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Genetic parameters for test day milk traits and somatic cell counts in Chios dairy sheep

Ch. Ligda*, A. Mavrogenis, Th. Papadopoulos* and A. Georgoudis*****
*Agricultural Research Station of Chalkidiki, NAGREF, 63 200 N, Moudania, Greece
**Agricultural Research Institute, PO Box 22016, 1516 Nicosia, Cyprus
***Dept. of Animal Production, Aristotle University, 54 006 Thessaloniki, Greece

SUMMARY – The objective of the present study is to estimate of genetic and environmental factors affecting the incidence of mastitis in dairy sheep. The analysed data correspond to 2295 observations of the Chios flocks of the Agricultural Research Institution in Athalassa and the Agricultural Research Station of Chalkidiki. The traits analysed were milk yield, fat, protein percentage and somatic cell counts. The heritability estimates for milk yield, fat, protein and log_2SCC were 0.35, 0.21, 0.31 and 0.14, respectively. Low negative genetic correlation was found between log_2SCC and milk yield. The results indicated that somatic cell count could be used as a selection criterion for mastitis resistance in Chios sheep.

Key words: Chios dairy sheep, somatic cell counts, multitrait animal model, genetic parameters, milk traits.

RESUME – *"Paramètres génétiques pour l'étude des caractères laitiers et comptages de cellules somatiques chez les ovins laitiers de race Chios". L'objectif de cette étude concerne l'estimation des paramètres génétiques et des effets de l'environnement qui influencent l'incidence de la mammite chez les ovins. Les données analysées correspondent à 2295 observations réalisées dans les troupeaux de la race Chios à l'Institution de la Recherche Agronomique à Athalassa et la Station de la Recherche Agronomique à Chalkidiki. Les caractères analysés sont la production de lait, la matière grasse, la protéine et les cellules somatiques. Les héritabilités pour la production laitière, la matière grasse, la protéine et log_2SCC étaient 0,35, 0,21, 0,31 et 0,14, respectivement. Entre log_2SCC et la production de lait a été trouvée une corrélation génétique négative. Les résultats de cette étude ont indiqué que le nombre de cellules somatiques peut être utilisé comme un critère de sélection pour la résistance à la mammite chez la race ovine Chios.*

Mots-clés : *Ovin Chios, cellules somatiques, modèle animal multicaractères, paramètres génétiques, caractères laitiers.*

Introduction

Studies on the genetic resistance to mastitis have increased recently, showing the economic importance of this trait. Several methods for the detection of subclinical mastitis have been proposed, while the most common indicator is the somatic cell counts. The majority of the studies are referred to dairy cows while somatic cell counts have been introduced in many milk-recording schemes (Emanuelson *et al.*, 1988; Philipsson *et al.*, 1995; Reents and Dopp, 1997). However, an increase of the published research results regarding dairy sheep has been observed the last years (Baro *et al.*, 1994; Gonzalo *et al.*, 1994; Barillet *et al.*, 1999; El-Saied *et al.*, 1999; Mavrogenis *et al.*, 1999; Rupp *et al.*, 2001).

In Greece and Cyprus in general, the breeding programs aim at the increase of milk production and meat output. Traits related to milk characteristics and to functional ability, such as milkability and longevity or to safety and quality of the products, like the resistance to scrapie and mastitis, are not regularly recorded. Nevertheless, as mastitis is one of the major causes for ewe disposal, accounting for 46% of all culls and almost 60% of milk losses, research interest has been directed towards the analysis of these traits.

The aim of this study was to investigate the environmental factors influencing the somatic cell counts, milk yield, fat and protein content and to estimate the genetic parameters for the traits analysed, in order to use these parameters in the genetic evaluation procedures.

Materials and methods

The data for the analysis were obtained in the frame of a bilateral project between Greece and Cyprus, on the estimation of genetic and environmental factors affecting the incidence of mastitis in dairy sheep. The project has been carried out with the collaboration of the National Agricultural Research Foundation of Greece, the Aristotle University of Thessaloniki and the Agricultural Research Institute of Cyprus.

Data were collected form the two flocks of Chios dairy sheep, kept in the Agricultural Research Station in Chalkidiki and in the Athalassa farm, in a period between 1997 and 1999. The data were collected from the first test day 7 ± 3 days after weaning, which occurred at 42 days in Chalkidiki flock and at 35 days at Athalassa flock, until the 7th month of the lactation. Records of milk yield were measured every month, in morning and evening milkings and milk samples were taken at the same time. In the Athalassa flock the samples for the somatic cells count were taken for an adjusted mixture of morning and evening sample, while in the Chalkidiki flock the somatic cell count represents the mean of the somatic cell count of the morning and evening sample. The final data set was comprised of 2295 test days records of 282 Chios ewes. These ewes were the progeny of 133 sires and 101 dams.

