Small Ruminant Research 123 (2015) 22–26

Contents lists available at ScienceDirect

Small Ruminant Research

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

Genetic evaluation of fiber length and fiber diameter from Inner Mongolia White Cashmere goats at different ages

Zhiying Wang[b,1], Zhixin Wang[a,1], Yan Liu[c], RuiJun Wang[a,*], Yanjun Zhang[b], Rui Su[b], Jinquan Li[b,**]

[a] College of Animal Science, Inner Mongolia Agricultural University, Hohhot, Inner Mongolia 010018, China
[b] Key Laboratory of Animal Genetics Breeding and Reproduction, Hohhot, Inner Mongolia 010018, China
[c] Vocational and Technical College, Inner Mongolia Agricultural University, Hohhot, Inner Mongolia 010018, China

ARTICLE INFO

Article history:
Received 17 September 2014
Received in revised form
16 November 2014
Accepted 17 November 2014
Available online 26 November 2014

Keywords:
Genetic correlation
Estimated breeding values
Genetic improvement
Fleece properties

ABSTRACT

The purpose of this study was to estimate the genetic parameters for fiber length (FL) and fiber diameter (FD) in Inner Mongolia White Cashmere goats (IMCGs) across age groups to determine whether genetic improvement of these fleece traits can be attained by early selection. Data on FL and FD were collected for analysis from 2008 to 2012 on IMCGs at the ages of 1–5 years. The 6851 repeat records of 3251 Inner Mongolia Cashmere goats were analyzed. These goats were descendants of 104 sires and 2172 dams. Genetic parameters for FL and FD in IMCGs from 1 to 5 years old were determined using the average Information Restricted Maximum Likelihood (AIREML) method in a multivariate animal model. Estimates of direct additive heritability for each fleece trait were significant across all age groups. The values were 0.19, 0.34, 0.21, 0.23 and 0.18 for FL, and 0.40, 0.39, 0.29, 0.38 and 0.29 for FD from 1 to 5 years old, respectively. The genetic correlation coefficients between FL and FD at each age ranged from 0.12 to 0.38, which were low to moderate. However, the genetic correlations for FL or FD were positive and high for all pairwise age comparisons, ranging from 0.75 to 0.99, and most values for a given trait between any two age classes exceeded 0.85. The high genetic correlations between yearlings and adults for each fleece trait inferred that selecting stocks at earlier ages may lead to genetic progress and improved fiber quality of IMCGs at later ages.

1. Introduction

Genetic improvement of fiber quality in Inner Mongolia White Cashmere goats (IMCGs) is important to the cashmere producing industry of Inner Mongolia. This region has the advantage of unique natural prairies, which have become a very important production base for animal husbandry (Li et al., 2010). Previous studies on genetic evaluation of IMCGs have been performed: Zhou et al. (2002, 2003) studied the non-genetic effects and the genetic parameters of the production traits of IMCGs, Bai et al. (2004, 2006) described a most appropriate model for early growth traits by comparing accuracy among the different models, and analyzed the genetic trends connected to economic traits of IMCGs (e.g., cashmere yield, body weight). These studies showed that cashmere yield and live body weight of IMCGs had an obviously improvement in phenotype and genetic, however, fiber diameter are becoming coarser. The estimates of variance components and genetic

* Corresponding author. Tel.: +86 471 4309178; fax: +86 471 4309178.
** Corresponding author. Tel.: +86 471 4309297; fax: +86 471 4309297.
E-mail addresses: imauwrj@126.com (R. Wang), lijinquan_nd@126.com (J. Li).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.smallrumres.2014.11.015
0921-4488/

parameters of fleece traits in yearling Inner Mongolia Cashmere goat have been studied by Wang et al. (2012), which illustrated that heritability of fiber quality is moderate. Therefore, genetic gain will be obtained by genetic evaluation. Both of two reports studied by Brash et al. (1997) and Huisman and Brown (2009) indicated that estimates of genetic parameters for wool traits of sheep were significantly different at three age classes, yearling, hogget and adult; thus, these traits cannot be treated as one across an animal's lifetime. Fozi et al. (2012) reported that the ages of mean fiber diameter for fine-wool data were genetically partitioned into yearling, 2 years, 3 years and later ages and for medium-wool data into hogget, 2 years and later ages in a multivariate model. However, there have been no reports on genetic evaluation of fleece traits of IMCGs at different ages.

Based on the statistic, the price of fine cashmere was higher than that of coarse cashmere. The increased fiber diameter in cashmere can lead to cashmere being classified as B diameter (14.0–16.0 μm), which leads to a 40% discount compared with A diameter (≤14.0 μm) (http://faostat3.fao.org/faostat-gateway/go/to/browse/P/*/E). Ma et al. (2008) explained that fiber length should be greater than 5 cm, which would facilitate the processing of cashmere, while fiber diameter directly impacts cashmere's softness, an important property in wearer's comfort. Thus, genetic improvement of fiber length and fiber diameter will be beneficial to improve the income of herdsmen. The measurement of fiber quality is time-consuming and expensive. In this study, genetic parameters for fiber length and fiber diameter across age groups were estimated to determine whether genetic improvement of the two fleece traits can be attained by early selection.

