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Relationships between Milkability Traits in Brown Swiss

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Abstract

Milkability is an important functional trait in dairy cattle breeding. It is well documented that milking speed is unfavourably correlated with somatic cell count. Earlier studies in Simmental indicated that milk flow rate also may be unfavourably related with other milkability traits, e.g., bimodality and machine stripping. Aim of this study was to analyse these relationships more in detail. For the analyses 750,000 test-day records from 75,000 Brown Swiss first calf cows from Bavaria were available. Several data sets with approximately 140,000 records each were sampled from the total data set. Estimates of (co)variances for maximum flow rate (MFR) and machine stripping rate (MSR) from six 30-day periods were obtained by REML using an average information method. For MFR, estimates of heritability ranged from .52 to .56 and estimates of genetic correlation between time periods ranged from .92 to .99. For MSR, estimates of heritability ranged from .04 to .09 and estimates of genetic correlation between time periods ranged from .84 to .96. Estimates of the genetic correlation between MFR and MSR were moderate to large in magnitude (.30 to .78). Results suggest that while increased milk flow rates decrease milking time they may require a more thorough milking routine and/or a good milking technology.

1. Introduction

In 2002, a joint genetic evaluation for all traits in Simmental and Brown Swiss from Austria and Germany (Baden-Wuerttemberg, Bavaria) was implemented. For somatic cell count (**SCS**) and milkability a multiple trait model with five traits is applied: SCS in lactations 1 to 3, average flow rate from Austria and Baden-Wuerttemberg, and average flow rate from Bavaria. These two milkability traits are considered different traits because definition of average flow rate and collection of data are slightly different across countries and states, respectively (for details, see Sprengel et al., 2001). In Austria and Baden-Wuerttemberg, personnel from the dairy recording organisations measure milking duration and milk yield in order to calculate average flow rate. In Bavaria, a number of milk flow rate parameters is available from the routine dairy recording. Studies have these parameters shown to be highly correlated (Sprengel et al., 2000). The average flow rate used in the joint genetic evaluation is calculated from duration of main milking plus duration of machine stripping, and total milk yields (**AFR_MM_MS**). It was chosen because it is the flow rate parameter most similar to the average flow rate recorded in Austria and Baden-Wuerttemberg. A genetic correlation of .88 between the flow rates is assumed in the genetic evaluation. However, genetic relationships of AFR_MM_MS with other milk flow parameters have not been analyzed. In a previous study (Sprengel et al., 2000) it was shown that in Simmental milk flow parameters from the main milking period were unfavourably correlated with machine stripping yield, i.e., high flow rates may lead to larger stripping yields. Objective of this study was to estimate genetic parameters for maximum flow rate (**MFR**) and rate of machine stripping in Brown Swiss.

2. Materials and Methods

Data from the routine dairy recording were provided by the Bavarian dairy recording organisation, LKV Bayern. Test-day records were from first lactation Brown Swiss cows from 1999 to 2004. Depending on the recording method (two milkings per day or alternative milking) one or two observations per test-day were available. Figure 1 illustrates how a number of milkability traits are automatically derived based on threshold flow rates. For details see Worstorff et al. (1992) and Dodenhoff et al. (1999). In addition machine stripping (**MS**) was introduced as a binary trait depending on if a machine stripping yield was recorded (MS=1) or not (MS=0).

Records were selected from cows that had calved at an age of d 600 to 1260 and had been tested from d 8 to 275 after calving. Additional edits with respect to herd size and number of observations per test-day left 745,044 records from 73,624 cows. Characteristics of the data are given in Table 1. MS was recorded in 41.3% of milkings , i.e., after a period of over-milking with a flow rate below 0.2 kg/min the milk flow increased to a rate above 0.2 kg/min. Average rate of MS increased from ~35% at the beginning of lactation to ~48% at day 275. This is the reason why average DIM for milkings with MS is higher (144 DIM) than for milkings without MS (132 DIM). Milk yield per milking was not affected by MS. Average machine stripping yield was 0.35 kg. Maximum flow rate and average flow rate during main milking period (**AFR_MM**) was considerably higher in milkings with MS. Average flow rate during machine stripping was very low. Therefore, AFR_MM_MS is very similar for milkings with or without MS. In milkings without MS, AFR_MM_MS is somewhat larger than AFR_MM because the relatively small amounts of milk from the period until the flow rate reaches 0.5 kg and from the period of over-milking are included in its computation. Because of the larger flow rate milking duration was considerably shorter in milkings with MS. Interestingly, there was almost no difference between duration of over-milking in milkings without MS and the sum of duration of over-milking and duration of machine stripping in milkings with MS.

