ENVIRONMENTAL AND GENETIC FACTORS ON GROWTH TRAITS OF BLACK BONI SHEEP IN YEMEN

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INTRODUCTION

Sheep population of the Yemen is estimated to be 9.08 million head in 2009 (Yemen Agricultural Statistics, 2009). Eleven traditional sheep breed is recognized in Yemen of which 5 are wool and 6 are hair types (Wilson, 2003). All sheep breeds in the country were indigenous with fat tail whose conformation varied considerably (Hasnain et al., 1994).

Black Boni sheep, a local breed of central and northern highland region of Yemen, despite having lower growth rates, they are characterized by the ability to survive and reproduce normally in the range without supplementary feeding. The early growth traits (birth and weaning weight) are important in productivity and are the major selection traits in sheep breeds known to be influenced by genetics and environmental factors (Mandal et al., 2003; Behzadi et al., 2007).

Information on the relative performance of indigenous sheep breeds in Yemen may vary from year to year. It is, therefore, important to investigate the effects of various factors on the variation among animals in order to find efficient breeding plans to improve production. Very little information on the genetic and environmental aspects of productive and reproductive performance of sheep in Yemen is available. Therefore the objective of this study was to evaluate the environmental and genetic effects on growth traits for Black Boni sheep in the central and northern highlands region of Yemen.

MATERIALS AND METHODS

The sheep in this study were raised at Regional Research Station in the central highlands of Yemen, located at 14°38 north by 44°21 east and a latitude of over 2,400 meters, about 10 kilometres north of the Dhamar town, directly west of the Sana’a–Taiz road. The region is semi-arid with an annual rain fall between 350 to 400 mm and temperature varying 29°C and -4°C.

Animal management

The management system used the traditional method of sheep husbandry in the area, in terms of grazing and supplementation. A controlled mating scheme was used with three mating periods over two years. The ewes were mated with unrelated rams, with each ram mated to a group of 30 to 40 ewes; mating continued for 54 days. After lambing each ewe was put separately with their lamb into a lambing pen for about 2 to 7 days. Ewes and their lambs were weighed and ear-tagged. All the lambs were tattooed on the fat tail after weaning. Male and female lambs were allowed to remain with their mother until weaning. The weaning of lambs took place at an average of 91 days of age with a range in age from 79 to 98 days.

All ewes grazed together during the day for about 6-8 hours and were housed in covered pens with free access to grass hay, water and mineral lick blocks. During the mating season ewes were supplemented with fresh alfalfa, alfalfa hay or with fresh barley or barley hay and occasionally sorghum stover. Also a supplementary concentrate ration of 250-500 g/head/day, depending on season and physiological status, was fed to animals in the morning before grazing.

The sheep shed was cleaned every two to three days with removal of sicks from their pens and treated separately. All

ABSTRACT

The data were collected from 1992 to 2009 of Black Boni sheep maintained at the Regional Research Station in the Central Highlands of Yemen. Data were analyzed to study the effects of environmental and genetic factors on body weight and growth rate from birth to weaning. The overall least-square means for body weights were 2.18 kg, 10.58 kg and 98.68 g for birth, weaning and growth rate respectively. Year of birth effects were significant (p<0.05) on BW, WW and growth rate. Also, analysis of variance showed that the sex of the lambs and type of birth were important sources of variation (p<0.05) for all traits. The size of the ewe during lambing had also significant effect (p<0.01) on birth. The results show direct heritability for all traits was 0.38 of BW, 0.30 of WW and 0.26 of growth rate. Higher estimates of heritability for growth performance traits refers to of presence of more additive genetic variance.

KEY WORDS

Environmental Effects
Genetic Parameters
Growth Traits
Yemen

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animals were dipped for external parasite control once per year and were vaccinated once against rinderpest and sheep pox and drenched twice against internal parasites.

**Statistical analysis**

The data in the study was obtained from records of weights of 812 and 710 lambs at birth and weaning respectively over 18 years period (1992-2009) which was maintained at Regional Research Station of the Central highlands, in Dhamar, Yemen. Data were first analysed using the General Linear Models Procedures of the Statistical Analysis Systems (SAS, 2003) to identify the environmental factors affecting lambs weights and growth rate from birth to weaning in this breed.

