Genetic Parameters of Mastitis-Correlated Milk Components in First Parity Dairy Cows

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Introduction

Mastitis is one of the most important diseases in dairy cattle because of lower production, discarded milk, culling, and lower milk payment. Healing is difficult and number of chronically infected cows is important. Genetic selection for production traits has decreased the averaged genetic merit for functional traits, such as udder health. For a few years, udder health has been added in breeding programs, but only a few countries (e.g. Nordic countries) collect clinical mastitis in the field. Other countries generally estimate udder health breeding values indirectly from somatic cell score (**SCS**), which is more heritable (0.15 – 0.30) than clinical mastitis (0.03 – 0.06) (Shook (2006)). However, the genetic correlation between SCS and clinical mastitis ranged from 0.3 to 0.7 (Wojdak-Maksymiec et al. (2006)) indicating that in some cases, SCS is not sufficient.

With recent advances in estimation of milk components using mid-infrared spectrometry (e.g. Soyeurt et al. (2006), Soyeurt et al. (2009)), it is now possible to have the composition of several additional milk components.

The objective of this study was to estimate heritabilities and genetic correlations between mastitis-correlated milk components and therefore to study the interest of using of a multi-trait model instead of a single-trait (SCS) model for providing udder health breeding values.

Material and methods

Choice of milk components. As the Walloon Region of Belgium does not collect clinical mastitis routinely, SCS was used as the principal indicator of udder health and phenotypic correlations between SCS and available milk components were estimated. Data used were 590,083 test-day records from Walloon Region of Belgium collected between 2007 and 2009 on 113,905 cows. The three components that presented the highest phenotypic correlations were kept: ind. lactoferrin, ind. sodium and lactose. The term ind. for "indicator of" means that calibrations of these components have a lower precision, but predictions give a good estimation of component content (RPD = 2.07 for sodium (Soyeurt et al. (2009)) and 1.98 for lactoferrin (Soyeurt et al. (2007))).

(Co)variance components estimation. A multi-trait single-lactation random regression test-day model was used for first parity. The following model was applied:

$$\mathbf{y} = \mathbf{X\beta} + \mathbf{Zp} + \mathbf{Za} + \mathbf{e}$$

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where:

- **y** is the vector of observations (SCS, lactoferrin content, sodium content and lactose content);
- **β** is the vector of fixed effects: class of breed x class of age at calving x class of 5 DIM;
- **p** is the vector of permanent environmental random regression coefficients;
- **a** is the vector of genetic additive random regression coefficients;
- **e** is a vector of residuals;
- **X** and **Z** are incidence matrices assigning observations to effects.

Three breed classes were defined as Holsteins, Dual-Purpose Belgian Blue, and others. Classes of age at calving were defined as 28 month and less, between 29 and 32 month, and 33 month and more. Regression curves were modeled using Legendre polynomials of order 2. Random effects were assumed to be normally distributed and residual variances were assumed to be independent and constant over the lactation.
Only test-day records in parity one, and DIM between 5 and 365 were kept. A subset of 51 herds was used to estimate (co)variance. This subset contained 11,223 test-day records from 2,900 cows. Pedigree file was extracted from Walloon pedigree for routine genetic evaluations and contained 15,931 animals. (Co)variance estimation was performed using Gibbs sampling with 100,000 samplings. Heritabilities were defined as the ratio of genetic variance to the sum of all random effects variances. Genetic (co)variances were obtained as the diagonal of **QGQ'**, where **G** represented the genetic additive (co)variance matrix and **Q** was a 21 x 3 matrix containing Legendre polynomials coefficients computed for DIM 5 to 305 with increment of 15 days. The average of daily heritabilities and daily genetic correlations gave mean daily heritabilities and mean genetic correlations.

Results and discussion

Phenotypic correlations of the five most correlated milk components (including milk yield) with SCC are shown in table 1. SCS was positively correlated with ind. lactoferrin content, ind. Na content and protein content, whereas lactose content and milk yield were negatively correlated. Correlations were moderate. Miglior (2007) found lower correlations for lactose content (-0.23), milk yield (-0.08) and protein content (0.09).

