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Genetic study of reproductive traits in Iranian native Ghezel sheep using Bayesian approach

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ABSTRACT

The genetic parameters of reproductive traits in Iranian native Ghezel sheep were estimated using different univariate and bivariate animal models. For this research 4173 records of 2420 ewes, collected during 1992 to 2010 in breeding center of Ghezel sheep (Miandoab), were used. Significant effects were determined using Logistic and GLM procedure of SAS software for discrete and continuous traits, respectively. Genetic parameters were estimated for four basic and four composite traits using Gibbs sampling methodology of Bayesian inference. Basic traits were conception rate (CR), number of lambs born (NLB), number of lambs born alive (NLBA), number of lambs alive at weaning (NLAW) and composite traits were number of lambs born per ewe exposed (NLBEE), number of lambs at weaning per ewe exposed (NLWEE) total litter weight at birth per ewe lambing (TLBW), total litter weight at weaning per ewe lambing (TLWW). Based on Derivative Information Criteria (DIC), for each trait the most appropriate model was determined. Heritability estimates for direct genetic effect ranged from 0.032 ± 0.01 for NLWEE to 0.196 ± 0.01 for TLBW and for maternal genetic effect ranged from 0.023 ± 0.01 for NLWEE to 0.074 ± 0.02 for TLWW. Growth rate traits (TLBW and TLWW) had higher heritability than reproductive traits that may probably be due to non-normal distributions of reproductive traits and as well as little genetic variability for these traits. Genetic correlation estimates ranged from -0.39 for CR and NLBA to 0.91 for NLBA and NLBEE. Genetic correlations were usually more than phenotypic ones. Negative correlations may depend on distributions of the data in which CR is binary and others are not. Results of this study showed that the model with genetic correlation between direct and maternal effects seem to be reliable for genetic evaluation of reproductive traits in Ghezel sheep.

1. Introduction

Ghezel sheep is an Iranian fat-tailed; medium-sized breed distributed in the mountainous areas of the country, especially in Western and Eastern Azerbaijan provinces. Meat, wool, skin and milk are valuable products of this sheep. The color of this sheep varies from light brown to dark brown (legs wool are usually darker than the body wool). The tail (unique characteristic of this sheep) is completely round and pear-shaped. On the other hand, a sidewise looking at the tail represents 'S' shape in which the sheep popularity decreases when the tail is less S-shaped. Most of them have knot in front of their neck. Growth rate of this sheep is high and is about 200 g/day

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(Izadifard and Zamiri, 2007). Both rams and ewes have no horn.

A traditional and delicious kind of cheese called Lighvan cheese is basically made from Ghezel sheep milk in the area of Sahand mountainside, located in the northwest of Iran. It is the most popular traditional and expensive cheese made from raw sheep's milk in Eastern-Azerbaijan province. The Lighvan cheese is characterized by unique hardness (semi-hard), saltiness and spiciness (Rasouli Pirouzian et al., 2012). Thus, improving this native sheep for these traits can increase products in which milk, meat, wool and skin can be improved and consequently, more cheese and meat will be obtained which is economical.

The greatest part of the sheep farming income is derived from lamb production. Efficiency of lamb production is controlled by reproduction, mothering ability, milk production of ewe, growth rate (Rao and Notter, 2000). Reproductive traits are the most important ones affecting the profitability (Matos et al., 1997). By increasing the number and weight of lambs produced per ewe within a year, number or total weight of lambs weaned per ewe can be improved (Duguma et al., 2002). Within breed selection of native breeds is an appropriate approach for genetic improvement in the traditional low-input production systems of small ruminants in the tropics (Kosgey et al., 2006). As genetic parameter estimation of reproductive traits to plan optimum designs for selection programs in this breed is scarce and reliable estimates are needed to establish efficient selection programs in reproductive traits, this study was carried out to estimate genetic parameters and correlations of reproductive traits for native Ghezel sheep that are necessary to develop efficient selection programs to improve reproduction.

2. Materials and methods

2.1. Data and management

The data set and pedigree information used in this research included reproductive traits of Ghezel ewes, collected during 1992–2010 in breeding center of Ghezel sheep (Miandoab) located in Western-Azerbaijan province of Iran. Aim of this station is to establish a nucleus source to genetic improve other flocks in the region. The flock is under semi-migratory management system. The number of records per each trait is listed in Table 1. Mating season commences in late August to October. First mating of animals was at 18–24 months of age. Artificial insemination (A.I.) is run during the breeding season and used ewes in this research were from 1 to 7 parities. In mating strategy controlled AI is done, in which mating between very close animals is avoided. Maximum number of allocated ewes to each AI ram is not more than 25 heads in every breeding year. Animals that cannot conceive by AI are allocated to natural servicing in which ewes are allocated to ram breeding groups with an average mating ratio of 10–15 ewes per ram. Lambing season commences in January and continues till April. At birth, all lambs are identified and birth weight, birth type, sex and pedigree information are recorded. Lambs are fed with their mother's milk and also with dry alfalfa hay from 15 days of age. Weaning usually occurs at 3 months of age. The flock (ewes and weaned lambs) usually grazes in pasture during the day and penned at nights and winter with supplemental feeding comprising alfalfa, wheat straw and barley grain.

