Milk Yield Traits, Somatic Cell Score, Milking Time and Age at Calving of Pure Holstein Versus Crossbred Cows

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Summary

Pure Holstein (HO, n=430), crosses between Swedish Red and HO (SRxHO, n=41), Montbeliarde and HO (MOxHO, n=18), and MO and SRxHO (MOxSH, n=53) were compared for milk, fat and protein yield, fat and protein percentage, somatic cell count (SCC), milking time (MT), and age at first and second calving. A total of 180,933 test-day information for milk yield and MT, and 5,249 for fat and protein percentage and SCC were recorded on first and second parity cows milked in one herd of Cremona province (northern Italy). Somatic cell count and MT were log-transformed to somatic cells score (SCS) and LnMT, respectively, before statistical investigation. Production traits, LnMT and SCS were analyzed through a mixed model that included fixed effects of test-day, parity, days in milk (DIM), genotype and interaction between parity and genotype, and the random effects of cow nested within genotype and residual, whereas the model for age at calving included year and month of calving and genotype as fixed effects, and residual as random. MOxHO and pure HO cows differed only for age at second calving (70 d higher for purebreds; P<0.05). Holsteins produced more milk (+2.86 kg/d; P<0.01) and protein yield (+0.05 kg/d; P<0.05) than SRxHO crossbreds, but lower protein percentage (-0.09%; P<0.01), and age at second calving was 44 d (P<0.01) higher than SRxHO. Also, HO produced more milk and fat than MOxSH cows (+1.61 and +0.08 kg/d, respectively; P<0.05), but lower protein percentage (-0.11%; P<0.001), and calved later, both at first and second calving (+24 and +43 d, respectively; P<0.05). Results indicated that crossbred cows can compete with the cosmopolitan breed for several traits.

Key words

age at calving, crossbreeding, dairy cattle, milk production, milking time

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Aim

Crossbreeding has become a topic of great interest in dairy cattle, mainly because fertility and survival are rapidly deteriorating and inbreeding levels of the major dairy breeds are increasing. Also, changes in pricing systems tend to reward milk with high fat and protein contents, stimulating the interest in different breeds. The objective of this study was to compare pure Holstein with crossbred cows for milk production traits, somatic cell count (SCC), milking time (MT) and age at first and second calving.

Material and methods

Initial data were composed of 185,435 test-day information for milk yield and MT, and 5,425 for fat and protein percentage and SCC recorded on first and second parity cows (n=542) from 2008 to 2011 in one herd of Cremona province (northern Italy). The notably higher number of records for milk yield and MT compared with quality traits was because the former were available daily, whereas the latter were obtained from samples collected during monthly test-day milk recording. All traits were retrieved from the management software Afifarm, version 3.06 (S.A.E. Afikim, Israel) and were from four genotypes: pure Holstein (HO, n=430), and crosses between Swedish Red and HO (SRxHO, n=41), Montbeliarde and HO (MOxHO, n=18), and MO and SRxHO (MOxSH, n=53). For each cow and within a given day, the software retained the longest MT between morning and evening milking. Fat and protein yields were calculated by multiplying milk yield and the relative percentages of fat and protein. Only cows with days in milk (DIM) between five and 600 d were considered. Days in milk were grouped into classes of 30 d each, except for the first, which was a class of 25 d and the last, which was an open class (>300 DIM). Traits were edited according to their mean ± 3 standard deviations. Following editing of the data as above, 180,933 records for milk yield and MT, and 5,249 for fat and protein percentage and SCC were available for further analyses. Somatic cell count was log-transformed to somatic cell score (SCS) according to the formula by Ali and Shook (1980): $SCS = \log_2(SCC/100{,}000) + 3$, and MT was transformed to LnMT by means of natural logarithm. The log-transformation of these traits was necessary to normalize the distribution of the data. Milk production traits, SCS and LnTM were analyzed using the MIXED procedure of SAS (SAS Institute, 2008) with the following linear model:

$$y_{ijklm} = \mu + TD_i + DIM_j + Parity_k + Genotype_l + (ParityxGenotype)_{kl} + Cow_m(Genotype_l) + e_{ijklm},$$

where y_{ijklm} is the dependent variable; μ is the overall mean; TD_i is the fixed effect of the *i*th test-day (*i* = 1 to 1,167); DIM_j is the fixed effect of the *j*th class of days in milk (*j* = 1 to 11); $Parity_k$ is the fixed effect of the *k*th parity (*k* = 1 to 2); $Genotype_l$ is the fixed effect of the *l*th genotype (*l* = 1 to 4); $(ParityxGenotype)_{kl}$ is the fixed interaction effect between parity and genotype; $Cow_m(Genotype_l)$ is the random effect of the *m*th cow nested within the *l*th genotype (m = 1 to 542) N ~ $(0, \sigma^2_{cow(genotype)})$; e_{ijklm} is the random residual N ~ $(0, \sigma^2_e)$. Significance of genotype effect was tested on the cow within genotype variance.

An analysis of variance was performed on age at first and second calving with the GLM procedure of SAS (SAS Institute, 2008). The linear model included the fixed effects of year and month of calving, and genotype.

