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# KNOWLEDGE OF MILK TRAITS IN SLOVAK DAIRY SHEEP: A REVIEW

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## ABSTRACT

The objective of this review is to summarize the knowledge of milk traits, lactation curves and genetic evaluation of dairy sheep in Slovakia. Thus, an emphasis was given on milk yield (daily and milking period yield), fat content and protein content. The special attention was drawn to modelling of lactation curves for these traits using the Ali and Schaeffer regression model. The following breeds: Tsigai, Improved Valachian i.e. breeds of local provenience providing low milk yields, and Lacaune (a specialized dairy breed providing high milk yield), were involved in the analyses. Various sources of information: test day records with daily milk yield, milking period yield, fat content and protein content incorporated in single-trait models and multi-trait models were reviewed. Accordingly, the experience with estimations of genetic parameters and proportions of variance components for milk traits was covered. Approaches based on alternative strategies treating milk yield (fat and protein content) in individual months of lactation either as the same trait or as a different trait were documented (Tsigai chosen as a model breed). The review attempts to summarize the recent experience with description of milk traits (lactation curves and genetic evaluation) in dairy sheep in Slovakia.

**Key words:** Tsigai; Improved Valachian; Lacaune; dairy; lactation curve; genetic evaluation

## INTRODUCTION

Sheep industry is an important branch of livestock production in Slovakia with about 400 thousands heads in total, out of which 270 thousands are ewes. Milk and cheese production predominate; about 168 thousand ewes are milked. In 2013, marketed milk production was 11000 tons (Gálik, 2014). The most numerous dairy sheep in Slovakia are breeds of local provenance: Tsigai and Improved Valachian. The less numerous are imported dairy breeds: Lacaune and East Friesian. At present, a size of synthetic population of Slovak dairy sheep with genetic portion of Lacaune and East Friesian is increasing. The proportion of ewes in milk performance recording is up to 10 % of dairy ewes. An average milk yield per ewe in recorded flocks is about 110 kg in Tsigai and Improved Valachian, and about 210 kg in Lacaune (see Results of Milk Performance Testing of Sheep and Goats, 2012, 2013, 2014). The first study dealing with analyses of milk yield and milk composition in sheep kept in the territory of Slovakia was done in the beginning of the 20$^{th}$ century (Laxa, 1908). In recent times, studies have been aimed at investigating lactation curves and genetic evaluation of dairy sheep based on either milking period or daily milk yield (Margetín and Milerski, 2001; Oravcová *et al.*, 2005, 2006a,b, 2007; Oravcová and Peškovičová, 2008). However, no comprehensive review summarizing up-to-date knowledge of milk traits in dairy sheep in Slovakia has been published yet. The objective of this review is to summarize the knowledge of milk traits, lactation curves and genetic evaluation of dairy sheep in Slovakia.

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**Milk traits**

The most important milk traits in Slovak sheep are considered milk yield, fat and protein content. The first study dealing with investigations on these traits in ewes kept on the territory of Slovakia originated in the beginning of the 20th century (Laxa, 1908). Further studies were conducted since 1950s (Šulc, 1957; Janotík, 1958; Semjan, 1972; Špánik and Mikuš, 1988). Recently, either milk traits of ewes in individual flocks (Čapistrák *et al*., 1995, 2002, 2005) or milk traits of ewes in milk performance recording (Margetín *et al*., 1998a, 1998b, 2005; Oravcová *et al*., 2006, 2007) have been analyzed. Milk performance testing of Slovak sheep using the AC method as defined by ICAR (2014) has been routinely recorded under the guidance of the Breeding Services of the Slovak Republic since 1995.

Local Tsigai and Improved Valachian ewes produce lower milk yields than most breeds in Europe. Daily milk yield (Oravcová *et al*., 2015) of ewes in milk performance recording was 0.640 kg (Tsigai) and 0.667 kg (Improved Valachian) during the period 2006-2010, reflecting the effort to increase milk yield from 0.583 kg (Tsigai) and 0.562 kg (Improved Valachian) during the period 1995-1999. Daily milk yield of Lacaune ewes was 1.053 kg (Oravcová *et al*., 2006). This corresponds with the fact that Lacaune ewes in Slovakia are of lower milk yields (Oravcová, 2007) than Lacaune ewes in France (Barillet *et al*., 2001; Berger, 2004). Opposite to daily milk yield, fat and protein content decreased between the periods 2006-2010 and 1995-1999: 8.22 vs. 7.59 % (Tsigai) and 7.92 vs. 7.51 % (Improved Valachian). Fat and protein content in Lacaune ewes were lower in comparison to Tsigai and Improved Valachian ewes i. e. 6.97 and 5.62 % (Oravcová *et al*., 2007). In the beginning of milk performance testing (years 1995 and 1996), Margetin *et al*. (1998a, 1998b) reported the following milk yields: 0.55 L (Improved Valachian) and 0.53 L (Tsigai), fat contents: 8.15 % (Improved Valachian) and 8.46 % (Tsigai), protein contents: 5.73 % (Improved Valachian) and 6.74 % (Tsigai). Comparisons with earlier study of Špánik and Mikuš (1988) showed that fat and protein contents changed minimally during last thirty years. For local sheep breeds, these authors reported fat content about 7.8 % and protein content about 6.05 %.

Among factors affecting the variability of milk traits in Slovak dairy sheep the most important were: flock-test day effect, parity, number of lambs born, days in milk, and also, direct additive genetic and permanent environmental effect of ewe. The statistical models applied to study the influence of factors affecting milk traits in Slovak dairy sheep were able to explain 49 % to 59 % of the total variability (Oravcová *et al*., 2006a, 2007).

