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ScienceDirect
Small Ruminant Research 72 (2007) 87–91
Small Ruminant Research
www.elsevier.com/locate/smallrumres

Genetic parameters for body weight, longissimus muscle depth and fat depth for Suffolk sheep in the Czech Republic

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Received 20 March 2006; received in revised form 22 April 2006; accepted 27 April 2006
Available online 27 November 2006

Abstract

In this study, heritabilities and (co)variance components for body weight at 100 days (BW), muscle depth (MD) and fat depth (FD) were estimated for Suffolk, the most common sheep breed in the Czech Republic. Data from 1996 to 2004 were extracted from the sheep recording database of the Czech Sheep and Goat Breeding Association. Genetic parameters were estimated using multivariate animal models, including both direct and maternal genetic effects and permanent environmental effects. Average values for BW, MD and FD were 27.91 kg, 25.5 mm and 3.3 mm, respectively. Direct and maternal heritability for BW were 0.17 and 0.08, respectively, and direct heritabilities were 0.16 for MD and 0.08 for FD. Maternal heritability estimates for ultrasonic measurements were generally low. Direct genetic correlations between BW and MD and maternal genetic correlations between BW and MD were positive and favourable. Both direct genetic correlations between BW and FD and maternal genetic correlations between BW and FD were negative, but not significantly different from zero. The favourable genetic correlations between BW and MD make ultrasound measurements a valuable tool in breeding programs focusing on growth and carcass characteristics.

Keywords: Sheep; Body weight; Muscle depth; Fat depth; Genetic parameters

1. Introduction

In the Czech Republic, there are about 140,000 sheep of which 36% are of meat sheep breeds. About 540 flocks are participating in an intensive registration programme. A total of 29 breeds are registered in the Czech recording system with Suffolk, the most common breed, accounting for about 22% of the flocks and about 18% of the purebred ewes (Holá, 2005). Knowledge on genetic parameters and heritabilities are crucial for genetic evaluation and for choosing the best selection schemes. In the Czech Republic, sheep breeding programs are based on preliminarily estimates and values from the literature. Therefore, there is a need for estimating these parameters based on current Czech data.

Among other traits, growth and carcass characteristics of the lamb are important for genetic improvement of lamb for meat production. Ultrasound measures have been used to predict carcass traits of live animals and such information is included in genetic

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doi:10.1016/j.smallrumres.2006.04.018

evaluation programs to improve growth and carcass traits in many countries. The ultrasound scanning of muscle and fat depth started in the Czech Republic in 1994. Several studies have evaluated genetic parameters for growth and ultrasound measured traits in sheep (Fogarty, 1995; Van Heelsum et al., 2001; Nsoso et al., 2004), but there are only few studies describing additive maternal genetic effects on muscle and fat depth (Larsgard and Olesen, 1998; Maniatis and Pollott, 2002).

The objective of this study was to estimate heritabilities and genetic correlations between body weight and ultrasound measured traits in Suffolk, based on data from Czech Republic.

2. Materials and methods

2.1. Data

Data were collected from 1996 to 2004 by the Czech Sheep and Goat Breeding Association. The traits studied were body weight (BW), muscle depth (MD) and fat depth (FD). The measurements were collected across a major part of the Suffolk population, and management and environmental conditions varied between flocks. Lambing was mainly taking place in spring season from mid-March to mid-May, and lambs were usually grazed on pastures until the end of fattening period at approximately 100–150 days of age. Slaughter weights vary from 35 to 40 kg. During the fattening period, ultrasonic and weight measurements were provided. Age at weaning in most cases corresponded with age at recording of body weight and ultrasonic measurements. Body weight was defined as the live weight of lamb adjusted to 100 days of lamb's age assuming linear growth curves from birth to weighing (weight at 100 days was measured within ±20 days). At scanning, muscle depth and fat depth were recorded by using ultrasonic technology with a UST-5011U (5 MHz) probe. Ultrasonic measurements were taken over the first lumbar vertebra at the age of 100 days (±20 days). The measurements were performed at this age, to ensure as many records as possible before lambs were slaughtered. Muscle depth was measured at the deepest point of the longissimus muscle. The characteristics of the data used in the analyses are presented in Table 1. Extreme weights and animals with more than 12% of other breed genes were excluded from the analyses. Only animals belonging to a flock-year class with six or more animals were included. All pedigree information available was included in the analyses.

