mean of BW, WW, W_6, ADG_1, ADG_2, $WW^{0.75}$, $W_6^{0.75}$, KR_1 and KR_2 are presented in Tables 2 and 3.

The lamb sex was highly significant effect on growth traits. Male lambs were always heavier and grew faster than female lambs. A weight difference of 0.19 kg (5.0%) at birth increased to 1.06 kg (6.83%) at weaning and 2.12 kg (8.27%) at month 6. The birth type had a significant (P<0.01) effect on BW, WW, W_6, ADG_1, ADG_2, $WW^{0.75}$, $W_6^{0.75}$, KR_1 and KR_2. The birth year effect exhibited significant (P<0.01) difference on W_6, ADG_1, $W_6^{0.75}$ and KR_2 and dam age also showed significant effect (P<0.01) on all traits except WW and $WW^{0.75}$. Blaclwell and Henderson (1955) and Brown-Douglas *et al.* (2005) have reported a similar result of birth year effect on growth traits. As well as, the levels of advantages of male lamb recorded in this study are comparable to those reported for sheep breeds (Blackburn and Field 1990, Warmington and Kirton 1990, Hermiz *et al*. 1997).

Table 1. Metabolical weight and Kleiber ratio in Karakul sheep

Traits	No. of records	Means±SE
BW	1491	4.20±0.760
WW	1094	16.50±3.690
W_6	1203	24.90±5.360
ADG_1	1094	0.136±0.038
ADG_2	1203	0.114±0.028
$WW^{0.75}$	1094	8.20±1.380
$W_6^{0.75}$	1203	11.11±1.790
KR_1	1094	0.016±0.002
KR_2	1203	0.010±0.001

Heritability estimates

The corrected and uncorrected heritability estimates obtained for the various growth traits and Kleiber ratios (KR) are shown in Table 4. In general, heritability estimates for the growth traits, metabolical weight and Kleiber ratio were moderate to high. The heritability estimate for BW in present investigation is 0.288 which is comparable with finding of Gizaw *et al*. (2007). It is evident that heritability estimates were significantly different (P<0.01) between the corrected and uncorrected using regression model for BW, W_6, ADG_2, $WW^{0.75}$and $W_6^{0.75}$traits. A similar estimate of heritability for growth traits were reported by (Burfening and Kress 1993, Snyman *et al*. 1995, Yazdi *et al*. 1997, Al-Shorepy 2001, Assan *et al*. 2002, Matika *et al*. 2003). The present finding revealed that using appropriate model for data analysis (apply fix and random effect in model) cause accurate heritability estimate for growth traits.

Badenhorst *et al*. (1991) and Van Wyk *et al*. (1993) reported that heritability estimates of Kleiber ratio for pre-weaning growth is 0.116±0.054, 0.137±0.027 and 0.309±0.126, respectively. Bergh (1994) indicated that Kleiber ratio (KR) is highly heritable (h^2 = 0.50) in beef cattle, which suggests that herd feed conversion could be improved through a selection process. The present finding demonstrated high heritability estimates for all traits in this study. As regards to our results, it seems that the Kleiber ratio is highly heritable and suggesting that breeders can select Kleiber ratio as important breeding parameters to

Table 2. Growth traits in Karakul sheep

Factors		Traits				
		BW (kg)	WW (kg)	W_6 (kg)	ADG_1 (g/d)	ADG_2 (g/d)
Mean		4.25±0.75	16.53±3.69	24.94±5.36	136±0.038	114±0.028
Sex	Female	3.78±0.09^{b}	14.46±0.49^{b}	23.52±0.68^{b}	118±0.005^{b}	109±0.003^{b}
	Male	3.97±0.09^{a}	15.52±0.51^{a}	25.64±0.70^{a}	128±0.005^{a}	120±0.003^{a}
Birth type	Single	4.27±0.06^{a}	17.01±0.30^{a}	26.13±0.42^{a}	141±0.003^{a}	121±0.002^{a}
	Twin	3.48±0.14^{b}	12.98±0.84^{b}	23.04±0.17^{b}	105±0.008^{b}	108±0.006^{b}
Birth year	1996	3.97±0.08	15.28±0.48	24.15±0.65^{ac}	124±0.005	111±0.003^{b}
	1997	3.87±0.07	14.45±0.46	24.03±0.64^{ac}	117±0.004	111±0.003^{b}
	1998	3.91±0.07	14.43±0.47	23.68±0.64^{b}	116±0.004	109±0.003^{b}
	1999	3.62±0.23	14.55±1.19	26.60±0.66^{a}	121±0.012	127±0.009^{a}
	2000	3.96±0.07	14.92±0.45	22.00±0.63^{a}	121±0.004	100±0.003^{b}
	2001	3.92±0.27	16.34±1.30	27.30±0.81^{bc}	138±0.013	128±0.009^{a}
Dam age (year)	2	3.67±0.10^{c}	14.17±0.60	22.93±0.80^{d}	117±0.006^{ab}	107±0.004^{d}
	3	3.69±0.10^{c}	14.51±0.55	23.77±0.76^{bcd}	120±0.005^{ab}	111±0.004^{bcd}
	4	3.83±0.09^{ab}	15.32±0.54	24.90±0.75^{abc}	127±0.005^{a}	117±0.004^{abc}
	5	4.00±0.09^{a}	15.37±0.54	24.85±0.73^{abc}	126±0.005^{a}	115±0.003^{abcd}
	6	3.91±0.09^{ab}	15.13±0.53	24.61±0.73^{abc}	123±0.005^{ab}	114±0.003^{abcd}
	7	3.85±0.10^{ab}	14.70±0.55	25.52±0.78^{ab}	120±0.005^{ab}	120±0.004^{ab}
	8	3.98±0.16^{ab}	13.90±0.86	23.78±1.26^{cd}	109±0.009^{b}	109±0.006^{cd}