2.2. Studied traits

Studied traits can be grouped into two main categories: basic and composite traits. Basic traits were conception rate (CR with measure of 1 or 0, meaning whether a ewe exposed to ram lambed or not), Total number of lambs born (NLB, with measures of 0, 1, or 2, which was the number of lambs born per ewe lambing), Number of lambs born alive (NLBA, with measures of 1 or 2, which was number of lambs alive at 24 hours of age), Number of lambs alive at weaning (NLAW, with measures of 1 or 2, which was number of lambs weaned alive). Conception rate is a binary random variable that is based on continuous variation on the underlying liability scale expressed when a certain threshold is achieved and all other basic traits have discrete numerical observation. Composite traits with discrete numerical observation were number of lambs born per ewe exposed (NLBEE = CR × NLB) and number of lambs weaned per ewe exposed (NLWEE = CR × NLAW). Composite traits with continuous expression were total litter weight at birth (TLBW), total litter weight at weaning per ewe lambing (TLWW).

2.3. Statistical analysis

Important effects which should be in final model were preliminarily determined by Logistic and GLM procedure of SAS software package (SAS Institute, 2002) for discrete and continuous traits, respectively. Fixed effects included in the final statistical model were lambing year with 18 classes (1992–2010), herd of ewe with 6 classes, age of ewe with 7 classes and random parts were as additive genetic of animal, maternal genetic and permanent environmental of ewe. The variance components for studied traits were estimated with six different univariate animal models and based on Derivative Information Criteria (DIC), the most appropriate model was determined.

$$DIC = 2 \times \overline{D(\theta)} - D(\bar{\theta})$$

where $\overline{D(\theta)}$ is the posterior expectation of Log-likelihood and $\overline{D(\theta)}$ is Log-likelihood evaluated at the posterior mean of the parameters. Models applied to each trait were:

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_1\mathbf{a} + \mathbf{e} \quad (1)$$

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_1\mathbf{a} + \mathbf{Wpe} + \mathbf{e} \quad (2)$$

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_1\mathbf{a} + \mathbf{Z}_2\mathbf{m} + \mathbf{e} \quad \mathrm{Cov}(\mathbf{a}, \mathbf{m}) = 0 \quad (3)$$

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_1\mathbf{a} + \mathbf{Z}_2\mathbf{m} + \mathbf{e} \quad \mathrm{Cov}(\mathbf{a}, \mathbf{m}) \neq 0 \quad (4)$$

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_1\mathbf{a} + \mathbf{Z}_2\mathbf{m} + \mathbf{Wpe} + \mathbf{e} \quad \mathrm{Cov}(\mathbf{a}, \mathbf{m}) = 0 \quad (5)$$

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Z}_1\mathbf{a} + \mathbf{Z}_2\mathbf{m} + \mathbf{Wpe} + \mathbf{e} \quad \mathrm{Cov}(\mathbf{a}, \mathbf{m}) \neq 0 \quad (6)$$

Table 1
Descriptive statistics of data sets.

Traits*	No. of records	No. of ewes	No. of sires	Mean	S.D	C.V. (%)	Range
CR	4173	2420	175	0.89	0.30	33.72	0–1
NLB	3673	1906	163	1.116	0.31	28.49	0–2
NLBA	3669	1906	163	1.112	0.31	28.41	1–2
NLAW	3405	1761	163	1.10	0.31	28.36	1–2
NLBEE	4173	2420	175	0.99	0.44	44.44	0–2
NLWEE	4173	2420	175	0.99	0.43	43.43	0–2
TLBW	3669	1906	163	4.60	1.43	31.08	1.9–7.1
TLWW	3405	1906	163	24.12	2.79	11.56	14.71–29.8

* CR: conception rate; NLB: number of lambs born per ewe lambing; NLBA: number of lambs born alive per ewe lambing; NLAW: number of lambs alive at weaning; NLBEE: number of lambs born per ewe exposed; NLWEE: number of lambs weaned per ewe exposed; TLBW: total litter weight at birth; TLWW: total litter weight at weaning; S.D: standard deviation; C.V.: coefficient of variation.