Three data sets with approximately 140,000 records each were created from the total data set. For each animal in these data sets two additional generations of pedigree information, if available, were added. Each data set included about 30,000 animals, and the observations were from about 14,000 cows. The lactation was divided into 30-day periods which were considered to be different traits. Six time periods (d 8-37, d 38-67, d 68-97, d 128-157, d 218-247, d 248-275) for MFR and MS, respectively, with approximately 9,000 to 12,000 observations were included in the analyses, i.e., the total number of traits was twelve. For each data set about 40 multiple trait analyses with four traits were run for various combinations (two MFR, two MS) of these twelve traits. Fixed effects fitted were herd test-day and calving year x calving month, and DIM and age at first calving were linear covariates. Components of variances were estimated by restricted maximum likelihood using an average information algorithm implemented in the DMU package (Madsen and Jensen, 2000). Estimates then were combined applying an algorithm for iterative summing of expanded part matrices (Mäntysaari, 1999).

3. Results and discussion

Only approximately half of the runs reached conversion. For no obvious reasons no reliable estimates of variance components could be obtained from runs with a certain combination of traits. However, estimates from runs that did not reach convergence were included in the iterative summing unless they were obviously unreasonable. The 12 x 12 matrix of estimates of heritabilities (h^2) and genetic correlations (r_g) from data set 3 is presented in Table 2. Estimates were fairly similar for the three data sets. For MFR estimates of h^2 for the six time periods were from .52 to .56 and did not show an increase or a decrease over the course of lactation. These estimates are larger than those obtained with a repeatability model from Simmental data (.43) by Sprengel et al. (2000). All estimates of r_g between 30-day periods for MFR were above .90. Estimates of h^2 for MS ranged from .04 to .09. In general, estimates from the 30-day periods later in lactation tended to be higher. Estimates of r_g between 30-day periods for MS were from .84 to .96. However, not in all cases correlations between neighbouring 30-day periods were larger than those from periods that were farther apart. Estimates of r_g between 30-day periods for MFR and MS were moderate to large in magnitude, ranging from .30 to .78. However, no distinct pattern was obvious.

Results from these analyses seem to indicate that milking cows with high MFR require a thorough milking routine and/or good milking equipment. Mein (1998) stated that a cow with a good milkability milks out quickly and evenly with no further adjustment needed for the milking unit, and no need for machine stripping. Therefore, AFR_MM_MS, as currently included in the genetic evaluation for milkability in Bavaria, seems to be useful for genetic selection. This average flow rate in a way accounts for machine stripping by including the usually rather low milk flow rate during MS.

However, it can not be concluded from the data that machine stripping is disadvantageous. If MS is recorded the exact reason is not known. No information is available about milking procedures and milking technology (e.g., automatic cup removers). After a period of over-milking, milk flow can be expected to increase, resulting in MS, if the milker uses his hands to increase the cluster weight or if he corrects the unit alignment. But this would not necessarily have to be the case. Milk flow rate could also increase above the threshold flow rate of .2 kg/min without any external effects. This would be more likely be the case in cows with high (maximum) flow rates. This could also explain why in milkings with MS the sum of duration of over-milking and duration of MS is even slightly smaller than the duration of over-milking in milkings without MS.

