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Genetic parameters for milkability and somatic cell score in Slovak dairy sheep

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Selection for milk yield improves milk ejection traits even though the relationships between individual milk flow traits and udder type traits are very weak (Bruckmaier *et al.* 1997). Selection for milk yield would have a deleterious effect on udder depth and teat placement, which could have an economic impact on milking ability (Legarra and Ugarte 2005, Adegoke *et al*. 2016, Sezenler *et al*. 2016, Makovický *et al.* 2013, 2015b). The somatic cell count (SCC) of milk represents a marker of the sanitary state of the udder. In dairy sheep, goats, cows and buffaloes, good udder conformation is associated with a decreased risk of mastitis. Problems in milking, for example due to udder conformation, may lead to milk contamination and mastitis (Marie-Etancelin *et al.* 2005, Pajor *et al*. 2014 and 2016, Tanèin *et al*. 2017, Tóth *et al*. 2017). Breeders are increasingly interested in improving the machine milkability of European dairy sheep by selection for udder morphology, and as a trait with a high repeatability, animal's udders can be scored by a single, early lifetime score (Makovický *et al*. 2014, 2015a).

Udder type traits show genetic variation and moderate heritability estimates which ultimately suggest that improvement by selection is feasible, however, estimates of genetic correlations of udder type traits with milk yield varied among breeds. There is a rapid increase in machine milking in Slovak dairy ewes. Traits related to milkability are of high importance when machine milking is applied. There is a raising need for quick and careful machine milking and milk quality to be in accordance with given requirements. More attention is given to milkability, mainly due to possible utilization of milkability traits in selection schemes (Marnet and McKusick 2001, Marie-Etancelin *et al*. 2006).

Optimization of machine milking process would lead to increased labour efficiency, as well as inclusion of milkability traits in selection schemes, and hence, research on milkability traits has been intensified also in Slovakia (Tanèin *et al.* 2011, Antoniè *et al.* 2013, Maèuhová *et al*. 2017). Keeping in view the importance of these traits, the present study aimed at estimation of heritability values and genetic correlations of some traits related to milk yield, milk quality and milkability in dairy ewes in Slovakia.

Estimate of (co)variance matrices and genetic parameters for selected traits related to milkability, was done based on data taken from ewes kept at the one experimental flock of dairy sheep. Ewes were milked twice daily in a 1 × 24 low-line side by side milking parlour. Milking machine was set to provide 140–160 pulsations per minute in a 1:1 pulsation ratio with a vacuum level of 38–42 kPa. Since milk samples to determine somatic cell count (SCC; Fossomatic 500), were taken at the same time, genetic parameters were also estimated for transformed SCC (Log_{10} SCC; SCS = $\log_2$ (SCC/100000 +3)). These traits are the main indicators for udder health and may be used as selection criteria for ewes' resistance against mastitis.

Genetic parameters were estimated for the following traits, viz. milk yield in 30 sec (MY30s), machine milk yield (MMY), total milk yield (TMY), proportion of machine stripping from total milk yield (MS/TMY) and proportion of milk yield in 30 sec from total milk yield (MY30s/TMY) using 7-trait BLUP-AM. For each trait, 962 measurements were taken from 303 ewes available. REML F90 and VCE 4.0 package (Groeneveld and García-Cortés, 1998) were used to estimate (co)variance matrices and genetic parameters for the traits under study. The model equation was as follows:

$y_{ijklmn} = m + RO_i + Lakt_j + Gen_k + b_1 dnilak + a_l + tp_m + e_{ijklmn}$,

where, y_{ijklmn} is a vector of observations, RO_i is composite fixed effect of year*season (24 levels; all ewes were kept in one flock), $Lakt_j$ is fixed effect of lactation (3 levels), Gen_k is fixed effect of breed and breed group (9 levels), b_1 is covariate of days in milk, a_l is additive genetic effect, tp_m is permanent environmental effect and e_{ijklmn} is random error associated with each observation assumed to be NID $(0, \sigma^2_e)$.

High variability in the traits under study was found (Table 1). The values for MMY and SM/TMY were within the range with values ranging between 0 and 1200 ml

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Table 1. General statistics of milk yield traits

Trait	n	Avg.	Std.	Min.	Max.
MY30s (ml)	962	225.2	104.91	0	840
MMY (ml)	962	329.2	174.52	0	1200
TMY (ml)	962	448.1	203.44	30	1339
MS/TMY (%)	962	26.9	15.45	0	95
MY30s/TMY (%)	962	53.7	18.72	0	100
DIM (days)	962	124.2	32.36	48	189
SCC (no.)	962	540002	1712949	10000	19907000
Log_{10} SCC	962	5.18	0.576	4.00	7.36
SCS (no.)	962	2.43	0.986	1.63	7.66

MY30s, milk yield in 30s; MMY, machine milk yield; TMY, total milk yield; MS, machine stripping; DIM, days in milk; SCC, somatic cell count; SCS, somatic cell score.

