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Genetic parameters and selection for casein content in Italian Holstein and Brown Swiss

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ABSTRACT - A total of more than 2,000,000 records on casein contents were collected in Lombardia (Italy) during routine milk recording of Italian Holstein and Brown Swiss dairy cows. Variance components for casein were estimated as well as all the genetic correlations of casein with production and type traits considered in selection. According to the heritabilities estimated (12.4% for Brown and 9.36% for Holstein), breeding values were calculated for bulls and compared to the breeding values for total protein. The results of two different selection scenarios were compared for each breed when including protein or casein as selection criterion. Genetic progress expected for all traits selected were compared after 10 years of selection. The genetic variability of casein allows the use of this trait as selection criterion with the estimation of breeding values and its inclusion in selection indexes. Ranking of breeding values for casein and protein are very similar in both breeds. But some differences in genetic values for casein exist for the same level of breeding value for protein. Nevertheless results in genetic gain differ between breeds depending mainly on genetic correlations with the other traits selected. The positive results in selection response estimated for several traits suggest to the Brown Swiss Association the replacement of protein selection with casein. In contrast the smaller effects estimated for the Italian Holstein suggest to wait for more casein data collected before any change in selection program.

Key words: Casein, Genetic parameters, Selection, Dairy cows.

Introduction - Selection for milk quality and animal functionality is of primary importance for the Italian Holstein and Brown Swiss dairy breeds. The protein content in milk samples, also called total protein, is normally estimated from the total amount of nitrogen multiplied by 6.38 to express the results on a protein equivalent basis and includes, therefore, both protein and non-protein nitrogen. Casein represents about the 76.3% of the total proteins (Rowlands, 1938) but this amount is not always constant. Moreover, although high genetic correlation exists between casein and protein (Ikonen *et al.*, 2004), the casein content has higher genetic and phenotypic correlations with milk coagulation properties and less frequent occurrence of non-coagulating milk than protein (Ikonen *et al.*, 2004). The content on casein can now be recorded regularly on a monthly basis with milk recording data on field data for all samples. The possible use of these phenotypes as traits in breeding selection of dairy cows was considered. Estimates on casein contents indicate that individual variability among cows exists (Wood *et al.*, 2003; Ikonen *et al.*, 2004; Mitchell *et al.*, 2005). The estimates on field data collected during regular milk recording confirmed

previous literature results (Stoop *et al.*, 2006) also when using large data set of casein data (Samoré *et al.*, 2007). For the two breeds, Italian Holstein and Brown Swiss, this study aims: 1) to estimate genetic parameters for casein content, 2) to estimate the genetic correlations between casein and all the production and type traits included in selection objectives; 3) to estimate bulls breeding values for casein; 4) to estimate the selection response when the casein is considered as selection criterion.

Material and methods – A total of 2,086,895 test day records of casein content were collected from 2005 to 2007 in Lombardia for Italian Holstein and Brown Swiss dairy cows. Milk components were obtained from samples collected during national routine milk recording by Fourier Transformed Infrared (IR) Spectroscopy with MilkoScanTM FT6000 (Foss Electric, Denmark). Production traits considered were milk yield, fat, protein, casein (yield and %), urea content (mg/dL), lactose %, the logarithmic transformation of milk somatic cell count (SCS) (Ali and Shook, 1980). A total of 20 or 24 type traits, depending on the breed, were also analyzed. After the editing, two samples, one for each breed, were created to estimate variance components. Estimates were based on 200,484 test day records on 26,279 cows for the Brown Swiss, and based on 376,652 test day records on 41,543 cows for the Italian Holstein. Pedigree information was extracted for each sample from the relative Herd Book. Sire test day repeatability models were applied for production traits considering the effects of herd-test-date, days in milk, and age at calving within parity. Type traits were analyzed according to the official model used for each breed. Using the variance components estimated, breeding values were calculated for casein for each breed. Results in selection response obtained using, alternatively in the selection index, total protein or casein were compared in a scenario of 10 years selection for each breed. Selection intensity, generation intervals, and accuracy used in the analyses were conformed to the usual estimates based on selection scheme of Italian Holstein or Brown Swiss.

Results and conclusions – For casein and protein yield, heritabilities estimated were 9.5% and 9.5% for Italian Holstein and 12.4% and 10.7% for Brown Swiss, respectively. Heritabilities estimated for all production traits resulted to be smaller than the values actually used for breeding values estimation (EBV) in the two breeds. This depends mainly on two factors. Data structure with few generations of data does not allow animal model estimates, and data quality of pedigree information in the whole Italian system decreased in recent years due to several factors as the quality of workers in the stable that first record data and the increase size of herds.

Table 1. Genetic correlations with casein yield in the Italian Holstein and the Brown Swiss.

	Milk kg	Protein kg	Fat kg	Urea mg/dL	Lactose %	SCS	Casein Index
Holstein	78%	99%	57%	-11%	9%	7%	18%
Brown	96%	99%	85%	-3%	19%	-29%	44%

Genetic correlations near 1 (Table 1) between protein and casein yield were estimated in both breeds indicating that both traits underlie the same parameters. Different values of correlations were estimated for Italian Holstein and Brown Swiss between casein yield and production and type traits (Table 1 and 2) affecting, by consequence, the results in genetic response expected for the two breeds.

Ranking of individuals for protein and casein yield EBV and genetic trends estimated between these traits. Nevertheless some differences existed between EBV for some bulls. In Brown Swiss when considering EBV for protein yield of 20 kg, the EBV for casein varies from 15 to 18 kg. Similarly in the Italian Holstein, with EBV for protein of 45 kg, the EBV for casein varies from 27 to 40 kg. This means that, although EBV for

Table 2. Genetic correlations between casein yield and most important type traits in selection in the Italian Holstein and the Brown Swiss.

	Total score	Udder depth	Fore udder attachment	Rear udder height	Ligament	Feet & legs	Rump angle	Teat position
Holstein	29.1%	23.2%	15.6%	16.1%	11.0%	13.2%	16.0%	9.3%
Brown	15.7%	21.2%	12.4%	10.9%	10.4%	7.1%	20.9%	15.9%

protein are good estimation of genetic values for casein, the estimation of specific EBV for casein yield would be useful in identifying best bulls in milk quality selection for cheese production.

The selection response estimated when including protein or casein yield in the selection index differs in the two breeds as expected by the values of genetic correlation estimated and by the specific selection objective of Italian Holstein and Brown Swiss (Table 3). In Brown Swiss the genetic progress, obtained while selecting for casein, increased for all production traits, except for protein contents. The genetic progress for casein increases of 0.11 and 0.16 standard deviation, for casein content and yield respectively. Different is the situation for the Italian Holstein with smaller advantages of including casein in the selection index: milk and protein yields decrease and the advantage for casein yield is smaller than in the other breed. Results indicate also that an indirect positive selection response is expected also with the actual selection indexes of both breeds including protein as selection criterion.

Table 3. Differences in standard deviation in the expected genetic gain, in 10 years selection, between using selection indexes with protein or casein yield in Italian Holstein and Brown Swiss.

	Milk kg	Fat kg	Fat %	Protein kg	Protein %	Casein kg	Casein %
Holstein	-0.22	0.39	0.06	-0.05	0.01	0.13	0.08
Brown Swiss	0.20	0.08	0.10	0.10	-0.06	0.16	0.11

Based on the results of this study, the Italian Brown Swiss Association (ANARB) is considering, as soon as most of national data would include casein recording, to move to EBV for casein and to the inclusion of this trait in selection objectives, while the Italian National Association of Holstein is planning to collect more data on casein before changes in selection criteria.

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