Relationship Between Lactation Persistency And Change In Body Condition Score In First-Lactation Holstein Cows

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Introduction

Selection for total milk yield markedly increases milk production in early lactation, but this increase places metabolic stress on cows and increases disease susceptibility (Uribe et al. (1995); Jakobsen et al. (2003)). To improve health and address the negative energy balance in early lactation in dairy cows but maintain total milk yield, it has been suggested that the lactation curve could be modified to reduce milk yield in early lactation and give higher lactation persistency after the lactation peak (Dekkers et al. (1998); Jakobsen et al. (2003); Togashi and Lin (2003, 2004, 2007)). Body condition score (BCS) and its changes have been used to indicate body reserves in cows (Coffey et al. (2001); Berry et al. (2006)) and are related to health status (Banos et al. (2006); Roche et al. (2009)). Total milk yield has negative genetic correlations with BCS throughout lactation (Veerkamp et al. (2001)) and with BCS change in early lactation (Dechow et al. (2002)). Berry et al. (2002) reported positive genetic correlations between milk yield in mid- to late lactation and BCS change at the same lactation stage. We hypothesized that lactation persistency is related to energy balance and health not in early lactation but in mid to late lactation. Our objective was therefore to examine the relationships between the persistency of the first-parity lactation curve and changes in BCS at different stages of lactation.

Material and methods

We used daily milk records from cows at 5 to 305 days in milk (DIM) and BCS records obtained twice every month from 191 first-lactation Holstein cows calving in 2006 and 2007 at the National Livestock Breeding Center Niikappu Station (Hokkaido, Japan). The lactation periods were at least 255 days, and the ages at calving ranged from 22 to 35 months. The 305-day total milk yield from first-parity lactations was about 10,000 kg/cow. Condition scores were based on the scoring system proposed by Edmonson et al. (1989), with units ranging from 1 (lean) to 5 (fat) and increments of 0.25.

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Traits for lactation curve shape. The following statistical model was used to estimate individual lactation curves by the MIXED procedure of the SAS software package (SAS Institute Inc. (2008)):

$$y_{ijkl} = TYS_i + \sum_{m=0}^{2} AGE_{jm} \cdot w_{klm} + \sum_{m=0}^{2} u_{km} \cdot w_{klm} + e_{ijkl}$$

where, y_{ijkl} is daily milk record l in the ith year-season of cow k calved at jth age in months, TYS_i is the fixed effect of the year-season of the test day, AGE_{jm} is mth coefficient in a fixed regression of the age at calving, u_{km} is a random regression coefficient of individuals, w_{klm} is the mth covariate of the Wilmink function (Wilmink 1987) associated with DIM, and e_{ijkl} is a random residual effect associated with y_{ijkl}. The days in peak (peak-DIM), peak yield, lactation persistency (persistency) and cumulative milk yield from 5 to 305 DIM (305-milk) were calculated from individual lactation curves. Persistency was defined as the difference in estimated milk yields between 240 DIM and 60 DIM, which is the definition of lactation persistency used in dairy sire and cow evaluation in Japan (National Livestock Breeding Center (2009)).

Traits for change in BCS. Early stage was defined as the period from 0 to 30 DIM, nadir stage as 31 to 90 DIM, and late stage as 91 to 240 DIM. Changes in BCS in the early and late stages were defined as linear regression coefficients in each stage (early-RBCS and late-RBCS, respectively). The model used to estimate each coefficient was the same as the above, except that linear regression was used instead of the Wilmink function. Mean BCS in the early stage was defined as BCS at 15 DIM (15d-BCS), and that in the late stage was defined at 165 DIM (165d-BCS), as estimated by the respective linear regressions. Mean BCS in the nadir stage (nadir-BCS) was estimated by the above model, without the regression term.

We examined correlations among traits for lactation curve shape and for change in BCS, and between the two sets of traits.

Results and discussion

Correlations among traits for lactation curve shape (Table 1). Persistency had a high positive correlation with peak-DIM and a moderate negative correlation with peak yield. This is consistent with reports that the shape of the lactation curve with high lactation persistency tends to have a low peak yield and to peak late (Rekaya et al (2000); Tekerli et al. (2000)). There was no correlation between persistency and 305-milk. Tekerli et al (2000) reported that the phenotypic correlation between persistency and 305-milk was 0.08. Positive genetic correlations between persistency and total milk yield have been reported (Rekaya et al. (2000); Togashi et al. (2007)). These relationships between lactation persistency and total milk yield favor flattening lactation curve without a decrease in total milk yield.

Correlations among traits for change in BCS (Table 2). Early-RBCS had significant negative correlations with 15d-BCS, nadir-BCS, and 165d-BCS, whereas late-RBCS had significant positive correlations with these traits. Cows with low BCSs tended to have small changes in BCS over the whole lactation period. Ruegg and Milton (1995) reported that cows with higher BCSs at calving lost more condition and had higher nadir-BCSs. Unlike in our results, negative genetic correlations between gains in BCS in mid- to late lactation and nadir-BCS have been reported (Berry et al. (2002); Dechow et al. (2002)). The correlations in these other studies were estimated in both primiparous and multiparous cows, whereas we used only first-parity cows. It has been suggested that the energy requirements for growth decrease BCS gain post-nadir in first-parity cows (Roche et al. (2009)). We therefore consider that the maturity level in first-parity affected the results in this study.

Table 1: Correlation coefficients among traits for lactation curve shape

Traits	peak yield	persistency	305-milk
peak-DIM	0.02	0.61**	0.25**
peak yield		- 0.38**	0.89**
persistency			0.00

*******P*-value<0.01 **P*-value<0.05

Table 2: Correlation coefficients among traits for change in BCS

Traits	15d-BCS	nadir-BCS	late-RBCS	165d-BCS
early-RBCS	- 0.77**	- 0.30**	- 0.39**	- 0.34**
15d-BCS		0.68**	0.44**	0.62**
nadir-BCS			0.34**	0.86**
late-RBCS				0.51**

***P*-value<0.01 **P*-value<0.05

Correlations between traits for lactation curve shape and change in BCS (Table 3). Peak yield and 305-milk had significant negative correlations with nadir-BCS, late-RBCS, and 165d-BCS, suggesting that cows with high levels of lactation had low BCSs in mid- to late lactation and delayed recovery of body reserves. Veerkamp et al. (2001) estimated that the genetic correlations between BCS at different DIM and full lactation yield were estimated about -0.3 in first-parity cows. There was a positive correlation between persistency and late-RBCS in this study, suggesting that cows with high lactation persistency had good recovery of body reserves in late lactation. This also indicated that cows with high lactation persistency were in good health in late lactation, because BCS and its changes are related to health status throughout lactation (Wells et al. (1993); Lassen et al. (2003)).

Table 3: Correlation coefficients between traits for lactation curve and change in BCS

Traits	peak-DIM	peak yield	persistency	305-milk
early-RBCS	- 0.01	- 0.11	0.10	- 0.04
15d-BCS	- 0.06	- 0.06	- 0.05	- 0.10
nadir-BCS	- 0.18*	- 0.36**	- 0.09	- 0.33**
late-RBCS	0.19	- 0.28**	0.24**	- 0.29**
165d-BCS	- 0.04	- 0.33**	- 0.08	- 0.34**

***P*-value<0.01 **P*-value<0.05

Conclusion

Lactation persistency was positively correlated with change in BCS in late lactation in first-lactation cows, suggesting that cows with high lactation persistency tend to be healthy and recover body reserves well in late lactation. Therefore, modification of the lactation curve to promote an increase in lactation persistency could help to maintain the health of dairy cows in late lactation.

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