Statistical model included lamb’s gender in 2 class (male and female), birth type in 2 class (single and twin), dam weight at lambing in 3 class (≤ 24, 25-33 and > 33), season of birth 3 class (summer from March to June, autumn from July to October and winter frz)

Analyses were conducted according the following model for each breed.

\[ Y_{\text{ijklmr}} = \mu + A_j + S_k + T_r + X_m + W_r + D_l + E_{\text{ijklmr}} \]

Where \( Y_{\text{ijklmr}} \) is the observation on the trait, \( \mu \) the overall mean, \( A_j \) is effects of the \( n \)th period of lambing (\( n = 1 \) to 6), \( S_k \) is the effects of the \( k \)th season of lambing (\( k = \) summer, autumn, winter), \( T_r \) is the effects of the \( p \)th type of birth (\( p = \) single, twin), \( X_m \) the effects of the \( m \)th sex of lamb (\( m = \) male, female), \( W_r \) is the effects of the \( r \)th dam of weight during lambing (\( r = \) ≤ 24kg, 25-33 kg, ≥ 31kg), \( D_l \) is the effects of the \( j \)th parity number of dam (\( j = 1 \) to 6), \( E_{\text{ijklmr}} \) represent the random error associated with each observation.

(Co) variance components were estimated by restricted maximum likelihood procedures using MTDREML program (Boldman et al., 1995). Single trait animal models were fitted for all traits to obtain heritability estimates. The general representation of the animal model used is as follows

\[ y = X\beta + Za + e \]

Where \( y \) is a \( N \times 1 \) vector of records, \( b \) denotes the fixed effects in the model with association matrix \( X, a \) is the vector of direct genetic effects with association matrix \( Z_a \). Additive direct effects were assumed to be normally distributed with mean 0 and variance \( \sigma^2_a \), where \( A \) is the additive numerator relationship matrix and \( \sigma^2_a \) is additive direct variance. Residual effects were assumed to be normally distributed with mean 0 and variances \( I \sigma^2_e \), respectively, \( I \) are identity matrices with orders equal to the number individual records and \( \sigma^2_e \) are residual variances. Estimates of heritabilities were calculated as ratios of estimates of additive direct (\( \sigma^2_a \)) to the phenotypic variance (\( \sigma^2_y \)).

**RESULTS AND DISCUSSION**

**Environmental effects, Birth weight (BW)**

The overall least square means for lamb at birth weight were 2.18, kg (Table 1). The value of birth weight observed for period ranged from 1.92 to 2.22 kg and the differences between periods were statistically significant (\( p < 0.01 \)). Differences in body weight from year to year is mostly due to variation in climatic, feeding and management condition, which either affects the lambs directly or indirectly through their effects on dams. The result of this study are similar to the result of Albial et al. (2010) for White Boni sheep. Also similar results were found by Abbas et al. (2010), Thiruvenkadan et al. (2009), Mandal et al. (2003) and Petrovic et al. (2011).

Season of lambing in this study had significantly effect on BW. Lambs born in autumn had higher of body weight than those born in winter and summer at BW. The significant of body weight at birth between these seasons can be interpreted as the influence of moderate weather conditions and a viability of green forage during pregnancy and growth stages for lambs. The similar results were found by Albial et al. (2010), Dixit et al. (2001) and Mandal et al. (2003).

Analysis of variance showed that the sex of the lambs and type of birth were important sources of variation (\( p < 0.05 \)). Male lambs were heavier (\( p < 0.05 \)) than female lambs. The levels of advantages of male over female lambs were similar (3%). The differences may be attributed to difference in metabolic rate during embryonic stage of life (Mishra et al., 2007) and to difference in the endocrine profile of the two sexes (Gamasaee et al., 2010). This significant difference was confirmed by many authors (Dixit et al., 2001; Mandal et al., 2003; Mishra et al., 2007).

The birth weight of single born lambs was significantly heavier (\( p < 0.01 \)) than twin. The levels of advantages of single lambs have been reported in almost all studies (Dixit et al., 2001; Mishra et al., 2007; Thiruvenkadan et al., 2009; Abbas et al., 2010; Al-Bial et al., 2010). Gamasaee et al. (2010) stated that the effect of birth type was significant on birth weight of lambs and can be explained by limited uterine space and nutrition of lamb during pregnancy.