**Lactation curves**

Breed-specific lactation curves of daily milk yield were modelled using the Ali and Schaeffer (Ali and Schaeffer, 1987) regression (Oravcová *et al*., 2002, 2006a, 2006b, 2015) and Wood (Wood, 1967) model (Krupová *et al*., 2009). In modelling breed-specific lactation curves for fat and protein content the Ali and Schaeffer model was employed (Oravcová *et al*., 2007, Oravcová, 2015). Lactation curves were modelled as submodels incorporated in general linear model (SAS, 2002-2003) and mixed model methodology (variance component estimation). Formerly, regression coefficients for days in milk were estimated for the first, second and third (and later) parity separately (Oravcová *et al*, 2006 and 2007) i.e. different shapes of lactation curves resulted for each milk trait (milk yield, fat and protein content) in each investigated parity. In the recent analysis (Oravcová *et al*., 2015), regression coefficients of days in milk were estimated for each breed regardless of parity: shifting between parities was estimated on the basis of different intercepts. Due to limited number of test-day measurements in the first month after parturition (lambs are weaned about 55 days on average), lactation curves were estimated since day 30 (Oravcová *et al*., 2015). The shape of lactation curves for milk yield, fat and protein content in Slovak sheep was in accordance with the shape of lactation curves reported in literature. Lactation curves of Slovak Lacaune breed corresponded to lactation curves of dairy sheep (lower persistency, higher changes in milk traits between earlier and later days in milk), whereas lactation curves of Tsigai and Improved Valachian breeds corresponded to lactation curves of multipurpose breeds (higher persistency, smaller changes in milk traits between earlier and later days in milk). Milk yield decreased along with increasing days in milk, and fat and protein content increased along with increasing days in milk, regardless of difficulties with modelling the beginning and ending phases of lactation curves (Oravcová *et al*., 2015). When lactation curves were estimated for individual parity separately, some atypical shapes were revealed (Oravcová *et al*., 2006, 2007). When lactation curves were estimated (only for milk yield) with Wood model by Krupová *et al.* (2009), these were found to be of typical shape for both Tsigai and Improved Valachian. These curves slightly differed from lactation curves estimated by Oravcová *et al*. (2006), mainly in the beginning and end of lactation (less test-day measurements available and related underestimation or overestimation of milk yield).

**Genetic evaluation**

Single-trait and multi-trait animal models were employed in genetic evaluation of dairy sheep in Slovakia.

Genetic evaluation of milk traits can either be based on individual test day records or cumulative milking period records. Single-trait models based on cumulative milking period records were used in the beginning of effort aimed at adopting genetic evaluation in Slovak dairy sheep (Margetín and Milerski, 2001). Predicting accurate breeding values, however, needs all effects affecting the traits to be accounted for, to be known. Genetic evaluation based on individual test day records has a number of advantages. One main advantage, apart from operational ease lies in a better possibility to account for sources of variation affecting each test day (Swalve, 1998). Estimates of variance (covariance) components and predicted breeding values were calculated by means of univariate and multivariate animal models (test-day models) taking into account similar effects as statistical models analyzing most important factors affecting variability of milk traits in Slovak dairy sheep. Variance (covariance) components were estimated using REML (Restricted Maximum Likelihood) method as applied in VCE 5 (Kovač *et al*., 2002) and VCE 6 (Groeneveld *et al*., 2010) softwares. Breeding values were predicted using PEST software (Groeneveld *et al*., 1993). All these methodologies are incorporated in the routine genetic evaluation of Slovak sheep which is done by the Breeding Services of the Slovak Republic on a yearly frequency.

Estimated coefficients of heritability for daily milk yield ranged from 0.10 (Improved Valachian) to 0.19 (Tsigai), for fat content ranged from 0.06 (Improved Valachian) to 0.12 (Tsigai) and for protein content ranged from 0.07 (Improved Valachian) to 0.25 (Lacaune). These were found on the lower values reported for dairy sheep in literature (Oravcová *et al*., 2005, Oravcová, 2007, Oravcová and Peškovičová, 2008). Breeding values expressed as averages across birth years of animals involved in the analyses and environmental changes expressed as averages of flock-test day solutions over years and months of milk performance testing were used to analyze genetic and environmental trends in investigated populations. These are useful when revealing patterns how genetic and environmental effects influence variability of milk traits (mainly milk yield) depending on time (Oravcová and Peškovičová, 2008). With breeding values, research on their reliability in males has been done (Oravcová *et al*., 2005) recently. It showed that reliability increased with the number of daughters tested per male. Males and/or their sons with the higher breeding values as well as higher reliabilities should be preferred in selection. Thus, analyzed milk traits can be improved genetically.

The strategy of treating test day measurements in individual months of lactation as a different trait has been also investigated in Slovak dairy sheep recently (Oravcová 2014, 2015). These analyses, undertaken on milk performance data of Tsigai breed, showed that milk yield, fat and protein content are mostly correlated in the middle of lactation (0.95 to 0.98 for milk yield, 0.94 to 0.99 for fat content and 0.95 to 0.99 for protein content). When effects involved in animal models were defined similarly as in repeatability models, where milk yield (fat and protein content) was treated as the same trait, heritability estimates differed minimally for each milk trait (see Oravcová *et al*., 2005, Oravcová and Peškovičová, 2008 vs. Oravcová, 2014, 2015 for comparisons).

## CONCLUSION

The study attempts to summarize the knowledge of milk traits, lactation curves and genetic evaluation of dairy sheep in Slovakia. The information provided here, however, may not be considered as complete. For instance, recent research aimed at milkability and economic importance of milk traits in Slovak dairy sheep was not included in the present study.

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