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Phenotypic and genetic relationships between udder morphology and udder health in dairy ewes☆

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ABSTRACT

The aim of this paper was studying the phenotypic and genetic relationships between udder morphology traits and udder health in dairy sheep. From 2000 to 2008 udder traits, somatic cell count (SCC) and clinical mastitis cases were recorded in an experimental flock consisting each year of around 900 ewes. A logistic regression was performed to evaluate the risk for a ewe of showing either a mastitis or at least 2 daily SCC records greater than 1×10^6 cells/ml in one of its lactations as function of udder traits scored in 1st lactation. 1587 individual udder scores and 39,950 SCC daily records were used for the analysis. Secondly, genetic correlation between lactation mean of somatic cell score and udder traits were estimated by a REML method applied to four bi-trait animal models, using data from 2251 primiparous ewes. Logistic regression results indicated that the risk of mastitis or high SCC values during the productive life increased as the cistern height increased and the degree of udder suspension and udder depth decreased. This suggests that the appraisal of the udder is a useful tool for culling decision aimed at increasing the sanitary status of the flock. The genetic correlation between lactation SCS and udder traits were favourable for udder depth (-0.50 ± 0.12), teat placement (0.39 ± 0.011) and degree of udder suspension (-0.42 ± 0.011) and closed to zero for the degree of separation of the two halves. Thus selection for udder morphology, already implemented in some dairy sheep breeds with the aim of improving machine milkability, will lead to a favourable correlated genetic response on SCC.

1. Introduction

Improving udder health in dairy ewes is of major concern to contain production costs and satisfy the consumers' demand for safe and quality food. Clinical and chronic mastitis are, beside low milk production, the most frequent reason of ewes' culling (Barillet et al., 2001; Bergonier et al., 2003). Different studies showed that subclinical mastitis lead to milk production losses and curd yield reduction (Gonzalo et al., 2002; Leitner et al., 2004, 2008). The migration of polymorphonuclear leucocytes from blood to the mammary gland in response to an inflammation produces an increase in milk's somatic cells content. For such reason, milk somatic cell count (SCC) has been used as tool for assessing both animal health status (Fthenakis, 1996; Berthelot et al., 2006; Lafi, 2006) and milk quality (Pirisi et al., 2000; Raynal-Ljutovac et al., 2007). In addition, as in dairy cattle, SCC has been proposed as selection criterion for genetically improving udder health in sheep (Barillet et al., 2001). Somatic cell count recording has been implemented in several sheep breeds in France, Italy (Sardinian) and Spain (Astruc et al., 2009). So far, however, only the Lacaune breed has included the reduction of milk SCC among its breeding objectives (Barillet, 2007). Indeed heritability estimates of lactation mean of the logarithmic

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transformation of SCC (SCS) are quite low, ranging between 0.10 and 0.20 (El Saied et al., 1999; Barillet et al., 2001; Othmane et al., 2002; Rupp et al., 2003; Serrano et al., 2003; Legarra and Ugarte, 2005). In addition, knowledge of the relationship between SCC and clinical mastitis resistance in sheep is scarce. Preliminary results of an experiment based on two lines of Lacaune ewes divergently selected for SCS suggest that selection for reducing milk SCC may improve resistance to both clinical and subclinical mastitis also in this species (Rupp et al., 2009).

In dairy cattle there is evidence that udder conformation is associated with SCC values and clinical mastitis incidence (Seykora and McDaniel, 1986; Rogers et al., 1991; Rupp and Boichard, 1999). In dairy sheep linear appraisal methods of udder traits related to machine milking aptitude have been conceived (de la Fuente et al., 1996; Marie-Etancelin et al., 2005; Casu et al., 2006). Linear scores of udder traits are reliable because of high correlations between different classifiers (Marie-Etancelin et al., 2003); repeatable within and across lactation (Casu et al., 2006), enabling one lifetime score and from moderately to highly heritable, making feasible the genetic improvement of udder morphology (Fernandez et al., 1997; Serrano et al., 2002; Legarra and Ugarte, 2005; Marie-Etancelin et al., 2005; Casu et al., 2006). Thus, the most important European dairy sheep breeds have included udder traits into their breeding programs, mainly with the aim of improving machine milking ability (Marie-Etancelin et al., 2005; Casu et al., 2006).

