ARTICLE IN PRESS

Small Ruminant Research xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Small Ruminant Research

journal homepage: www.elsevier.com/locate/smallrumres

Statistical models for genetic evaluation of some first kidding and lifetime traits of the Egyptian Zaraibi goats

Sherif A. Moawed[a,*], Nazem. A. Shalaby[b]

[a] Department of Animal Wealth Development, Biostatistics Division, Faculty of Veterinary Medicine, Suez Canal University, Ismailia, 41522, Egypt
[b] Department of Animal Production, Faculty of Agriculture, Mansoura University, Mansoura, Egypt

ARTICLE INFO

Keywords:
Zaraibi goat
Animal models
Maternal effects
Variance components
Genetic parameters
Akaike information criteria

ABSTRACT

The aim of the present study was to define the best fitting model for genetic evaluation of the Egyptian Zaraibi goats using three statistical models. Models differed based on the inclusion or exclusion of maternal additive genetic effects and the direct-maternal genetic covariance (σ_{am}). The models used were; Model 1 (without maternal effects); Model 2 (with maternal effects where $\sigma_{am} = 0$) and Model 3 (as in Model 2, but $\sigma_{am} \neq 0$). The evaluated traits were; litter size at birth (LSB, kid), litter size at weaning (LSW, kid), litter weight at birth (LWB, kg), litter weight at weaning (LWW, kg), first lactation milk yield (FLMY, kg), first lactation length (FLL, day), total milk yield in productive life (TMY, kg) and total lactation length in productive life (TLL, day). Data represented some first lactation and longevity traits. A total of 2270 first kidding records produced from 600 does that were sired by 95 bucks. Statistical analyses were done using VCE-6 software. Model selection was built on the value of Akaike information criterion (AIC). Direct heritabilities were higher than maternal heritabilities in all models, and varied between 0.09 to 0.21, 0.05 to 0.22, 0.11 to 0.24 and 0.05 to 0.20 for LSB, LSW, LWB and LWW, respectively. Direct heritability for yield and lifetime traits were low to moderate and varied from 0.16 to 0.18, 0.07 to 0.34, 0.15 to 0.16 and 0.08 to 0.18 for FLMY, FLL, TMY and TLL, respectively. Maternal heritabilities ranged from 0.02 to 0.30 from models 2 and 3. Direct-maternal genetic correlations were low to moderate, negative for most of studied traits and ranged from −0.01 to −0.38. The inclusion of both direct and maternal effects in addition to the covariances between them in statistical models is recommended for the best genetic improvement of Egyptian Zaraibi goats.

1. Introduction

Zaraibi goats or the Egyptian Nubian is considered the most important and famous native breed due to its productive and reproductive capabilities. The Egyptian Nubian, which is widely distributed in the North Delta; Egypt, is believed to be the ancestor of the Anglo-Nubian. Therefore, genetic evaluations for the most economic traits in Zaraibi goats become imperative.

Nowadays, Egyptian animal breeders have been interested in goat breeding for milk and/or meat production due to the excessive increase of beef meat prices coupled with the high demand of dairy products. Appropriate and effective breeding schemes of goats would be conducted by genetic evaluation for a combination of reproductive, productive and lifetime traits of goats as an alternative native source of milk and meat.

Goat performance can be improved through selection programs on the basis of multiple traits, records and ancestors. The exploitability of dairy goats is determined not only by its efficiency in milk production but also by their mothering ability, which is translated by the doe's reproductive status and how long these animals would perform throughout their life. Maternal effects of a healthy dam has a great contribution in determining the performance of kids in the early stage of life, especially for the young's growth traits such as, litter weights at birth and at weaning. Investigations demonstrated by Ghafouri-Kesbi and Eskandarianasab (2008) revealed that animal models without maternal effects denoted overestimates of direct heritability. Therefore, fitting an informative and concise statistical model would lead to boost up accurate estimates of genetic parameters.

