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Genetic parameters for the external udder morphology in commercial farms of Istrian sheep from Croatia

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Abstract

Istrian sheep is a local breed with superior milk yield and composition. Excellent udder shape of this breed needs to be preserved in future, since it's economic value resides within the artisanal cheese production. Genetic parameters for the teat angle (Alpha) and the height of the cisternal part below the teat orifice (Cis) were estimated in order to evaluate the possibility for conservation of udder traits amiable for machine milking. Udder morphometry of the 240 registered Istrian ewes was measured from digital photographs of the posterior view of the udder on 10 commercial farms three times during lactation. Original pedigree records were trimmed to four recent generations. Heritabilities were estimated using single trait animal model. The stage of the lactation, interaction of lactation number, month of lambing and the farm were fixed effects, and the additive genetic value of the individual and permanent environment of the individual were random effects. Estimated heritability was 0.05 for Alpha and 0.71 for Cis mid-lactation measurements. Measurements of Cis during lactation did not result in a significant additive effect. The result shows potential in estimating genetic parameters of important udder traits in small commercial dairy ewe populations, using the digital mesurements, given the reduction of non-genetic variability in the sample.

Keywords: animal model, digital morphometry, genetic parameters, udder shape

Introduction

Istrian sheep is the second smallest autochthonous sheep population in Croatia with 2,515 animals registered on 38 farms, and makes for 5% of the total number of sheep of an approved selection program of the Croatian Agricultural Agency. Predominately semi-extensive farms have average herd size of 55 animals. Milk is processed into hard artisanal cheese and curd on small family cheese dairies, or sold for industrial cheese production. Machine milking is present in Istrian sheep, while the other local breeds in Croatia are predominately milked by hand. The aptitude of the Istrian sheep for machine milking is evaluated positively: small angle that teat closes with the vertical axis of the udder (Alpha), small cisternal height below the teat orifice (Cis), and satisfactory milk flow kinetics (Šalamon and Džidić, 2014).

Improved udder traits in the selection objectives of ovine breeding schemes were implemented on the experimental intensive farms in the Mediterranean (De La Fuente et al., 1996; Marie-Etancelin et al., 2005; Casu et al., 2006) because of the “baggy udders” of the ewes selected for high milk yield. The cisternal part of the udder below the teat orifice is enlarged in such udders, as is the angle between the teat and the vertical axis of the udder (Fernandez et al., 1997; Marie-Etancelin et al., 2005). Milking of the “baggy udders” is not efficient because part of the cisternal milk remains below the teat orifice unless the milker applies manual manipulation of the udder during stripping (Bruckmaier et al., 1997). Additionally, horizontally implanted teats cannot hold the weight of the milking unit, which then tends to fall off. With milking already being the most time-demanding procedure on ewe dairy farms, this additional manipulation prolongs the total milking time of the herd. Dry milking can appear, injuring the teat tissue and the udder (Fernandez et al., 1997; Bergonier et al., 2003; Legarra and Ugarte, 2005). Udder traits as selection goals for sheep are not common outside experimental farms due to the recording cost. Besides the on-farm measuring of the udder at experimental farms, successful appraisal method based on 9-point linear scale has been applied in production herds of the Churra breed, proposed by De La Fuente et al. (1996) and adapted for other dairy breeds (Fernandez et al., 1997; Legara and Ugarte, 2005; Marie-Etancelin et al., 2005; Casu et al., 2006). To lessen the cost of the trained technicians, the use of digital photographs of the udder for digital measuring was proposed by Dzidic et al. (2009). The aim of this study was to evaluate the possibility for conservation of udder traits amiable for machine milking by estimating the genetic parameters for the teat angle (Alpha) and the height of the cisternal part below the teat orifice (Cis) using the digital measurements of the udder.

Materials and methods

Six of the sampled commercial farms performed milking by hand and five used machine milking. Digital photographs of 750 ewe’s posterior view of the udder were taken prior to evening milking three times during the lactation: early (days 8 to 95), mid- (between days 96 and 135) and late lactation measurements (days 96 to 135 of lactation). Cis and Alpha were measured from the digital photographs as described in Šalamon and Džidić (2014). Total of 1,397 records were edited removing non-logical values, animals without ID information or without information on the beginning of lactation, and animals with less than two records. Values 1.5 interquartile range lower than the first and higher than the third quartile were removed. Mixed model including all of the fixed effects used later in the animal model was used to remove all records having RStudent by leverage estimation of residuals higher than 2 or lower than -2. Description of the 140 ewes’ data from 10 farms clustered in three groups due to small number of observations, and of the average lactation stage 1.94 (lactations 6 and higher were pooled in one common cluster) is shown in Table 1.