Table 1: Phenotypic correlations with somatic cell score (SCS)

	SCS
Ind. lactoferrin content	0.44
Ind. Na content	0.41
Lactose content	-0.38
Milk yield	-0.24
Protein content	0.23

Mean daily heritabilities and mean genetic correlations are shown on table 2. Daily heritabilities are shown on figure 1. Mean daily heritabilities of ind. lactoferrin content (0.34), ind. Na content (0.37) and lactose content (0.42) are higher then SCS (0.16). Other studies showed similar heritabilities for SCS and lactose (Miglior et al. (2007), Welper and Freeman (1992)). Arnould et al. (2009) and Gaunt et al. (1979) showed heritabilities of 0.22

for ind. lactoferrin and 0.44 for lactoferrin content, respectively. Mean genetic correlations were moderate to high, showing that these traits are not redundant and could be used together to describe udder health instead of SCS alone. Miglior et al. (2007) and Welper and Freemen (1992) had lower genetic correlations between SCS and lactose content (-0.20 and -0.11, respectively). Arnould et al. (2009) found similar genetic correlation (0.24) between SCS and ind. lactoferrin content. Daily heritabilities varied slightly along lactation, except for ind. lactoferrin where heritatility was 0.20 at the beginning and at the end of the lactation, and 0.50 at 200 DIM.

Table 2: Mean daily heritabilities on diagonal, and mean genetic correlations above diagonal between SCS, ind. lactoferrin content, ind. Na content, and lactose content.

Traits	SCS	Ind. lactoferrin content	Ind. Na content	Lactose content
SCS	0.16	0.26	0.42	-0.35
Ind. lactoferrin content		0.34	0.30	-0.18
Ind. Na content			0.37	-0.73
Lactose content				0.42

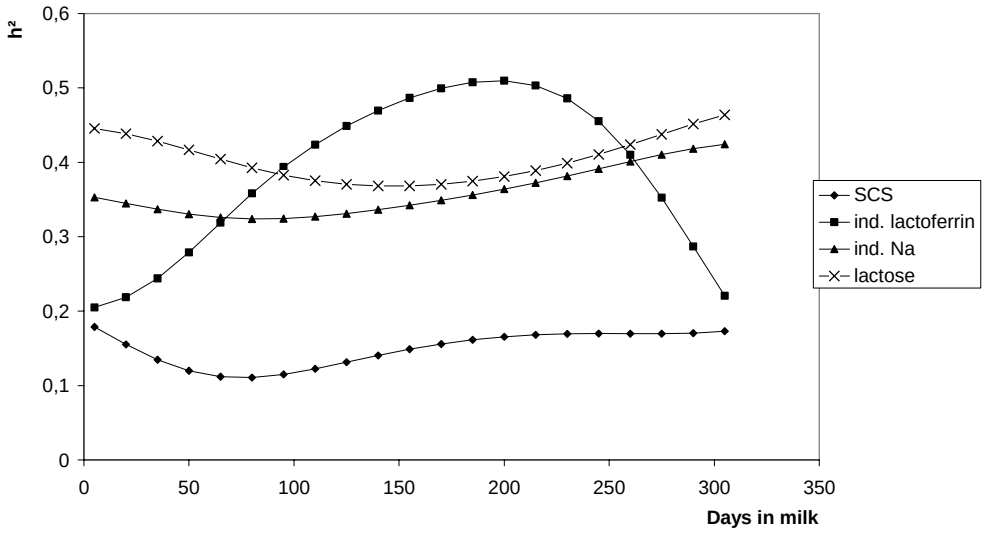

Figure 1: Daily heritabilities for SCS, ind. lactoferrin, ind. Na, and lactose.

Conclusion

These preliminary results realized on first parity dairy cows gave estimated mean daily heritabilities for ind. lactoferrin content, ind. Na content and lactose content higher than for SCS, with moderate mean genetic correlations. The results support that these milk

components could be used jointly with SCS for udder health genetic evaluation, even if correlations with clinical mastitis data must be confirmed.

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