The size of the ewe which was reflected by dam weight during lambing had also significant effect (\( p < 0.01 \)) on birth weight of the lamb born. Similar positive relationships have been reported by (Dixit et al., 2001; Al-Bial et al., 2010). Ewe parity did not influence (\( p > 0.05 \)) on lamb birth weight. The variation within breed was very small. The interpretation of parity effects seems to be complicated by external confounding factors such as feeding during pregnancy, and selection and culling strategies that may influence birth weight. Similar results were reported by Thiruvenkadan et al. (2009).

**Weaning weight (WW)**

Factors affecting the weaning weights are shown in Table 1. Weaning weight ranged 9.28kg to 10.58kg. Period/year of birth effects were significant (\( p < 0.05 \)) for weaning weights. Our results are in accordance with those reported by Mandal et al. (2003) and Thiruvenkadan et al. (2009).

Season of lambing in this study had significant effect (\( p < 0.05 \)) on WW as shown in Table 2. Lambs born in the autumn lambing season were the heaviest body weight at weaning as compared to lambs born in summer and winter seasons. This finding was in agreement with those reported by Albial et al. (2010) for White Boni sheep and Thiruvenkadan et al. (2009) for Mecheri and their crossbred lambs. The higher weaning weight of lambs born during autumn might be due to the carryover effect of birth weight, because they were heavier at birth. Similar seasonal effect on weaning weight was also observed by Dixit et al., (2001) and Abbas et al. (2010).
Sex of lambs effects were (p > 0.05) not significant on weaning weight (Table 1). The average weights of the both sexes were similar. Such results are in accordance with those results reported by Petrovic (2003). Similar results as reported by Dixit et al. (2011) and Al-Bial et al. (2009) for White Boni sheep, Thiruvenkadan et al. (2009) in Mecheri sheep and Mandal et al. (2003) in Muzaffarnagari sheep. The significant differences in growth rate of lambs in different periods may be attributed to differences in management, selection of rams and environmental condition such as ambient temperature, humidity, rainfall, and other factors.

Results also show that season of lambing had effect (p < 0.05) on growth rate of lambs. Lambs born in the autumn season were faster in growth rate than lambs born in summer and winter seasons. These results are in agreement with the finding of Gbangboche et al. (2006), Dixit et al. (2001) and who obtained a significant effect of season on this trait. There had significant different (p < 0.05) on growth rate of lambs of different sexes (Table 1). Male lambs had growth rate faster than female lambs. Several authors have also reported that male lambs grow faster than female from birth to weaning (Dixit et al., 2001; Mishra et al., 2007; Abbas et al., 2010).

Single born lambs were superior to lambs born as twins in growth rate and the different between them was highly significant (p < 0.01). The values were 101.69 ± 2.57 vs. 95.21 ± 2.73.

The effect of parity had consistently showed no significant effect (p > 0.05) on weaning weight of this study (Table 1). Similar with the reports by Thiruvenkadan et al. (2009).

Growth rate

Period /year had a significant (p < 0.01) effect on growth rate (Table 1). The effects of years lambing on growth rate. Similar with reported by Al-Bial et al. (2010) for White Boni sheep, Thiruvenkadan et al. (2009) in Mecheri sheep and Mandal et al. (2003) in Muzaffarnagari sheep. The significant differences in growth rate of lambs in different periods maybe attributed to differences in management, selection of rams and environmental condition such as ambient temperature, humidity, rainfall, and other factors.