(329.2±174.52 ml) and SM/TMY was within the range between 0 and 95% (26.9±15.45%), respectively. It should be noted that MY30s of the ewes with the highest milk ejection was 840 ml. The average SCC was about 540 ths., however, some ewes were of SCC above 5 mio. Heritability values were low to middle, ranging from 0.066 (SCS) to 0.275 (MMY). Heritability values for MMY and TMY were almost the same (0.275 and 0.266). Heritability for MS/TMY was relatively low (0.105). It indicated low additive genetic values for machine stripping, nevertheless, MS/TMY can be effectively included in selection scheme. With regard to improvements in milkability, findings on negative genetic correlations between MY30s and MS/TMY (–0.983) and between MMY and MS/TMY (–0.734) were of high importance. Descendants with low MS/TMY may be produced by selecting ewes with high milk ejection to be dams for the next generation.

Selection of ewes aimed at MY30s and MMY can be of high efficiency when milkability is to be improved. Estimates of genetic parameters for traits related to milk yield and milkability agreed with estimates referenced in the literature (Legarra and Ugarte 2005). Heritability values for transformed SCC (log_{10}SCC, SCS) were lower than 0.1 (0.094 and 0.066 for log_{10}SCC and SCS, respectively). The possible explanation for low heritability values might be due to a lack of precision in laboratory determination of SCC. However, Ligda *et al.* (2003) also reported low heritability for log_2 SCC (0.14). These authors reported negative genetic correlation between log_2SCC and TMY (–0.11 vs. –0.144, the present value). Moreover, Rupp *et al.* (2002) reported low heritability values for SCS (0.12 and 0.13, respectively). With regard to breeding aimed at good milkability as well as high quality of milk and good udder health (low SCC), findings on negative genetic correlations between MY30s and SCC, MMY and SCC, and TMY and SCC are of high importance (Table 2). In contrast, genetic correlations between MS/TMY and log_{10}SCC and MS/TMY and SCS were positive and moderately high (0.354 and 0.323, respectively). The estimates of genetic parameters indicated that additive genetic values for selected traits related to milk yield, milkability and udder health (SCC) are sufficiently high and may be efficiently used when selection programmes are designed. Not only increase in milk yield, but also improvements in ewes' health status and longevity have to be taken into account in selection schemes. Therefore, milkability and udder traits are of high interest when actual breeding aims are defined for dairy sheep in Slovakia.

Table 2. Heritability values (on diagonal) and genetic correlations (above diagonal)

Trait	MY 30s	MMY	TMY	MS/ TMY	MY30s/ TMY	Log_{10} SSC	SCS
MY30s	0.096	0.779	0.577	–0.983	0.245	–0.478	–0.446
MMY	-	0.275	0.959	–0.734	–0.361	–0.249	–0.283
TMY	-	-	0.266	–0.516	–0.591	–0.144	–0.198
MS/TMY	-	-	-	0.105	–0.319	0.354	0.323
MY30s/ TMY	-	-	-	-	0.229	–0.328	–0.280
Log_{10}SCC	-	-	-	-	-	0.094	0.989
SCS	-	-	-	-	-	-	0.066

SUMMARY

Mastitis is the most important disease of dairy small ruminants used for dairy purpose affecting animal welfare, agricultural economy and food safety. Milk yield and milkability were measured through recording of ewes' milk flow in 10 sec interval. At the same time, milk samples were taken to determine somatic cell count (SCC). REML and 7-trait BLUP-AM (VCE 4.0 package) were used to estimate (co)variance matrices and genetic parameters. Heritability values for milk yield and milkability traits ranged from 0.096 to 0.275. Heritability values for machine milk yield (MMY), total milk yield (TMY) and proportion of machine stripping from total milk yield (MS/TMY) were 0.275, 0.266 and 0.105, respectively. Heritability values for transformed SCC (log_{10}SCC and SCS) were lower than 0.1. Moderately low (between TMY and SCC, MMY and SCC, and MY30s and SCC: from –0.144 to –0.478) to high negative correlations existed among these traits (between MY30s and MS/TMY: –0.983 and MMY and MS/TMY: –0.734). In contrast, genetic correlations between MS/TMY and log_{10}SCC and MS/TMY and SCS were positive and moderately high (0.354 and 0.323).

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