2. Materials and methods

2.1. Data

The repeat records of 3257 Inner Mongolia Cashmere goats in this study were collected from 2008 to 2012 at a Cashmere goat flock that located at the Arbas stock farm in southwestern Inner Mongolia, China. These goats were descendants of 104 sires and 2172 dams. From now on, this flock has gone through eight generation intervals. Details on the feeding and management of this flock were described by Zhou et al. (2002, 2003), Bai et al. (2006) and Wang et al. (2012). Twelve herds were reared by different herdsmen; these included three yearling does' and two yearling bucks' herds, as well as six adult does' and one adult bucks' herds. Apart from the adult buck herd, the average size of the other herds was about 200 goats. Molted cashmere was harvested by combing once a year in May. Every individual was measured from yearling until they were slaughtered or died of illness. Patch samples of 10 cm^2 on the side of the shoulder were obtained by shaving the area prior to combing. Fleece samples were evaluated by Projection Microscopy (PM) in the Cashmere Analysis Laboratory of Inner Mongolia Agriculture University. Samples were washed with petroleum ether to remove contaminants such as soil and grease. Then, laboratory assistants carefully separated the primary follicle fiber from the samples, the rest were cashmere. The traits analyzed in this study were fiber length (FL) and fiber diameter (FD). Using standard PM procedure, we measured 160 fibers for sample for diameter. The mean, standard deviation (SD) and coefficient of variation (CV) were reported automatically by the PM system. The 50 fiber for sample for length in each individual was measured with standard rulers. Both FD and FL were measured to the nearest 0.5 μm and 1 mm, respectively. Data were expressed as 95% confidence intervals (mean ± 1.96σ), which can reduce the error. Then, the mean, SD and CV of each trait for every individual were recomputed and applied in the next analysis.

2.2. Statistical analysis

Fiber quality traits including FD and FL from individuals aged 1 to 5 years old were recorded and analyzed. The statistic results were shown in Table 1. Based on previous studies by Zhou et al. (2003) and Wang et al. (2012), influencing factors were accounted for by the general linear model (GLM) procedure using SAS (8.0) software (SAS Institute, 1999) including: years of production (2008–2012), herds (1–12), litter size (single or twin) and sex (female or male). Several reports (Bishop and Russel, 1996; Olayemi et al., 2011; Wang et al., 2012) demonstrated that post-weaning traits were not influenced by maternal effects. Therefore, a multivariate animal model that included only direct additive genetic effects was analyzed using the Average Information Restricted Maximum Likelihood (AIREML) method in WOMBAT software (Meyer, 2007) to obtain the genetic parameters of each fleece trait at ages of 1–5 years and the genetic correlation between FL and FD at each age group. The default convergence criterion was 10^{-8}. The formula for the model was as follows:

$$y_i = X_i b_i + Z_i a_i + e_i$$

3. Results

3.1. Change trend of phenotype with ages

The statistics results of the FL and FD for IMCGs aged from 1 to 5 years old are shown in Table 1. The maximum value for FL was reached at two years old, then, decreased sharply in the successive years. However, the mean value of fiber diameter increased with ages. There was a significant difference between yearling and adults.

3.2. Estimates of genetic parameters

Variance components and heritabilities for FL and FD of IMCGs aged from 1 to 5 years old are presented in Table 2. The estimates of heritability at ages of 1 to 5 years were as follows: 0.19, 0.34, 0.21, 0.23 and 0.18 for FL, 0.40, 0.39, 0.29, 0.38 and 0.29 for FD, which were moderate to high across these age groups. As shown in Table 2, the genetic correlations between FL and FD at each age class were positive and low to moderate, ranging from 0.12 to 0.38. The phenotypic and genetic correlations for each fleece trait between any two age groups were summarized in Table 3. Genetic correlations for each trait were strong and positive among all of the age groups. The correlation coefficients ranged from 0.75 to 0.99. Phenotypic correlations for each trait between any two age groups, except FL between yearlings and adults, were moderate to high and positive. The values ranged from 0.27 to 0.49.

4. Discussion

4.1. Change trend of phenotype with ages

The maximum value of FL was at two years old. The mean value for FL in this study was longer than the value (9.17 cm) reported by Bai et al. (2006), which may be related to environmental factors, such as the years of data collection, the improvement of feeding and management and breeding plan. McGregor and Butler (2008) reported that ages had a significant effect on fiber length of Australian Cashmere goats. However, the FL (8.7 cm) of Australian Cashmere goats is lower than that of IMCGs