The traits analysed were the somatic cell counts, the $\log_2$ transformation of the Somatic Cell Counts ($\log_2$SCC), the milk yield and the fat and protein percentage of the test day records.

Estimates of (co)variances were obtained by Restricted Maximum Likelihood fitting a multitrait animal model. Standard errors of heritabilities, permanent environment effects and genetic correlations were also estimated. The estimation of the genetic parameters was carried out using the VCE 4.2 software package (Groeneveld, 1998).

The following model was used:

$$Y_{ijklmnp} = Flock_i + Year_j + Lacno_k + Lbs_l + Test_m + a_n + perm_p + e_{ijklmnp} \qquad (1)$$

where,

$Y_{ijklmnp}$ is the observations' vector for the four traits ($\log_2$SCC, milk yield, fat and protein percentage); $Flock_i$, is the fixed effect of the flock (i = 1, 2); $Year_j$ is the fixed effect of the productive period, (j = 1, 2); $Lacno_k$ is the fixed effect of the lactation number (k = 1, …, 5); Lbs_l is the fixed effect of the number of lambs born (l = 1, …, 3); and $Test_m$ is the fixed effect of the number of the test record (m = 1, …, 7). The random effects included in the model were, the additive genetic effect of the animal (a_n, n = 1, …, 624), the permanent environmental effect ($perm_p$, p = 1, …, 282) and the residual ($e_{ijklmnp}$).

A second analysis was performed including $\log_2$SCC and total milk yield, analysing the records of each test month as a different trait. The same model was used, excluding the effect of the test record.

Results

A general description of the data set is presented in Table 1.

Table 1. Descriptive statistics of test day milk yield, $\log_2$SCC, protein and fat percentage

Trait	No. of observations	Mean	Standard deviation
Milk yield (ml)	2295	1363	744.4
$\log_2$SCC	2181	7.7	1.96
Protein (%)	2287	5.8	0.51
Fat (%)	2287	6.6	1.09

Stage of lactation, which included in the model as the month of the month of the test day record, influenced the somatic cell counts and milk yield. The effects of flock, year, lactation number and number of lambs born were significant on the protein percentage.

Table 2 shows the descriptive statistics for the four traits, in the subsequent test days, while the relation of milk yield and somatic cells count over the milking period is presented graphically in Fig. 1.

Table 2. Means and standard deviations for milk yield, fat, protein and somatic cell counts

Test day	Milk yield (g)	Fat (%)	Protein (%)	Somatic cell counts ($\times 10^3$)
1	2308 ± 785.1	6.1 ± 1.23	5.5 ± 0.48	692 ± 1958
2	1730 ± 604.8	6.5 ± 1.11	5.7 ± 0.42	569 ± 1205
3	1344 ± 487.1	6.5 ± 0.95	5.9 ± 0.52	619 ± 1373
4	1106 ± 416.9	6.6 ± 1.02	5.9 ± 0.55	700 ± 1207
5	980 ± 442.8	6.8 ± 0.92	5.9 ± 0.48	709 ± 1623
6	866 ± 420.8	6.9 ± 1.17	5.9 ± 0.53	622 ± 1786
7	586 ± 254.0	6.8 ± 0.88	5.7 ± 0.34	371 ± 862