Pedigree records obtained from the Croatian agricultural agency (24,219), were cleaned (9% non-logical) and trimmed the last four generations, shown in Table 2.

Table 1. Descriptive statistics for Cis and Alpha measurements

	N (N_1, N_2, N_3)	Lact.	Min-Max	Mean	SD	SE
Cis	862 (286, 342, 234)	3.14	0-3.7	1.26	0.69	0.02
Alpha	848 (281, 338, 229)	3.2	3.5-71.9	37.61	13.31	0.46

Alpha - the teat angle (°); Cis - the height of the cisternal part below the teat orifice (cm); N (N_1, N_2, N_3) – number of observations (number of early lactation, of mid-lactation, and of late lactation observations); Lact. – Average number of lactation; Min-Max – minimal and maximal observation; SD – standard deviation; SE – standard error.

Table 2. Characteristics of the Istrian sheep pedigree for the final four generations

	Number	Founders	With offspring	Without offspring
Rams	1,722	59	326	1,396
Ewes	5,769	708	3,553	2,216
Total	7,491	767	3,879	3,612

Breeding values were estimated using the univariate animal model, where fixed environmental factors to be included were additionally explored beforehand. Stage of lactation, complex effect of farm, lactation number and the month of lambing (pooled in two clusters: winter or spring) are defined as fixed effects. Additive genetic value of the individual and permanent environmental effects within the day of measuring were the random effects in udder shape models as shown in the following equation:

$$y_{ijklm} = \mu + D_i + F_j{*}L_k{*}S_l + a_{mi} + p_{mi} + e_{ijklm}$$

where: y_{ijklm} = individual observation of Alpha and Cis; μ = intercept; D_i = fixed effect of measuring day (i = 1, 2 and 3, stage of lactation: early, mid, late; F_j = fixed effect of the farm (j = 1 to 3, cluster of farms); L_k = fixed effect of the lactation number (k = 1, 2, 3, 4, 5 and 6+); S_l = month of lambing (l = 1, 2); a_m = the random additive genetic effect of animal; p_{mi} = the random permanent environmental effect within day of measurement; e_{ijklm} = the residual.

Descriptive statistics, data cleaning and the development of the fixed part of the model were obtained using TRANSREG, REG, GLM, UNIVARIATE and MEANS procedures In SAS 9.4, while MIXED was used for the animal model and INBREED for the additive matrix. Pedigree was handled using ENDOG (Gutierrez and Goyache, 2005) and CFC (Sargolzaei et al., 2006).

Results and discussion

Measurements of Cis during lactation did not result in a significant additive effect. To reduce some of the unexplained individual variance in Cis, mid-lactation measurements were run in a similar animal model, without the permanent environment effect and the effect of the measuring day. Relatively high heritability estimate (0.7), could address most basic selection objectives and criteria.

Overall, the obtained estimates (Table 3) reflect enormous variability in the management of Istrian sheep with variation that is difficult for the univariate model to recognize and partition correctly, especially in a small sample. Exceptionally low heritability values, such as estimated for Alpha (0.05), are predicted for dairy traits in extensive production systems where milk production is lower and irregular because of variations in herbage availability (Barillet et al., 2001). Farming conditions in Istrian sheep that could affect Cis and Alpha due to the development of the mammary complex and the quantity of the cisternal milk during lactation include: suckling period (30-60 days, rarely more), milking period (until August, depending on the water availability), number of daily milking in the final weeks of the lactation, the availability of supplementary feed during the milking. Nevertheless, repeatability obtained for Alpha (0.43) was relatively high, similar to heritability estimated by Marie-Etancelin et al. (2005) or Makovicky et al. (2017), indicating usable extreme case for the upper limit of heritability in Croatian population of Istrian sheep. Fernandez et al. (1997) obtained higher Alpha repeatability and suggested one measurement per lactation for udder traits with repeatability higher than 0.5. Aditionally, Alpha does not change within or among lactations and is independent on the udder milk content, unlike the cisternal height below the teat orifice (Šalamon and Džidić, 2014).