Table 1
Number of records and means (with S.D. in parenthesis) for each trait for Suffolk

Animals in pedigree	10,291
Sires with offspring	272
Average no. offspring per sire	35
Average no. animals in fyc[a]	37
Average no. sire per fyc	2.2
Min and max sire per fyc	1–18
Average no. fyc per sire	2.1
Min and max fyc per sire	1–12
Body weight (kg)	
No.	8,135
Mean (S.D.)	27.91 (6.04)
Muscle depth (mm)	
No.	5,239
Mean (S.D.)	25.5 (4.2)
Fat depth (mm)	
No.	5,339
Mean (S.D.)	3.3 (0.9)

[a] Flock-year class.

2.2. Statistical methods

A multivariate animal model was used for estimation of genetic parameters. Both direct and maternal additive genetic effects, and permanent environmental effects due to the dam or litter, were considered in the analyses. The common litter effects were not significant and therefore excluded from the analyses. Effects included in the model differed between the traits, and they were as follows:

$$\mathrm{BW}_{ijklmpq} = \mathrm{S}_i + \mathrm{FY}_j + \mathrm{LS}_k + \mathrm{AE}_l + \mathrm{G}_m + \mathrm{adir}_p + \mathrm{amat}_q + \mathrm{pe}_q + \mathrm{e}_{ijklmpq}$$

$$\mathrm{MD}_{ijklmpq} = \mathrm{S}_i + \mathrm{FY}_j + \mathrm{LS}_k + \mathrm{AE}_l + \mathrm{G}_m + b_1(\mathrm{AW}_p) + b_2(\mathrm{LW}_p) + \mathrm{adir}_p + \mathrm{amat}_q + \mathrm{pe}_q + \mathrm{e}_{ijklmpq}$$

$$\mathrm{FD}_{ijklmpq} = \mathrm{S}_i + \mathrm{FY}_j + \mathrm{LS}_k + \mathrm{AE}_l + \mathrm{G}_m + b_3(\mathrm{AW}_p) + b_4(\mathrm{LW}_p) + \mathrm{adir}_p + \mathrm{amat}_q + \mathrm{pe}_q + \mathrm{e}_{ijklmpq}$$

where $\mathrm{BW}_{ijklmpq}$ is the body weight of animal p; $\mathrm{MD}_{ijklmpq}$ the muscle depth of animal p; $\mathrm{FD}_{ijklmpq}$ the fat depth of animal p; S_i the fixed effect of sex; FY_j the fixed effect of flock-year class; LS_k the fixed effect of litter size; AE_l the fixed effect of age of ewe (years); G_m the fixed effect of genotype group (three groups: 1 = purebred; 2 = max. 6.5% of other breed genes; 3 = max. 12% of other breed genes); AW_p the age at weighing (days) of animal p; LW_p the live weight at the day of weighing (kg) of animal p; b_1 the regression coefficient of MD on AW of animal p; b_2 the regression coefficient of MD on LW of animal p; b_3 the regression coefficient of FD on AW of animal p; b_4 the regression coefficient of FD on LW of animal p; adir_p the random direct additive genetic effect of animal p; amat_q the random maternal additive genetic effect of animal q; pe_q the random permanent environmental effect of ewe on lambs BW, MD and FD; $\mathrm{e}_{ijklmnopq}$ is the random residual.

Homogenous residual variance was assumed for all models. Estimation of (co)variance components for all models was carried out with the AI-REML algorithm (Madsen et al., 1994; Johnson and Thompson, 1995) using the DMU package (Madsen and Jensen, 2000). The convergence criterion used