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Genetic variability in the body weight of Sudan desert goats

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Abstract

Data on 586 kids from 30 bucks and 120 does of Sudan desert goats was used in the present study. The study aimed at investigating the genetic variations of body weight at various ages. Range of heritability estimates for body weight from birth to 6th month was 0.04-0.54. The estimates from dam component ranged 0.28-0.68 which was higher than that from sire component estimates. The genetic correlations for body weight at various ages were substantially high, ranged from 0.51-0.99 as sire, dam and dam nested in sire components. Phenotypic correlations of body weight at various ages ranged from 0.43-0.99 with differences being significant (P<0.01). Low to high environmental correlations (0.10-0.33) were encountered as dam component. However, the random effect of sire was found to be significantly (P<0.01) positively correlated.

Keywords: body weight, desert goats, heritability, genetic and phenotypic correlations, Sudan

Zusammenfassung

Die genetische Variabilität des Körpergewichts von sudanesischen Wüstenziegen

In der aktuellen Studie wurden 586 Nachkommen von 30 Böcken und 120 Muttertiere sudanesischer Wüstenziegen aus dem nördlichen Darfur genutzt. Ziel dieser Untersuchung war es die Variation der Körpergewichte in unterschiedlichen Alterabschnitten aufzuzeigen. Die Schätzung der Heritablität für das Merkmal Körpergewicht im Abschnitt Geburt bis zum 6. Lebensmonat variierte zwischen 0,04 und 0,45. Die Schätzung des maternalen Anteils lag dabei zwischen 0,25 und 0,68 und war deutlich höher als der paternale Anteil. Die genetische Korrelationen für Körpergewicht in verschiedenen Altersabschnitten rangierte zwischen 0,51 bis 0,99 für die Effekte Vater, Mutter und Mutter genestet mit Vater. Die phänotypischen Korrelationen für dieses Merkmal lagen zwischen 0,43 und 0,99 und zeigten signifikante Unterschiede (P<0,01) auf. Niedrige bis mittlere Umweltkorrelationen (0,10 bis 0,33) konnten den maternalen Komponenten zugeordnet werden. Hingegen war der zufällige Effekt des Vaters signifikant positiv korreliert (P<0,01).

Schlüsselwörter: Körpergewichte, Wüstenziegen, Heritabilität, Genetische und phänotypische Korrelation, Sudan

Introduction

Genetic improvement is an integral part of many goat development programs in the tropics. Goats play a vital role as shrub-fighters in landscape conservation and its meat production is one of the important traits for the extensive production (Herold *et al.* 2007). However, many people associate grazing goats with overgrazing, soil degradation and deforestation (Peacock & Sherman 2010). Some goat breeds emphasized increasing interest that might be due to the recent development of agroturistic activities as well as some possibilities of usage of goat breeds in landscape management and in the agro-environmental programs (Niznikowski *et al.* 2006). Kid growth, birth and body weights of other ages are traits of breeding and economic importance in goat breeds, performance and morphological diversity in goat could be attributed to several genetic, non genetic factors and existence of many goat populations (Afzal 2004, Liu *et al.* 2005, Diken *et al.* 2008, Traore *et al.* 2008).

In Sudan and other arid regions, desert goats are mainly raised for meat production especially in rural areas and also provide milk for family needs and variety of fiber (El-Fadil 2001, Galal 2005). In some countries goats also provide a major source of animal protein and household cash income for smallholder farmers (Toplu & Altinel 2008). Desert goats had significantly greater carcass weight and dressing percentage that might be partly due to the heavier body components (El-Khidir *et al.* 1998). Babiker *et al.* (1990) indicated that desert goat meat had superior processing properties. Genetic and phenotypic parameter estimates are scarce in goats reared under arid conditions. Few works, however, have explored the variability within goat populations (Snyman & Olivier 1996, Lanari *et al.* 2003). This study was initiated to estimate heritability, genetic, phenotypic and environmental correlations for body weight at various stages of growth from birth to six month of age in a flock of desert goat in Sudan.

Materials and methods

The study was carried out in the premises of Western Sudan Agricultural Research Station. The breeding flock which was consisted of 30 bucks and 120 does aged 1-2 years were randomly distributed for mating in a sex ratio of one male to four females in individual breeding pens, each with 3×2×3 m dimension. The flock was fed a formulated ration constituted of 30 % grain, 69 % ground nut cake and 1 % salt, and in addition to that the animals were sent to grazing around the area. The pasture was mainly consisted of natural grasses, bushes shrubs and small trees. The delivered kids were kept with their dams from birth to maturity. Initial body weight was taken individually from the breeding flock at the start of the experiment and then on biweekly interval up to the end of the experiment. Birth weight of the born kids was recorded during 2-4 h after birth, there after the kids were weighed throughout the experimental period (up to 6 months) at monthly interval.

