BAYESIAN INFERENCES FOR MILKING TEMPERAMENT IN CANADIAN HOLSTEINS

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INTRODUCTION

In dairy cattle production the majority of research has concentrated on yield traits, which represents only one component contributing to overall efficiency and profitability. For some other dairy production traits, including management traits such as milking temperament, little or no attention has been given in genetic selection programs. Temperament can be defined in terms of either milking behavior, ease of handling or aggressiveness at feeding. In Canada, temperament at the time of milking, referred to as milking temperament, has been recorded for several years by milk recording agencies. Moreover, several reports have shown that milking temperament has been a factor for dairy cow disposal to an amount up to 1.5% (Burnside *et al.*, 1971 ; Westell *et al.*, 1980 ; PATLQ, 1999). Although milking temperament can be considered a trait of importance, especially in herds with automated milking systems, relatively little work has been done in the past to evaluate the genetic component of such a behavioral trait and its relationship with other traits such as production, type and other auxiliary traits.

Estimates of the heritability of milking temperament in the literature range from 0.05 to 0.20 (Sullivan and Burnside, 1987; Hayes, 1997) for Canadian Holstein cattle. Moreover, Cue *et al.* (1996) reported a heritability estimate of 0.14 for shed temperament in New Zealand Holsteins. These estimates vary possibly due to differences in the data used and in the analytical methods applied. The main objectives of this study were to estimate the genetic parameters for milking temperament in Canadian Holsteins, develop a national genetic evaluation system for milking temperament in all dairy breeds in Canada, and assess the relationship between bull estimated breeding values (EBVs) for milking temperament and EBVs for other available traits.

MATERIALS AND METHODS

A total of 656,839 milking temperament records were obtained for first lactation Holstein cows that calved from September 1993 to May 2001. Within the first six months in lactation, each cow was evaluated at the time of milking for their milking temperament and given a subjective score based on a five-point linear scale with 1=Very Nervous, 2=Nervous, 3=Average, 4=Calm and 5=Very Calm. In an attempt to reflect the current population for variance component estimation, only records associated with calvings since January 1997 were used. The phenotypic frequency of each subjective score was 0.91%, 8.81%, 49.22%, 37.34% and 3.71%, respectively. The raw linear scores were transformed to Snell scores (1964) to account for the skewness of the raw data. The analysis was done on two sets of data, with 10,000 records each, that were selected based on herd size (largest herds and smallest herds). The number of herds and the average herd size in each data set is shown in Table 1.

Table 1. Number and average size of herd-year (HY) groups in each data set

	# of HY groups	Average HY size	Minimum	Maximum
Largest herds	159	62.43	8	219
Smallest herds	8,092	1.23	1	9
All data (1997–2001)	33,872	9.13	1	221

Variance component estimation. The variance components were estimated from a single trait animal model that included random effects of animal and residual. The Multiple Trait Gibbs Sampling Animal Model (MTGSAM) package was used (Van Tassell and Van Vleck, 1996). Data **y** (the transformed Snell Score for the 1st lactation milking temperament for a cow) was analyzed using the following model :

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Za} + \mathbf{e}$$

Where **b** is the vector which contains the fixed effects herd-year, season of calving, age at calving, months in milk, **a** is the vector of the additive genetic effect for the animal, **e** is the random residual effect and **X** and **Z** are the corresponding known incidence matrices relating fixed effects and random animal effects to the observations. The vector of fixed effects **b** was assumed to follow an *a priori* improper uniform distribution,

$$\mathbf{p(b)} \ \alpha \ \mathbf{constant}$$

An inverted Wishart distribution was assigned to describe prior uncertainty about additive genetic and residual variances (Sorensen, 1996). The derivation of the fully conditional posterior densities of unknown parameters in the model has been described elsewhere (Sorensen*,* 1996; Van Tassell and Van Vleck, 1996).

Gibbs sampling. The Gibbs sampler consists of a set of fully conditional densities of unknown parameters in the model. Gibbs sampling was used to generate a random sample from a marginal posterior distribution by sampling successfully from the full conditional distribution of the variables included in the model. Monte Carlo standard errors were estimated using time series analytical techniques as suggested by Geyer (1992) and used by Sorensen *et al.* (1995). Different starting points of the Gibbs sampler were used. After making sure that the magnitude of the different starting values had no more than a minor effect on parameter convergence the Gibbs sampler was run in a long chain scheme. The first 5,000 samples were discarded as a burn-in period. A chain length of 205,000 was used and one sample was saved every 10 rounds so that a total of 20,000 samples were available for posterior density estimation and for estimating Monte Carlo standard errors.

Genetic evaluation and correlations. Estimated genetic parameters from this study were used to develop a national genetic evaluation system for milking temperament for application in all dairy breeds, based on all available records for calvings since September 1993. EBVs were computed by iteration on the data using the same model as for variance component estimation. Subsequently, correlations between bull EBV for milking temperament and EBV for other available traits were estimated.

RESULTS AND DISCUSSION

Genetic parameters. Marginal posterior distributions for heritability estimates of milking temperament were similar in both data sets (Table 2). Generally, the mean, mode and median were nearly identical in all analyses (Table 2). The fact that the additive genetic variance was higher and the residual variance was lower in the data set based on the largest herds compared to the results from the smallest herds, indicates an advantage of larger contemporary groups.

