Livestock Science 124 (2009) 66–71

Contents lists available at ScienceDirect

Livestock Science

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

Genetic and phenotypic parameter estimates for growth traits in Boer goat

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ARTICLE INFO

Article history:
Received 30 June 2008
Received in revised form 20 December 2008
Accepted 23 December 2008

Keywords:
Boer goat
Body weights
Growth rates
Heritability

ABSTRACT

An understanding of influencing factors and genetic principles affecting the growth traits is needed to implement optimal breeding and selection programs. In this study, heritabilities (direct additive and maternal) of body weights at birth (BW0), 90 days (BW90) and 300 days (BW300) of age and average daily gains from birth to 90 days (ADG0-90), birth to 300 days (ADG0-300) and 90 days to 300 days (ADG90–300) of age in Boer goats were estimated on the basis of 1520 Boer goats at Boer Goat Breeding Station in Yidu, China, during 2002–2007. The parameters were estimated using a DFREML procedure by excluding or including maternal genetic or permanent maternal environmental effects, four analysis models were fitted in order to optimize the model for each trait. Influencing factors such as parity, litter size, kidding year and season, as well as sex of kids and some significant interactions among these factors were investigated as the fixed effects for the models. The results showed that the birth year and maternal genetic effects such as parity and litter size of dam were important determinants of the genetic parameter estimates for pre-weaning growth traits, and environmental effects such as birth year, season and sex of kids had some significant effect on post-weaning growth traits. The mean values and standard errors (SE) of direct additive heritability estimates calculated with the optimum model were 0.17 ± 0.07, 0.22 ± 0.08, 0.07 ± 0.07, 0.10 ± 0.08, 0.30 ± 0.12 and 0.08 ± 0.10 for BW0, BW90, ADG0-90, BW300, ADG0-300 and ADG90–300, respectively. For pre-weaning weights, correlation estimates between direct additive and maternal genetic (r_{a-m}) effect were high and negative ranging from -0.74 to -0.86.

1. Introduction

The growth traits are important factors influencing profitability in any meat producing enterprise. Rapid growth during the early period can minimize the cost of rearing and thus provide more profit to the farmer. The birth weight and early growth rate of animals are determined not only by genetic potential but also by maternal and environmental factors (Mandal et al., 2006). Effective selection by tghe accurate use of genetic parameters and improving environmental condition are the main two ways to increase the productive profit (Al-Shorepy et al., 2002). Body weights and growth rates in pre-weaning are often considered as an early indicator of the late growth and economic benefit (Portolano et al., 2002; Hanford et al., 2006). Our previous research (Zhang et al., 2008) and many other studies (Eler et al., 1995; Al-Shorepy, 2001) showed that selection efficiency or genetic progress was largely dependent on the effective use of additive genetic variance, and maternal effects become more important for selection of early growth traits. So estimates of the additive genetic, maternal and environmental components of (co)variances become more important to make informative genetic evaluations and develop multi-trait selection indices (Hanford et al., 2005, 2006; Mandal et al., 2008). Accurate estimates of the genetic parameters largely depend on the pedigree structure, fixed effects, sample size and model selection. There have been a few heritability estimates for both early and late growth traits reported in goat (Al-Shorepy et al., 2002; Bosso

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doi:10.1016/j.livsci.2008.12.010

et al., 2007). However, most of these did not include all fixed factors and their interactions in the model, and few attempts have been made to use animal models to analyze the way that maternal effects influence post-weaning growth traits of the goat.

The Boer goat is a famous meat purpose breed for its rapid growth, excellent meat quality and high fertility (Malan, 2000). This breed originated in South Africa and was first imported to China in 1995 where the population has increased rapidly. Few researches have reported estimates of genetic parameters for early growth (Matika et al., 2003; Zhang et al., 2008), and little is known about the influence of factors and their interactions on the post-weaning growth for this breed.

The objective of this study is therefore to find the factors and their interactions affecting body weights at birth (BW0), 90 days (BW90) and 300 days (BW300) of age, and average daily gains from birth to 90 days (ADG0-90), birth to 300 days (ADG0-300) and 90 days to 300 days (ADG90–300) of age in Boer goat using SAS (GLM) procedure. Moreover, this paper also aims to estimate the genetic and phenotypic parameters for the above traits, by fitting four models included corresponding fixed effects, attempting to separate direct and maternal genetic and permanent maternal environmental effects.