Data on 586 kids (390 male and 196 female) obtained from three delivery batches was used in this study. Least squares analysis was performed using LSML (Least Squares and Maximum Likelihood) computer program (Harvey 1990). The mathematical model assumed was:

$$Y_{ijk} = \mu + S_1 + d/S_{ij} + e_{ijk} \qquad (1)$$

where Y_{ijk} is the *ijk*-th individual body weight, μ is the population mean, S_i is the Random effect of the *i*-th sire, d/S_{ij} is the Random effect of the *j*-th dam mated to the ith sire and e_{ijk} is the random error associated with the measurement of each individual, which assumed to be randomly and independently distributed with a mean of zero and variance δ^2.

Heritability was estimated by paternal half-sib analysis. Genetic, phenotypic and environmental correlation coefficients were also obtained.

Results and discussion

Least squares means showing the analysis of variance for the effect of random factors on body weight is presented in Table 1. It was found that sire significantly (P<0.05) affected body weight at ages from birth to the 6th month. This result was supported by Mourad & Anous (1998) and Hassan *et al.* (2007). Dam significantly affected kid body weights only from birth to the 2nd month of age. This finding was in accordance with those reported by Herold *et al.* (2007) and Diken *et al.* (2008).

Table 1
Mean squares and degree of freedom of the body weight according to sire and dam within sire effects at the period from birth to 6th month of age

Source variation		Mean squares of body weights						
		Month						
	D.F.	Birth	1st	2nd	3rd	4th	5th	6th
Sire	29	1.22*	3.89*	5.88*	10.22*	14.14*	19.08*	28.45*
Dam within sire	190	0.98**	1.53**	0.82*	0.72	0.75	0.88	0.75
Error	154	0.05	0.28	0.51	0.70	0.98	1.32	1.72

*differences are statistically significant at P<0.05, **differences are statistically significant at P<0.01

Results given in Table 2 showed a wide range of the heritability estimates for body weight from birth to 6th month of age. The potential for genetic improvement is largely dependent on the heritability of the trait and its genetic relationships with other traits of economic importance upon which some selection pressure may be applied. Information on heritability is essential for planning efficient breeding programs and for predicting response to selection (Falconer 1986). Heritability estimates for birth weight in the present study ranged between 0.15 and 0.28 which are higher than those reported by Mugambi *et al.* (2007) and Roy *et al.* (2008). On the other hand heritability estimates for body weight at various ages ranged from low to high (0.04-0.54). The lowest estimate (0.04) was for body weight at 1st month of age (from sire component) similar to the results of Mugambi *et al.* (2007); while the highest heritability estimates (0.54) was for body weight at 4th month of age (from dam component). The result was nearly agreed with that obtained by Snyman & Olivier (1999) for Angora goat in South Africa. The result shows the possibility of genetic selection and improvement within individual and family selection in the breed. It could also be noticed that post-weaning heritability estimates for body weights were higher than pre-weaning unlike the estimate obtained by Mugambi *et al.* (2007) for Kenya dual purpose goat composites. The higher heritability estimates for body weight from dam component compared to sire component of variance in this study could be attributed to maternal effect, presence of large additive genetic variance and covariance and less environmental variance and covariance. The relatively large standard error for the estimates may be due to sampling.

Table 2
Heritability estimates and standard errors (SE) of birth and body weights at different ages from sire, dam and sire and dam components

Age, month	Heritability estimates		
	Sire	Dam	Sire and dam
Birth	0.15±0.27	0.28±0.39	0.22±0.33
1st	0.04±0.24	0.28±0.39	0.16±0.28
2nd	0.14±0.26	0.35±0.36	0.25±0.31
3rd	0.19±0.28	0.40±0.35	0.30±0.31
4th	0.06±0.26	0.54±0.29	0.30±0.27
5th	0.14±0.27	0.53±0.28	0.32±0.27
6th	0.10±0.25	0.53±0.29	0.34±0.28

Genetic correlations for body weight at various ages from sire and dam components are shown in table 3. They were found to be significantly ($P<0.01$) positive and ranged from moderate to high. This may indicate that selection for increased body weight at any age will result in ultimate improvement of body weight at subsequent ages. The genetic correlations from sire component ranged from (0.33-0.85), whereas that from dam component ranged from 0.58-0.99, which seemed to be slightly higher than that from sire component of variance and could be due to maternal effects and interactions at different ages. The lowest genetic correlation (0.33) was between birth and 6th month of age; however the highest genetic correlation (0.99) was found to be between 2nd and 3rd month of age. Result was in good agreement with that reported by Sinha & Singh (1997), Portolano *et al.* (2002), but inconsistent with the findings of Mavrogenis & Papachristoforou (2000) for Damascus goat. This variation may be attributed to differences in additive and non additive genetic effects, Maternal and environment influences at different ages of the kids.