The effect of dam weight at lambing on live weight of lambs at weaning were significantly effect (p < 0.01) higher (Table 1). The variation in weaning weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning. The effect of dam weight at lambing on live weight of lambs at weaning.
observed by Dixit presented study for growth rate was 0.26. Similar to those parameter estimates for growth rate from birth to weaning for 0.28 reported by Albial dam at lambing (Table 1). Similar positive relationships have a tendency to increase with age (Behzadi weight and also reported that heritability for body weights these results are in agreement with the reports by Mishra et al. (2001). Ewe of Parity was significant effect (p<0.05) on average growth rate of lambs. Genetic parameters variance component ratios and the genetic parameter estimates resulted from Model 1 corresponded well with those (Mandal 2003; Thiruvenkadan et al., 2009). Heritability estimates resulted from Model 1 corresponded well with those reported by Rashidi et al. (2008) for Kermani sheep. Higher heritability estimates were reported by Al-Shorepy (2001) who found an estimate of 0.48 for crossbred lambs. The current h² estimates for this breed agreed well with those observed by Albial et al. (2010) for White Boni sheep and Dixit et al. (2001) for Bharat Merino lambs, whose estimate of h² was 0.18 and 0.23 respectively for both breeds. The moderate to high additive heritability estimates found in this study can be explained by uniformity of management at the sheep breeding station, creating small environmental variations. The estimates of heritability of weaning weights was higher (0.30) and is in agreement with those reported by several authors (Ghafouri Kesbi et al., 2008; Rashidi et al., 2008). More over, Behzadi et al. (2007) working with Kermani sheep reported estimates of h² to be between 0.22-0.62 for weaning weight and also reported that heritability for body weights have a tendency to increase with age (Behzadi et al., 2007). Parameter estimates for growth rate from birth to weaning for this breed are shown in Table 2. Heritability estimates in the present study for growth rate was 0.26. Similar to those observed by Dixin et al. (2001) in Bharat Merino. Estimate of heritability in White Boni lambs was similar to the estimate of 0.28 reported by Albial et al. (2010) in White Boni lambs.

Table 2: Variance component ratios for lamb birth weight, weaning weight and growth rate in Blak Boni sheep

<table>
<thead>
<tr>
<th>Item</th>
<th>Traits</th>
<th>BW</th>
<th>WW</th>
<th>Growth rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>s²</td>
<td>0.06631</td>
<td>2.06175</td>
<td>283.79518</td>
<td></td>
</tr>
<tr>
<td>s²</td>
<td>0.10714</td>
<td>4.85173</td>
<td>812.90632</td>
<td></td>
</tr>
<tr>
<td>s²</td>
<td>0.17345</td>
<td>6.91348</td>
<td>1096.70170</td>
<td></td>
</tr>
<tr>
<td>h²</td>
<td>0.38 (0.103)</td>
<td>0.30 (0.108)</td>
<td>0.26 (0.092)</td>
<td></td>
</tr>
</tbody>
</table>

* s², σ², σ² are additive direct, residual variance, and phenotypic variance, respectively. h² is heritability. BW: Birth weight, WW: Weaning weight, Growth rate at pre-weaning 84.64 ± 3.52 g/day, finding is in agreement with those reported by some authors (Mandal et al., 2003; Abbas et al., 2010). Growth rate were significantly (p<0.01) affected by weight of dam at lambing (Table 1). Similar positive relationships has been reported by Dixit et al. (2001). Ewe of Parity was significant effect (p<0.05) on average growth rate of lambs. These results are in agreement with the reports by Mishra et al. (2007) who found a significant effect of parity on this trait.

Genetic parameters

Variance component ratios and the genetic parameter estimates for this breed are given in Table 2. The birth weight in various sheep breeds have ranged from 0.04 to 0.49 (Mandal et al., 2003; Thiruvenkadan et al., 2009). Heritability estimates resulted from Model 1 corresponded well with those reported by Rashidi et al. (2008) for Kermani sheep. Higher heritability estimates were reported by Al-Shorepy (2001) who found an estimate of 0.48 for crossbred lambs. The current h² estimates for this breed agreed well with those observed by Albial et al. (2010) for White Boni sheep and Dixit et al. (2001) for Bharat Merino lambs, whose estimate of h² was 0.18 and 0.23 respectively for both breeds. The moderate to high additive heritability estimates found in this study can be explained by uniformity of management at the sheep breeding station, creating small environmental variations. The estimates of heritability of weaning weights was higher (0.30) and is in agreement with those reported by several authors (Ghafouri Kesbi et al., 2008; Rashidi et al., 2008). More over, Behzadi et al. (2007) working with Kermani sheep reported estimates of h² to be between 0.22-0.62 for weaning weight and also reported that heritability for body weights have a tendency to increase with age (Behzadi et al., 2007). Parameter estimates for growth rate from birth to weaning for this breed are shown in Table 2. Heritability estimates in the present study for growth rate was 0.26. Similar to those observed by Dixit et al. (2001) in Bharat Merino. Estimate of heritability in White Boni lambs was similar to the estimate of 0.28 reported by Albial et al. (2010) in White Boni lambs.

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