Early growth traits of kids are affected by both animals' additive genetic effects and by maternal additive effects of dam (Mandal et al., 2006). It is necessary to get estimates for animals' additive and maternal additive (co)variance components for genetic evaluation and to construct better selection strategies (Heydarpour et al., 2008; Mona, 2013; Yazdanshenas et al., 2013). Furthermore, any improvement in the reproduction rate of goats will be reflected on the selection strategies and the genetic ameliorate of production traits. The objective of

* Corresponding author.
E-mail addresses: sherifmoawed@vet.suez.edu.eg (S.A. Moawed), shalaby151@mans.edu.eg (N.A. Shalaby).

https://doi.org/10.1016/j.smallrumres.2018.03.010
Received 24 February 2017; Received in revised form 17 November 2017; Accepted 22 March 2018
0921-4488/

Please cite this article as: Moawed, S.A., Small Ruminant Research (2018), https://doi.org/10.1016/j.smallrumres.2018.03.010

this study was to evaluate genetically some productive, reproductive and lifetime traits of Zaraibi goats using different statistical models, along with the inclusion of animals' additive genetic and maternal additive genetic effects.

2. Materials and methods

2.1. Animals and farm management

Data of the present study were collected from an Egyptian flock of Zaraibi goat (Egyptian Nubian), namely, El-Serw experimental station located in the North Eastern part of the Nile Delta, Damietta Province. The farm belongs to Agriculture research center, called Animal Production Research Institute (APRI); Ministry of Agriculture, Egypt. The total number of analyzed records was 2270; representing records of the first five lactations denoted by 600 Zaraibi does with 95 sires and 412 dams. Hence, data were pooled for the first five lactations for analysis of lifetime traits. In term of kidding years, data covered the records of kidding years from 2000 to 2015. All incomplete and abnormal records were excluded from analysis. Animals in the farm as cited by Hamed et al. (2009) and Mona (2013) were housed in semi-open pens and fed on the Egyptian clover or Berseem (Trifolium alexandrium) during winter and spring months. During autumn and summer seasons, animals were fed on clover hay and on green forage, sometimes on concentrate mixture if available. Mating begins for the newly introduced does approximately reaches 15 months of age. During mating season does were randomly allocated to about thirty-goats-mating groups per buck. In the same flock, bucks were undergone replacement every 3 mating seasons. Natural mating ensued once a year with half of the flock mated in October and the other half in June. Milk yield in the studied flock was recorded every two weeks throughout the suckling stage, followed by weekly milking until the end of lactation. After the kids were weaned, milk production was estimated twice a day hand milking.

2.2. Studied traits and statistical models

The present study involved a variety of some productive, reproductive and lifetime traits. The studied traits were; litter size at birth (LSB, kid), litter size at weaning (LSW, kid), litter weight at birth (LWB, kg), litter weight at weaning (LWW, kg), first lactation milk yield (FLMY, kg), first kidding lactation length (FLL, day), total milk yield in productive life (TMY, kg), and total lactation length (TLL, day). Data were analyzed using mixed models for estimation of (co)variance components and genetic parameters of these traits. Genetic parameters were estimated via Restricted Maximum Likelihood (REML) procedures of the general linear models using VCE 6.0.2 software (Groeneveld et al., 2008). All models incorporated mixed effects and included the same fixed with the only change in the random effects. Also, the inclusion or exclusion of covariance term was taken into account when fitting models with both animal's additive genetic effect and maternal genetic effects. The fixed effects in the studied models were; year of kidding (from 2000 to 2015), season of kidding (November and March), and dam's weight at the first kidding. Three different animal models were used and fitted. Model I was the simplest one, in which the direct additive genetic effect was the only random effect along with residuals term. Model II included both direct additive genetic effects and maternal additive genetic effects as the random effects, but with no covariance between direct and maternal genetic effects. Model III was fitted to be the same as model II, but the allowance of direct-maternal genetic covariance in model III was existed. The three models were summarized as follows:

