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Genetic parameters for external udder traits of different dairy ewes

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The udder is a very important gland for milk production. Several studies have confirmed that udder and teat characteristics are important determinants of milk yield and ease of milking or milking ability in dairy ewes (Casu *et al*. 2006, Kominakis *et al*. 2009, Ayadi *et al*. 2014), goats (Eyduran *et al*. 2013, Torres *et al*. 2013), cattle (Millogo *et al*. 2012), camels (Ayadi *et al*. 2013) and buffalloes (Prasad *et al*. 2010, Espinosa-Núñez *et al*. 2013). Morphological udder traits are studied from the genetic perspective in dairy cattle (Wiggans *et al*. 2004) and these traits are included in dairy cattle selection schemes. Several factors might influence the udder morphology, factors such as genotype, lactation number and lactation stage, udder health status and breeding system (Gelasakis *et al.* 2012). To determine optimal breeding strategies to increase the efficiency of sheep production, knowledge of genetic parameters for udder morphology traits and also the genetic relationships between the traits is needed. The objective of present study is to find out the genetic characteristics of selected parameters characterizing the external udder traits of ewes.

In the Slovak Republic, number of dairy sheep farms, and production with machine milking has increased in last 10 years. Improved Valachian (IV) and Tsigai (TS) represent Slovak sheep with high endurance and adaptability to walking and natural conditions. East Friesian and Lacaune sheep ranked among one of the most important dairy sheep breeds in the world (Barillet *et al*. 2001, Barillet 2007). Both above mentioned breeds are already several years reared in Slovakia either as purebreds, or as a sire breed crossed with improved Valachian and Tsigai breeds to improve the milk yield and milkability. Nine different sheep genotypes were included in this experiment to determine the external udder traits of the ewes belonging to the following populations: Improved Valachian (IV), n = 217; Improved Valachian × East Friesian (25%), n = 64; Improved Valachian × East Friesian (50%), n = 81; Improved Valachian × East Friesian (75%), n = 80; Tsigai (T), n = 274; Tsigai × East Friesian (25%), n = 18; Tsigai × East Friesian (50%), n = 146; Tsigai × East Friesian (75%), n = 46; Lacaune (LC), n = 259. Three-breeding crosses with 25%, 50% and 75% of the genetic proportion of both specialized dairy breeds: Lacaune and East-Friesian (SBD) formed during the entire period were significantly less from the assessed population (about 5%). For estimation of covariance components and genetic parameters determining the external udder traits of sheep were used from our own database, where the measurements carried on one experimental flock. Estimation of covariance components followed by calculation of genetic parameters was conducted using restricted maximum likelihood (REML) methodology and the multi-trait animal model, using the REMLF90 and VCE 4.0 programs (Groeneveld and García-Cortés 1998). The estimation of covariance was based on a multiple trait animal model including 7 traits performed.Genetic parameters were determined separately for udder length, udder width, rear udder depth, cistern depth, teat length and teat angle using untransformed data: 1185 measurements were taken in the seven year long experimental process from 355 ewes. In which 209 of them are purebred, and 146 crossbred. In addition to genetic correlations, the value was set using the Pearson phenotype correlations, for the calculation of the same data sets were used as the calculation for genetic correlations. Phenotypic correlations were calculated using CORR procedure in mathematical-statistical program package SAS/STAT v. 9.2, 2002–2008. For estimation of covariance components and genetic parameters for all of the above parameters, the following model was used:

$$y_{ijklmno} = m + Y_i + LS_j + GEN_k + P_l + b^{*}DIM_{ijklm} + a_m + tp_n + e_{ijklmno},$$

where:

$y_{ijklmno,}$ is the vector of observations for the investigated characteristics (see above for details); Y_i, year (fixed effect with 5 to 7 levels; depending on the analysed indicator); LS_j, lactation stage (fixed effect with 4 levels; from 40th to 99th lactation day, from 100th to 129th lactation day, from 130th to 159th lactation day and from 160th to 210th lactation day); $GEN_{k,}$ genotype (breed group, fixed effect with 9

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Table 1. Heritability coefficients (on diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations for external udder measurements

Traits	(1)	(2)	(3)	(4)	(5)	(6)
Udder length, mm (1)	0.24	0.53	0.93	0.31	0.23	0.24
Udder width, mm (2)	0.65	0.10	0.26	0.32	0.06	0.53
Rear udder depth, mm (3)	0.86	0.65	0.24	0.40	0.37	0.25
Cistern depth, mm (4)	0.59	0.35	0.54	0.45	–0.15	0.94
Teat length, mm (5)	0.01	–0.01	0.03	–0.10	0.34	–0.29
Teat angle, mm (6)	0.35	0.14	0.31	0.58	–0.194	0.30

levels; see above for characterization); P_l, parity (fixed effect with 3 levels; first, second, third and further parity); a_m, is the additive genetic effect of ewes; DIM_{ijklm}, days in milk (covariate; 40 to 210 days in milk); tp_n is the permanent environmental effect of ewes; $e_{ijklmno}$ is the random error.

Coefficients of heritability (on diagonal), genetic correlations (above diagonal) and phenotypic correlations (below diagonal) characterizing the external udder traits of sheep are given in Table 1. Heritability coefficients calculated using a 7 character were low and ranged h^2, 0.10 for udder width and for cistern depth: h^2,0.45.

SUMMARY

Estimates of genetic parameters are important to study characteristics that are to be included in a breeding program of a genetic group. The studies on the udder parameters of sheep using for milk production recently in relation to selection for machine milking have been of interest. Genetic parameters for external udder measurements have been estimated. 1185 measurements were included in the analysis for each character of 355 ewes of 9 genotypes. Nine breeds and genotypes were included in these experiments: purebred Improved Valachian (IV), Tsigai (T), Lacaune (LC) ewes, and IV and T crosses with genetic portion of Lacaune and East Friesian (EF) – 25%, 50% and 75%. Primary data were processed using restricted maximum likelihood (REML) methodology and the multi-trait animal model, using programs REMLF90 and VCE 4.0. Heritability coefficients estimated for external udder traits were low and ranged from: h^2=0.10 for udder width and for cistern depth: h^2=0.45. Implications of the current study can be discussed in the future for Improved Valachian and Tsigai European dairy breeds breeding programs.

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