Table 2. Genetic parameter estimates for milking temperament in the Holstein breed

	Parameter	Mean	Mode	Median	SD	MCSE	ESS
Largest Herds	h^2	0.0810	0.0809	0.0807	0.003	0.004	5,266
	σ^2a	0.2330	0.2340	0.2330	0.004	0.003	6,357
	σ^2e	2.6430	2.6580	2.6540	0.005	0.005	7,515
Smallest Herds	h^2	0.0724	0.0723	0.0724	0.003	0.004	6,976
	σ^2a	0.2093	0.2102	0.2091	0.003	0.005	5,582
	σ^2e	2.6827	2.6731	2.6810	0.060	0.050	9,773

SD=Standard deviation; MCSE=Monte Carlo standard error X 100; σ^2a= Additive genetic variance; σ^2e = Residual variance; ESS= Effective sample size

Genetic evaluation and correlations. Animal solutions for males were transformed to a scale of EBV expression that reflected the probability that a future daughter would be evaluated as "Average", "Calm" or "Very Calm" for milking temperament in first lactation. In order to facilitate the interpretation of bull EBVs for milking temperament, the breed average was set to equal a probability of 90 percent, in accordance with the phenotypic distribution across the subjective scale used to record the data. Starting August 2001, a national genetic evaluation system for milking temperament was introduced in Canada for all dairy breeds, using 8% heritability. In the Holstein breed, over 1,800 bulls born in the most recent 10-year period received an official EBV for milking temperament as well as for production and type traits. Simple correlations amongst bull EBVs can be useful for providing a basic understanding of various trait interrelationships (Table 3). Correlations between milking temperament and production traits were generally not significant. Most major type traits showed significantly positive correlations with milking temperament but none were higher than 0.17 for rump. A slightly significant negative correlation was, however, found with feet and legs (-0.06). A closer look at the correlations for descriptive type traits (not shown) suggests that this negative relationship is specific to traits related to feet rather than legs. While no correlation was found with functional longevity, it appears that an undesirable relationship exists between EBVs for milking temperament and other auxiliary traits including lactation persistency (-0.08), calving ease (-0.07) and somatic cell score (0.17), for which the low EBVs are desirable. These negative relationships among traits of economic importance suggest that they should all be incorporated into the overall breeding objective with proper economic weights. The positive correlation between bull EBVs for milking temperament and milking speed (0.14) suggests that cows with average or calm temperament during milking, let down their milk quicker and have a reduced total milking time while more nervous cows end up taking more time to milk.

Table 3. Correlations between bull EBV for milking temperament and other traits in Canadian Holsteins

Trait	Correlation with Milking Temperament EBV
1st lactation milk yield	0.03 ns
1st lactation fat yield	0.06 *
1st lactation protein yield	0.02 ns
Conformation	0.11 **
Dairy Character	0.09 **
Capacity	0.11 **
Rump	0.17 **
Feet and legs	-0.06 *
Mammary system	0.08 **
Herd life	0.00 ns
Lactation persistency	-0.08 **
Somatic cell score	0.17 **
Calving ease	-0.07 **
Milking speed	0.14 **

ns= (p> 0.05), *= (p<0.05), **= (p<0.001)

CONCLUSIONS

Although previous research has indicated that milking temperament is moderately heritable, the variance components estimated using Gibbs sampling with fairly recent data resulted in a relatively low heritability estimate of 0.08. Correlations between bull EBV for milking temperament and other available traits suggest no significant relationship with production traits and favorable relationships with milking speed and most type traits, with feet traits being the key exception. The undesirable relationships found between milking temperament and most other auxiliary traits suggest that they should all be considered for inclusion in the national selection index formula, based on proper economic weights.

REFERENCES

Burnside, E.B., Kowalchuk, S.B., Lambroughton, D.B. and MacLeod, N.M. (1971) *Can. J. Anim. Sci.* **51** : 75-83.

Cue, R.I., Harris, B.L. and Rendel, J.M. (1996) *Livest. Prod. Sci*. **45** :123-135.

Geyer, C.J. (1992) *Stat. Sci.* **7** : 473-511.

Hayes, J.F. (1998) *Proc 6th WCGALP* **23** : 391-394.

PATLQ (1999) Rapport de production 1999 du PATLQ, p. 50.

Snell, E.J. (1964) *Biometrics* **20** : 592-607.

Sorensen, D., Andersen, A., Gianola, D. and Korsgaard, I. (1995) *Genet. Sel. Evol.* **27** : 229-249.

Sorensen, D. (1996) Report No. 82, Danish Institute of Anim. Sci, Denmark.

Sullivan, B.P. and Burnside, E.B. (1987) *J. Dairy Sci.* **70** (Suppl. 1) : 233.

Van Tassell, C.P., and Van Vleck, D.L. (1996) *J. Anim. Sci.* **74** : 2586-2597.

Westell, R., Burnside, E.B. and Schaeffer, L.R. (1980) *Can. J. Anim. Sci*. **60**: 547 (Abstract).