4. Conclusions

It does not seem to be justified to include machine stripping in the calculation of average flow rate. Because of the low flow rate during machine stripping differences in flow rates between cows are somewhat disguised. Genetic selection for milkability could be less efficient. Further analyses are necessary to decide if MFR or AFR_MM should be included in a genetic evaluation. MFR is from a short time span (approximately 22 seconds) and, therefore, relatively little affected by milking routine and other environmental effects. While MFR mostly describes the flow rate at which milk can be removed from the udder, AFR_MM is also influenced by the milk ejection rate. Ejection rate can be defined as the active expulsion of milk from the alveoli and small milk ducts into the cistern.

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Figure 1: Milk flow curve

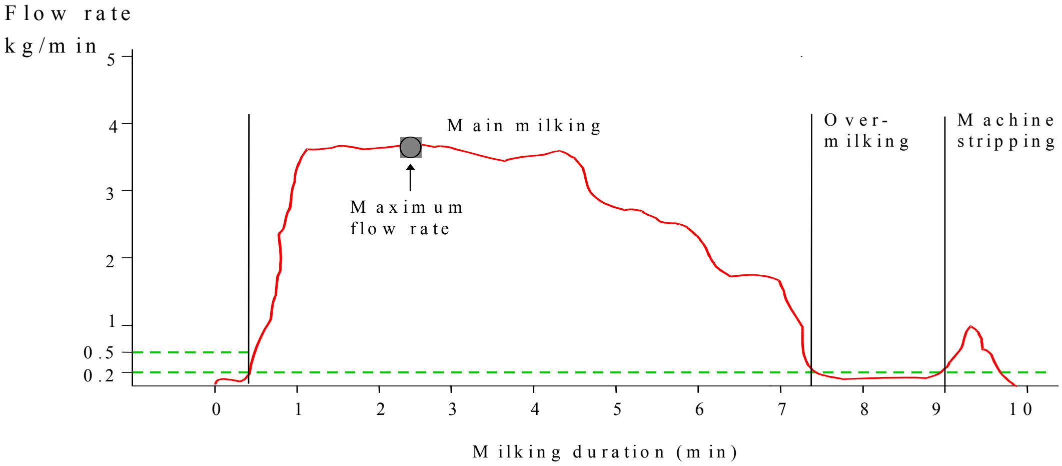

Table 1. Characteristics of the data

Trait	Unit	Machine Stripping 0	Machine Stripping 1
Number of milkings		437,215	307,829
Days in milk		132	144
Milk yield	kg	10.04	10.00
Milk yield during main milking	kg	9.75	9.33
Machine stripping yield	kg	-	0.35
Duration of milking	min	8.06	7.16
Duration before flow rate reaches 0.5 kg	min	0.46	0.44
Duration of main milking	min	5.56	4.74
Duration of over-milking	min	2.03	1.29
Duration of machine stripping	min	-	0.69
Maximum flow rate (MFR)	kg/min	2.65	3.02
Average flow rate during main milking (AFR_MM)	kg/min	1.86	2.07
Average flow rate during machine stripping	kg/min	-	0.47
Average flow rate during main milking and during machine stripping (AFR_MM_MS)	kg/min	1.92	1.93

Table 2. Estimates of heritabilities (on the diagonal) and genetic correlations (above the diagonal) for maximum flow rate and machine stripping from data set 3.

		Maximum flow rate; 30-day periods[a]						Machine stripping; 30-day periods[a]					
		1	2	3	4	5	6	1	2	3	4	5	6
Maximum flow rate	1	.536	.993	.976	.956	.939	.919	.563	.576	.771	.358	.485	.484
	2		.523	.986	.975	.965	.948	.564	.562	.780	.376	.471	.488
	3			.541	.992	.983	.969	.525	.511	.751	.324	.462	.487
	4				.550	.995	.989	.523	.500	.746	.336	.454	.496
	5					.562	.989	.492	.484	.736	.349	.440	.495
	6						.515	.493	.436	.697	.301	.394	.473
Machine stripping	1							.053	.919	.910	.838	.890	.895
	2								.044	.933	.901	.960	.905
	3									.085	.843	.891	.884
	4										.082	.877	.907
	5											.058	.953
	6												.069

[a] 1: d 8-37; 2: d 38-67; 3: d 68-97; 4: d 128-157; 5: d 218-247; 6: d 248-275