Table 3. Kleiber ratio and Metabolical weight in Karakul sheep

Factors		Traits			
		KR_1	KR_2	$WW^{0.75}$ (kg)	$W_6^{0.75}$ (kg)
Mean		16±0.0022	10±0.001	8.16±1.38	11.11±1.79
Sex	Female	15±0.0003 b	10±0.0001 b	7.36±0.18 b	10.61±0.23 b
	Male	16±0.0003 a	10.4±0.0001 a	7.74±0.19 a	11.32±0.23 a
Birth type	Single	16±0.0001 a	10±0.00008	8.34±0.01 a	11.51±0.14 a
	Twin	14±0.0005 b	10±0.00023	6.76±0.31 b	10.42±0.39 b
Birth year	1996	15±0.0003	10±0.0001 bc	7.66±0.18	10.82±0.21 bc
	1997	15±0.0002	10±0.0001 bc	7.34±0.17	10.79±0.21 bc
	1998	15±0.0002	10±0.0001 bc	7.33±0.17	10.67±0.21 c
	1999	16±0.0007	11±0.0003 a	7.40±0.44	11.65±0.55 a
	2000	15±0.0002	9±0.0001 c	7.52±0.16	10.10±0.21 c
	2001	16±0.0008	11±0.0003 ab	8.05±0.48	11.76±0.60 a
Dam age (year)	2	15±0.0003 a	10±.0001 bc	7.24±0.22	10.41±0.26 d
	3	15±0.0003 a	10±0.0001 abc	7.37±0.20	10.69±0.25 bcd
	4	16±0.0003 a	10±0.0001 ab	7.67±0.20	11.08±0.25 abc
	5	15±0.0003 a	10±0.0001 abc	7.69±0.20	11.06±0.24 abc
	6	15±0.0003 a	10±.0001 abc	7.61±0.19	10.97±0.24 abc
	7	15±0.0003 ab	11±0.0001 a	7.43±0.20	11.28±0.26 ab
	8	14±0.0005 b	10±0.0002 c	7.14±0.32	10.71±0.42 cd

BW, birth weight, WW, weaning weight; W_6, body weight at month 6; ADG_1, average daily gain from birth to weaning; ADG_2, average daily gain from weaning to month 6; $WW^{0.75}$, metabolical weight at weaning;$W_6^{0.75}$, metabolical weight at month 6; KR_1, Kleiber ratio from birth to weaning; KR_2, Kleiber ratio from weaning to month 6; Means having the same superscripts do not differ significantly at 1% level of significance.

improve the sheep production.

The environmental factors were significant sources of variation on growth traits that play an important role in expression of genetic potential. The findings from this research exhibit that weight at 6 month or about one year of age are the most important traits to consider for enhancing productivity in Karakul sheep. As per previous studies, the existence of high correlations between body weight at six month/year of age and earlier ages allows earlier weights to respond to improve protocols based on 12-month weight, and it also permits some initial culling on performance at an earlier age.

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Table 4. The uncorrected (h_1^2) and corrected (h_2^2) heritability estimates for some growth traits in Karakul sheep

Traits	h_1^2	h_2^2	Compression
BW	0.340±0.1	0.288±0.1	**
WW	0.350±0.2	0.307±0.2	NS
W_6	0.462±0.3	0.173±0.3	**
ADG_1	0.402±0.2	0.410±0.2	NS
ADG_2	0.418±0.3	0.170±0.3	**
$WW^{0.75}$	0.334±0.2	0.288±0.2	**
$W_6^{0.75}$	0.442±0.3	0.153±0.3	**
KR_1	0.552±0.3	0.606±0.2	NS
KR_2	0.482±0.3	—	—

BW, birth weight; WW, weaning weight; W_6, body weight at month 6; ADG_1, average daily gain from birth to weaning; ADG_2, average daily gain from weaning to month 6; $WW^{0.75}$, metabolical weight at weaning; $W_6^{0.75}$, metabolical weight at month 6; KR_1, Kleiber ratio from birth to weaning; KR_2, Kleiber ratio from weaning to month 6; NS, not significant; *, $P < 0.05$; **, $P < 0.01$; —, not measured

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