Table 3. Genetic parameters for the external udder morphometry of the Istrian sheep

	V_r	V_a	V_{pe}	V_i	V_p	h^2	r^2	e
Cis[a]	0.14	0.32	/	/	0.46	0.7	/	0.05
Alpha[b]	93	8.56	60.73	69.29	162.29	0.05	0.43	20.26

[a]Estimated using mid-lactation measurements; [b]Estimated using Equation 1; Alpha - the teat angle; Cis - the height of the cisternal part below the teat orifice; V_r – residual variance; V_a – additive variance; V_{pe} – permanent environment variance; V_i – individual variance; V_p – phenotype variance; h^2 - heritability; r^2 - repeatability; e - error.

Conclusions

Given the reduction of non-genetic variability in the sample, there is a possibility for conservation of udder traits amiable for machine milking by estimating the genetic parameters for the teat angle and the height of the cisternal part below the teat orifice using the digital measurements of the udder in Istrian sheep in Croatia.

References

Barillet, F., Rupp, R., Mignon-Grasteau, S., Astruc, J. M., Jacquin, M. (2001) Genetic analysis for mastitis resistance and milk somatic cell score in French Lacaune dairy sheep. Genetics Selection Evolution, 33, 297-415.

Bergonier, D., de Cremoux, R., Rupp, R., Lagriffoul, G., Berthelot, X. (2003) Mastitis of dairy small ruminants. Veterinary Research, 34, 689-716.

Bruckmaier, R. M., Paul, G., Mayer, H., Schams, D. (1997) Machine milking of Ostfriesian and Lacaune dairy sheep: udder anatomy, milk ejection and milking characteristics. Journal of Dairy Research, 64, 163-172.

Casu, S., Pernazza, I., Carta, A. (2006) Feasibility of a linear scoring method of udder morphology for the selection scheme of Sardinian sheep. Journal of Dairy Science, 89, 2200-2209. DOI: https://dx.doi.org/10.3168/jds.S0022-0302(06)72290-1

De La Fuente, L. F., Fernández, G., San Primitivo, F. (1996) A linear evaluation system for udder traits of dairy ewes. Livestock Production Science, 45, 171–178. DOI: https://dx.doi.org/10.1016/0301-6226(96)00003-6

Dzidic, A., Salamon, D., Kaic, A., Salajpal, K., Kaps, M. (2009) Relationship between udder and milking traits during lactation in Istrian dairy crossbreed ewes. Italian Journal of Animal Science, 8, 154-156. DOI: https://dx.doi.org/10.4081/ijas.2009.s3.154

Fernandez, G., Baro, J. A., De La Fuente, L. F., San Primitivo, F. (1997) Genetic parameters for linear udder traits of dairy ewes. Journal of Dairy Science, 80, 601–605. DOI: https://dx.doi.org/10.3168/jds.S0022-0302(97)75976-9

Gutierrez, J. P., Goyache, F. (2005) A note on ENDOG: A computer program for analysing pedigree information. Journal of Animal Breeding and Genetics 122 (3), 172-176. DOI: https://dx.doi.org/10.1111/j.1439-0388.2005.00512.x

Legarra, A., Ugarte, E. (2005) Genetic parameters of udder traits, somatic cell score, and milk yield in Latxa sheep. Journal of Dairy Science, 88 (6), 2238-2245. DOI: https://dx.doi.org/10.3168/jds.S0022-0302(05)72899-X

Makovicky, P., Margetin, M., Makovicky, P. (2017) Estimation of genetic and phenotipic parameters for udder morphology traits in different dairy trait genotypes. Acta Universitas Agriculturae et Sylviculturae Mendelianae Brunensis, 65 (1), 105-110. DOI: https://dx.doi.org/10.11118/actaun201765010105

Marie-Etancelin, C., Astruc, J., Porte, D., Larroque, H., Robert-Granié, C. (2005) Multiple-trait genetic parameters and genetic evaluation of udder-type traits in Lacaune dairy ewes. Livestock Production Science, 97 (2-3), 211-218.

Sargolzaei, M., Iwaisaki, H., Colleau, J. J. (2006) CFC: A tool for monitoring genetic diversity. Proceedings of the 8th World Congress of Genetic Application in Livestock Production, 27-28. Belo Horizonte, Brazil. [Online] Belo Horizonte: World Congress of Genetic Application in Livestock Production. Available at: http://www.wcgalp.org/proceedings/2006 [Accessed 30 April 2018].

Šalamon, D., Džidić, A. (2014) Preferences of Istrian sheep udder shape type on farms that apply machine milking. Acta Agraria Kaposvariensis, 18 (S1), 166-172.