The objective of this work was to study the relationship between udder morphology and udder health in dairy sheep. In particular, we investigated the effects of udder conformation on the risk of mammary infection during the productive life of a ewe and of selection for udder morphology, which is at present implemented to improve machine milkability, on udder health.

2. Materials and methods

From 2000 to 2008 udder traits, SCC and clinical mastitis cases were recorded in an experimental flock consisting each year of around 900 ewes. Recorded animals were 894 Sarda × Lacaune backcross ewes (BC) and 1368 offspring (693 daughters and 675 granddaughters) sired by 36 Sarda rams. All backcross ewes were born in 1999, whilst their offspring were generated from 2002 to 2007 in cohorts of around 200 ewes a year. There was no voluntary culling in the flock and each cohort of ewes was simultaneously slaughtered at the end of 4th lactation. Thus most of BC's granddaughters were still in production when the present analysis was realised. Udder scoring was performed at least twice per year. Teat placement (TP), udder depth (UD), degree of separation of the two halves (DS), degree of suspension of the udder (SU) were scored with 9-point linear scales used in the selection program of the Sarda breed (Casu et al., 2006). From 2000 to 2004 each ewe was monthly evaluated by at least two classifiers at every round of scoring. Since the average correlation between classifiers was high (from 0.76 for DS to 0.83 for SU), a single score per ewe and date of scoring was randomly selected for further analysis. From 2005 all ewes were always scored by a unique classifier. After editing 7558 scores of 2262 primiparous ewes were retained for the analyses.

SCC was measured bimonthly by a Fossomatic cell counter from milk samples collected at a.m. and p.m. milking. SCC was log-transformed to SCS. Daily SCC and SCS were calculated as the arithmetic mean of a.m and p.m. values of SCC and SCS, respectively. Ewes showing clinical mastitis signs (modification of the colour or consistency of the milk; hot, swollen or painful udder) were systematically recorded.

2.1. Phenotypic relationships between udder morphology and udder health

Only animals born before 2005 were used in this analysis, i.e. the backcross ewes and their daughters, which were potentially able to perform 4 lactations until 2008 and were not submitted to voluntary culling. In all 1587 ewes were considered with 39,950 SCC daily records. The udder health status of the ewes during the productive life was defined according to three categories: (1) M: including animals with at least one recorded episode with clinical mastitis signs; (2) SC: including animals with at least 2 daily SCC records higher than 1×10^6 cells/ml in one of the recorded lactations; (3) H: including animals with no detected udder health problem during their career. The SCC threshold of 1×10^6 cells/ml was chosen for identifying animals which were likely affected by subclinical mastitis or, in any case, presenting an inflammation of the udder. Note that this threshold was quite arbitrary since no accurate estimation of the relationship between SCC and subclinical mastitis study is available. Thus, it was based on the empirical observation of the SCC distribution and the thresholds used in the common veterinary practice to plan drying-off antibiotics treatments (Berthelot et al., 2006).

For udder morphology traits the most frequent score obtained for each trait in first lactation was retained for this analysis.

The logistic regression was used to model the probability of a given udder health status as function of udder morphology traits scored in first lactation. Three analysis were performed for each linear udder trait, restricting the dependent variable analysed to two levels: "M" versus "SC or H", "SC" versus "H" and finally "M or SC" versus "H".

The overall significance of the regression coefficient was assessed by a Wald test. Odds ratio (OR) and OR 99% confidence intervals were also computed.

2.2. Genetic correlations between somatic cell score and udder traits

Heritabilities of SCS and genetic correlations with udder traits were estimated on lactation basis on records from all primiparous ewes ($n = 2251$). For genetic analysis individual test date (TD) SCS records are usually adjusted for lactation stage and appropriately weighted in a lactation measure (Wiggans and Shook, 1987; Rupp et al., 2003). In our study, the adjustment for the stage of lactation was not performed since lactation lengths and DIM at first TD were similar, and data recording was frequent. Thus lactation SCS (LSCS) were calculated as the arithmetic mean of