Contrasts between least squares means of traits for HO versus SRxHO, MOxHO, and MOxSH were estimated, and a 5% level was referred to for testing if means were significantly different.

Results and discussion

Descriptive statistics of studied traits are summarized in Table 1. On average, cows produced 34.32 kg of milk per day with 4.12% of fat and 3.37% of protein. Mean values of SCC and MT were 115,000 cells/ml and 6.50 min, respectively. Finally, age at first and second calving averaged 767 and 1,150 d, respectively.

Table 1. Descriptive statistics of studied traits

Trait	n	Mean	SD	Min	Max
Milk yield (kg/d)	180,933	34.32	7.83	7.00	66.90
Milking time (MT, min)	180,933	6.50	2.04	2.80	20.00
LnMT	180,933	1.82	0.29	1.03	2.99
Fat (%)	5,249	4.12	0.79	1.40	7.00
Protein (%)	5,249	3.37	0.34	2.40	4.50
Fat yield (kg/d)	5,249	1.44	0.43	0.31	3.80
Protein yield (kg/d)	5,249	1.16	0.22	0.31	2.32
Somatic cell count (x 1,000/ml)	5,249	115	171	4.00	1,658
Somatic cell score	5,249	2.43	1.40	-1.64	7.05
Age at first calving (d)	532	767	48	633	941
Age at second calving (d)	284	1,150	80	965	1,400

Effects of test-day and DIM resulted highly significant (P<0.001) for all traits. Parity influenced LnMT, and milk, protein and fat yield, which were lower in first than in second lactation (data not shown). Interaction between parity and genotype was important for all traits except for fat percentage. Least squares means of studied traits and significance of contrasts for HO versus SRxHO, MOxHO, and MOxSH are reported in Table 2. Holstein cows did not differ (P>0.05) from crossbreds for LnMT, fat percentage, and SCS. Pure animals produced more milk than SRxHO (+2.86 kg/d; P<0.01) and MOxSH crossbreds (+1.61 kg/d; P<0.05), but lower protein percentage (-0.09 and -0.11%, respectively; P<0.01). Also, protein yield was higher for HO than SRxHO (+0.05 kg/d; P<0.05), and fat yield was higher for HO than MOxSH (+0.08 kg/d; P<0.05). MOxHO and pure HO did not differ for any traits, except for age at second calving that was 70 d (P<0.05) higher for purebreds. Age at calving was also higher for HO compared with MOxSH (+24 and +43 d in first and second calving, respectively; P<0.05) and SRxHO (+44 d in second calving; P<0.01). Heins et al. (2006) found notable differences between first lactation HO and MOxHO cows (+596 kg of milk, +2 kg of fat, and +12 kg of protein yield in favour of the first genotype). In a following study, Heins (2007) reported the same results between HO and MOxHO, but not between HO and MO x (Jersey x HO), which were not different for production traits. Walsh et al. (2008) found no differences for milk and protein yield between MOxHO and HO cows, but crosses produced less fat than purebreds (-7 kg/complete lactation).

Table 2. Least squares means of studied traits and significance of contrasts for HO versus crossbred cows

Item	Genotype [1]			
	HO	SRxHO	MOxHO	MOxSH
Cows (n)	430	41	18	53
Milk yield (kg/d)	35.21	32.35**	35.05	33.60*
LnMT	1.87	1.82	1.85	1.89
Fat (%)	4.12	4.22	4.27	4.07
Protein (%)	3.42	3.51**	3.45	3.53***
Fat yield (kg/d)	1.44	1.39	1.53	1.36*
Protein yield (kg/d)	1.18	1.13*	1.21	1.18
Somatic cell score	2.38	2.57	2.05	2.20
Cows (n)	423	40	18	51
Age at first calving (d)	774	760	768	750***
Cows (n)	213	38	8	25
Age at second calving (d)	1,196	1,152**	1,126*	1,153*

[1] HO - Holstein (reference genotype), SR – Swedish Red, MO - Montbeliarde, SH - SRxHO; *P<0.05, **P<0.01, ***P<0.001

In a previous study, Walsh et al. (2007) reported no differences between HO and MOxHO for MT and SCS in according with our work. Heins et al. (2011) did not find differences between HO and Jersey x HO for SCS during first and second lactation, but milk and protein yields were lower for crossbreds than purebreds. Prendiville et al. (2009) reported that HO produced higher milk than Jersey x HO at pasture, but lower protein and fat yields. Dechow et al. (2007) compared HO, Brown Swiss, and their crosses for production, SCS and age at first calving. Brown Swiss x HO crosses produced less milk and higher fat than HO, whereas no differences were found for SCS, protein yield and age at first calving.

Conclusions

Results showed that crossbred cows can compete with pure HO for several traits. Holstein was superior to SRxHO for milk and protein yield, and to MOxSH for milk and fat yield. However, protein content was higher for SRxHO and MOxSH than HO. Also, MOxSH had the first and second calving earlier than HO and SRxHO had the second calving earlier than HO. No differences were recorded for any traits between HO and MOxHO cows, except for age at second calving, in favour of crossbred animals. Finally, crossbreds were not different from HO for LnMT, fat percentage, and SCS.

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