2. Materials and methods

2.1. Feeding environment and management

All the experimental animals were raised at the Boer Goat Breeding Station in Yidu, China. The area is located in the western-centre of Hubei Province. The altitude is 800 m and the climate temperature, rainfall, relative humidity, sunlight length and frost free period per annum averaged 16 °C (ranges from −5 °C to 33 °C), 1200 mm, 85%, 1500 h and 240 days respectively.

The animals were generally pastured on irrigated pastures and supplemented with 0.7 to 1.0 kg/d per goat of concentrates comprised of maize (50%), wheat bran (35%), soybean meal (10%) and premix (5%). The forage consisted of ryegrass, red clover, white clover, orchard grass and magnolia, as well as meadow clover hay, peanut vine and sweet potato vine during the lean grass period. Animals drank freely and were vaccinated twice annually (in spring and autumn) against the general epidemic diseases. The does were mated with bucks at a ratio of 20–25 to 1. All the kids were kept with their dams continuously up to weaning at the age of 3 months.

2.2. Data collection and statistical analysis

Data of 5641 records on body weights were obtained from 1520 Boer kids born in January 2002 to January 2007, involving in 1520 records of birth weight (BW0), 1380 records of body weight at the age of 90 days (BW90) and average daily gain from birth to 90 days (ADG0-90), 487 records of body weight at 300 days (BW300) and average daily gain from birth to 300 days (ADG0-300), 378 records of average daily gain from 90 days to 300 days (ADG90–300). The pedigree was obtained from 2444 animals, including 129 sires and 552 dams. Birth weight (BW0) was recorded within 24 h after birth. Some body weights close to the age of 90 days and 300 days were pre adjusted to 90 days (BW90) and 300 days (BW300) of age using the routine method as described by Chen (1999). The average daily gains were calculated on the basis of adjusted records from birth to 90 days (ADG0-90), birth to 300 days (ADG0-300) and 90 days to 300 days (ADG90–300) of age.

Influencing factors of parities (the times of kidding, classed in 1–5 and ≥6), litter size (LS, the number of kids per litter) (1, 2 and ≥3), kidding years (2002–2007) and seasons (in four seasons on the basis of green grass supplement and the climate, namely, Spring in Mar. to Apr., Summer in May to Sept., Autumn in Oct. to Nov., Winter in Dec. to Feb.), sex (male and female) of kids as well as interactions that influenced the weights and growth rates were analyzed using the PROC GLM procedure (SAS 8.1). Only factors that influenced the records significantly ($P<0.05$ and $P<0.01$, Table 1) were fitted in animal models to estimate the genetic parameters.

The Least-squares means (LSM) and standard errors (SE) for growth traits in each level of the fixed factors were analyzed by PROC GLM procedure (SAS8.1). Genetic parameters were obtained for each data set by the derivative free restricted maximum likelihood procedure (DFREML) (Meyer, 1998; Meyer and Kirkpatrick, 2005). The convergence criterion was set at 1×10^{-8}. Single trait animal models were fitted for all traits to obtain variance components and heritability estimates. By excluding or including maternal genetic or permanent maternal

Table 1
Test of significance for body weights at birth (BW0), 90 days (BW90), 300 days (BW300) and average daily gains from birth to 90 days (ADG0-90), birth to 300 days (ADG0-300) and 90 days to 300 days (ADG90–300) of age for Boer goat in various influencing factors and their interactions.

Fixed effect	BW0/kg	BW90/kg	ADG0-90/g	BW300/kg	ADG0-300/g	ADG90–300/g
Parity	**	**	NS	NS	NS	NS
Year	**	**	**	**	**	**
Season	**	NS	NS	*	*	*
Litter size	**	**	**	NS	NS	NS
Sex	**	NS	NS	**	**	*
Parity–year	**	**	**	NS	NS	NS
Parity–season	**	NS	NS	*	*	NS
Year–season	**	**	**	**	**	NS
Year–sex	NS	NS	*	**	**	**
Year–LS	NS	**	**	NS	NS	NS
Parity–sex	NS	NS	NS	NS	NS	NS
Parity–LS	NS	NS	NS	NS	NS	NS
Season–LS	NS	NS	NS	NS	NS	NS
Season–sex	NS	NS	NS	NS	NS	NS

NS: $P>0.05$; *: $P<0.05$; **: $P<0.01$.