$$Y = Xb + Z_i\, a + e \tag{1}$$

$$Y = Xb + Z_i\, a + Z_j\, m + e \quad Cov\ (a, m) = 0 \tag{2}$$

$$Y = Xb + Z_i\, a + Z_j\, m + e \quad Cov\ (a, m) = A\sigma_{am} \tag{3}$$

Where; *Y* is the vector of observations of studied traits; *b*, *a*, *m* and *e* are the vectors of fixed effects, animal's (direct) additive genetic effects, maternal genetic effects (effects due to dam), and residual effects, respectively. *X*, Z_i and Z_j are the incidence matrices of fixed effects, direct additive genetic effects, and maternal genetic effects, respectively. In addition, σ_{am} is the covariance between direct and maternal genetic effects. The expected values and (co)variance structures for the tested models were assumed to be as follows:

$$E\ (Y) = Xb,\ E\ (a) = E\ (m) = E\ (e) = 0$$

$$Var\ (a) = A\sigma_a^2$$

$$Var\ (m) = A\sigma_m^2$$

$$Var\ (e) = I_e\ \sigma_e^2$$

$$Cov\ (a, m) = A\sigma_{am}$$

$$Cov\ (a, e) = 0$$

$$e \sim N\ (0, I\ \sigma_e^2)$$

The model assumptions can be written in matrix notation as the following:

$$\mathbf{E}\begin{bmatrix}\mathbf{Y}\\ \mathbf{a}\\ \mathbf{m}\\ \mathbf{e}\end{bmatrix} = \begin{bmatrix}X\mathbf{b}\\ \mathbf{0}\\ \mathbf{0}\\ \mathbf{0}\end{bmatrix}$$

$$\mathbf{V}\begin{bmatrix}\mathbf{a}\\ \mathbf{m}\\ \mathbf{e}\end{bmatrix} = \begin{bmatrix}\mathbf{A\sigma^2_a} & \mathbf{0} & \mathbf{0}\\ \mathbf{0} & \mathbf{A\sigma^2_m} & \mathbf{0}\\ \mathbf{0} & \mathbf{0} & \mathbf{I\sigma^2_e}\end{bmatrix}$$

Where; *A* is the numerator relationship matrix between animals; σ_a^2, σ_m^2 and σ_e^2 are the variances due to direct additive genetic effects, maternal genetic effects, and residuals, respectively; I_e is the identity matrix with an order equal to the number of animals in the farm pedigree. Genetic parameters estimated were direct heritability (h_a^2), maternal heritability (h_m^2) and genetic correlations between traits computed from the three models. The direct and maternal heritabilities were given from the following equations:

$$h^2_a = \frac{\sigma^2_a}{\sigma^2_p}$$

$$h^2_m = \frac{\sigma^2_m}{\sigma^2_p}$$

Where; h_a^2 is the direct heritability; h_m^2 is the maternal heritability; σ_a^2, σ_m^2 and σ_p^2 are the additive genetic variance, maternal genetic variance, and total phenotypic variance, respectively.

In term of statistical modeling and computing, many model diagnostics were available for researches to assess the goodness of fit of the interesting models. This study showed a quite variation in the number of parameters, which differed from one model to the other due to the replacements that have been occurred in the random effects in models under the study. Also, because of the covariance term alterations from model II to model III. Model selection and model ranking for the studied traits was based on Akaike information criterion (AIC) values. The model with the smallest number of parameters may result in an increase in the bias term, while a large number of parameters which is called over-parameterization may lead us to a model with lower accuracy (Burnham and Anderson, 2004). For this reason, akaike information criterion was utilized for model comparison and calculated as follows:

$$AIC\ (\theta) = (-2)\ \log\ (L) + 2k$$

Where; *log L* is the maximum Log Likelihood and *k* is the number of parameters in each model. The best fitted model was that one with the