Table 3
Genetic correlation estimates of body weights at various ages from sire component (above diagonal) and dam component (below diagonal)

Age, month	Birth	1st	2nd	3rd	4th	5th	6th
Birth	**1.00**	0.75**	0.76**	0.83**	0.53**	0.55**	0.33**
1st	0.87**	**1.00**	0.61	0.56**	0.52**	0.50**	0.47**
2nd	0.90**	0.87**	**1.00**	0.85**	0.51**	0.50**	0.46**
3rd	0.88**	0.81**	0.99	**1.00**	0.54**	0.52**	0.52**
4th	0.81**	0.72**	0.94	0.96**	**1.00**	0.45**	0.54**
5th	0.70**	0.70**	0.91	0.93**	0.94**	**1.00**	0.55**
6th	0.58**	0.65**	0.90	0.91**	0.91**	0.95**	**1.00**

**differences are statistically significant at $P<0.01$

Table 4
Phenotypic correlation from combined sire and dam components

Age, month	Birth	1st	2nd	3rd	4th	5th	6th
Birth	**1.00**	0.67**	0.67**	0.56**	0.54**	0.51**	0.48**
1st		**1.00**	0.86**	0.77**	0.73**	0.69**	0.60**
2nd			**1.00**	0.90**	0.84**	0.78**	0.71**
3rd				**1.00**	0.93**	0.87**	0.80**
4th					**1.00**	0.94**	0.87**
5th						**1.00**	0.95**
6th							**1.00**

**differences are statistically significant at $P<0.01$

Table 4 illustrates the phenotypic correlations for body weights from combined sire and dam components. The phenotypic correlations ranged from 0.48 to 0.95 which were highly and positively correlated ($P<0.01$). The least phenotypic correlation (0.48) was between birth and 6th month of age and the highest (0.95) was between 5th and 6th month of age. These results are higher (0.19-0.67) than those reported by Bosso *et al.* (2007) for west African dwarf goat and Hirooka *et al.* (1997) for crossbred German fawn goat and katjang local goat in Malaysia. Phenotypic correlations in this study were slightly higher than genetic correlations which indicate that phenotypic correlation can aid in combination between different traits for genetic improvements in livestock through different mating methods.

Table 5
Environmental correlations estimates for body weight at various ages
from sire component (above) and dam component (below)

Age, month	Birth	1st	2nd	3rd	4th	5th	6th
Birth	**1.00**	0.29**	0.28**	0.26**	0.27**	0.26**	0.26**
1st	0.27**	**1.00**	0.42**	0.37**	0.32**	0.30**	0.24**
2nd	0.19**	0.13**	**1.00**	0.43**	0.39**	0.35**	0.31**
3rd	0.26**	0.18**	0.33**	**1.00**	0.46**	0.43**	0.38**
4th	0.28**	0.12**	0.31**	0.11**	**1.00**	0.47**	0.42**
5th	0.25**	0.13**	0.25**	0.10**	0.12**	**1.00**	0.46**
6th	0.28**	0.17**	0.23**	0.13**	0.14**	0.11**	**1.00**

**differences are statistically significant at $P<0.01$

Table 5 presents the environmental correlations for body weights from sire and dam components of variance. The estimates showed low to high and positive ($P<0.01$) environmental correlations that ranged between (0.10-0.46). Results showed that the environmental correlations from sire component ranged between 0.30 and 0.46 and that from dam component ranged from 0.10-0.33 which was relatively lower than those from sire component. Notter & Hough (1997) stated that, partitioning maternal effects into additive and permanent environmental components requires larger amount of data with repeated records on individual dams and the presence of related dams in the data.

The study concluded that body weight in Sudan desert goats could be improved by selection procedure and the most appropriate age of selection seemed to be at 4th month due to relatively higher heritability estimates since any program of breed improvement is based on the maximum exploitation of genetic variation of the trait.

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