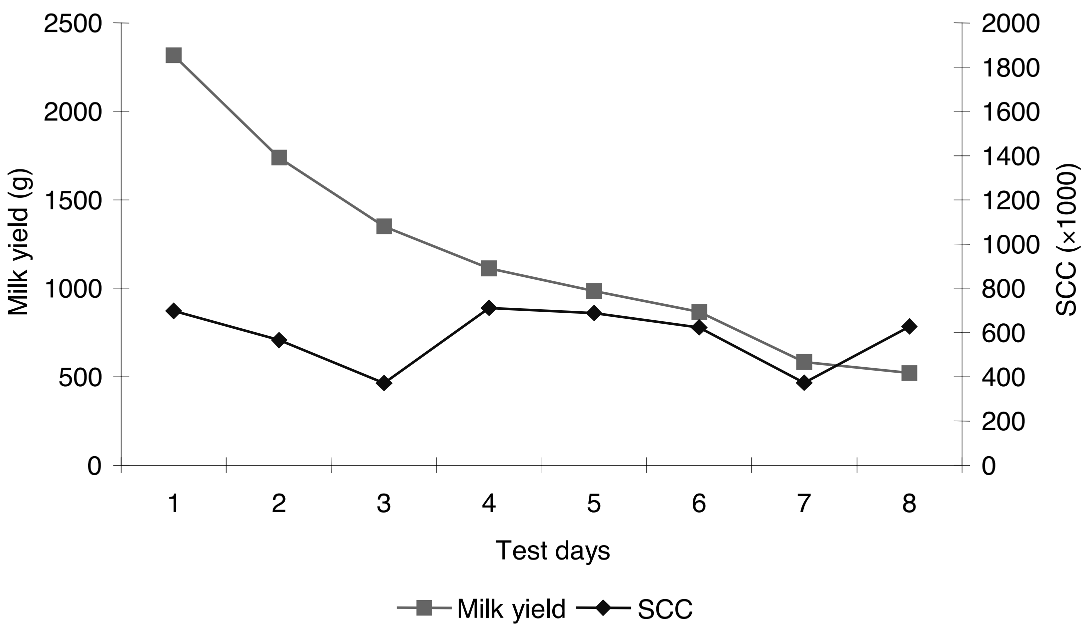

Fig. 1. The evolution of milk yield and somatic cell counts across lactation in the two flocks.

The heritabilities and the genetic and environmental correlations of the traits analysed are shown in Table 3. The heritability of test day milk yield was 0.35, which was high. Mavrogenis *et al.* (1999) analysing Chios earlier data from the Athalassa and Akhelia flock using paternal half sibs correlations, found a heritability of 0.26 on test day milk yield, while previous estimates of testday records of first lactation Chios ewes ranged from 0.28 to 0.14 from the first to sixth month of milking (Ligda *et al.*, 2000). Similar value (0.35) has been reported by Baro *et al.* (1994) for the Churra ewes, while for the same breed El-Saied *et al.* (1998) estimated a heritability of 0.18. Regarding the somatic cell counts, the estimated heritability (0.14) of the $\log_2$SCC is moderate and in agreement with previous findings of Mavrogenis *et al.* (1999), who reported a value of 0.18. Lower heritability estimates have been reported by Baro *et al.* (1994) and El-Saied *et al*. (1999), who have estimated a heritability of 0.04 and 0.09, respectively, for the Spanish Churra sheep. The estimated heritability is comparable to values corresponding to the lactation traits, which were 0.15 for the Lacaune breed (Rupp *et al.*, 2001) and 0.12 for the Churra sheep (El-Saied *et al.*, 1998). For fat and protein percentage the estimates of 0.21 and 0.31, respectively, were higher than the values reported for testday traits, which were 0.17 and

0.13 for the protein percentage in the Churra sheep (Baro *et al.*, 1994; El-Saied *et al.*, 1999), but lower from the lactation estimates of the Lacaune breed (Rupp *et al.*, 2001).

Table 3. Heritabilities and genetic correlations between $\log_2$SCC and milk traits for testday records

	Log_2SCC	Milk yield	Fat (%)	Prot (%)
Log_2SCC	0.14	–0.11	–0.05	0.12
Milk yield		0.35	–0.35	–0.10
Fat (%)			0.21	0.56
Prot (%)				0.31

The proportions of the permanent environmental variance were 0.09, 0.13, 0.001 and 0.006 for the milk yield, $\log_2$SCC, fat and protein percentage. Low negative (–0.11) and low positive (0.12) genetic correlations were estimated between $\log_2$SCC and milk yield and between $\log_2$SCC and protein percentage, respectively. The correlation of $\log_2$SCC with fat percentage was almost null. However, divergent results have been reported, varying from moderate negative to moderate positive values (Baro *et al.*, 1994; El-Saied *et al.*, 1998; Fuertes *et al.*, 1998; Rupp *et al.*, 2001).

The results from the second analysis of $\log_2$SCC show an increase of the heritability with the stage of lactation. The heritabilities range from 0.09 to 0.26, while after the 5th month of the lactation the estimates decrease.

Conclusions

The results provide indications on the environmental factors that influence milk characteristics and somatic cell counts. Moreover, the estimated genetic parameters can be useful on deciding on new selection objectives.

The estimated heritability for $\log_2$SCC showed that the selection response for the trait is expected to be similar to that achieved on dairy cows and therefore, can be used as a possible selection criterion for mastitis resistance in Chios dairy sheep. The negative genetic correlation between somatic cell counts and milk yield favours the selection for low somatic cell counts, while the low positive genetic correlation of somatic cell counts with protein percentage, suggests that an increase of protein percentage occurs with high somatic cell counts. It is important to investigate the trait in first lactation ewes, as results from literature suggest that the trait is expressed differently in first and later lactations. Nevertheless, the development of models accounting for the fact that somatic cell counts is a trait that changes across lactation will increase the accuracy of the estimates and the efficiency of the selection scheme.

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