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Association between dry period length and lactation performance, lactation curve, calf birth weight, and dystocia in Holstein dairy cows in Iran

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ABSTRACT

In this study, 65,971 lactations on 41,842 cows in 64 herds were used to determine the association between dry period length (DPL) and lactation performance, lactation curve, calf birth weight, and the incidence of calving difficulty during the subsequent parity in Holstein dairy cows in Iran. The length of the dry period was classified into 7 categories: 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d. Cows with the standard DPL (51 to 60 d) produced more 305-d milk, fat, and protein over the next lactation compared with those with shorter dry periods. Shorter dry periods (0 to 35 d and 36 to 50 d) were associated with lower initial milk yield, steeper inclining and declining slopes of the lactation curve, and higher milk persistency compared with dry period length of 51 to 60 d. Peak lactation was achieved later in cows with 0- to 35-d and 36- to 50-d dry period length than in those with dry period length of 51 to 60 d. We also observed a relationship between DPL and calf birth weight: smaller calf birth weight was recorded with a dry period of 51 to 60 d compared with longer dry periods. The incidence of calving difficulty did not differ in cows with 51- to 60-d dry period compared with cows with 0- to 35-d and 36- to 50-d dry periods. In conclusion, the results of this study did not support previous findings that suggested a shorter dry period could be beneficial to dairy production.
Key words: dry period length, lactation performance, lactation curve

INTRODUCTION

It is traditionally believed that dairy cows require a dry period between lactations to achieve maximum milk yield in the subsequent lactation (Collier et al., 2012). The traditional 305-d lactation and 51- to 60-d dry period has been in practice since World War II in the United Kingdom and later in the United States (Bachman and Schairer, 2003). However, optimal dry period length (**DPL**) may vary depending on parity, herd size, and level of milk production, among other factors (Grummer and Rastani 2004). Quantifying the potential effect of DPL on subsequent lactation performance is critical for choosing an optimum DPL in dairy cows (Sørensen and Enevoldsen, 1991; Annen et al., 2004; Rastani et al., 2005). Shortening the DPL between lactations in dairy cows has been an active area of research for several years (Gulay et al., 2003; Grummer and Rastani, 2004; Gumen et al., 2011; Collier et al., 2012). Although several reports indicated that reducing the DPL resulted in a reduction in milk yield in the next lactation (Dias and Allaire, 1982; Sørensen and Enevoldsen, 1991; Makuza and McDaniel, 1996; Watters et al., 2008; Mantovani et al.,2010), other studies indicated that the optimum DPL may be shorter than previously considered, and that a 30- to 40-d dry period is sufficient for maximizing milk yield in dairy cows (Bachman, 2002; Bachman and Schairer, 2003; Gulay et al., 2003; Annen et al., 2004; Pezeshki et al., 2007). Watters et al. (2009) also reported that shortening the dry period (35 vs. 43 d) was associated with better postpartum reproductive performance. The effect of DPL on subsequent lactation performance may be quantified more accurately, and in more detail, using mathematical models describing the lactation curve (Rajala and Grohn, 1998). Therefore, the first aim of this research was to characterize the DPL in Holstein cows in Iran. The second aim was to use an incomplete gamma function to quantify the association between different lengths of dry period and the subsequent lactation curve and partial and 305-d lactation performance. The association of different lengths of dry period with calf birth weight and dystocia during the subsequent lactation was also determined.

MATERIALS AND METHODS

Data used in this study were records on Holstein cows collected from January 2000 to December 2009 by the Animal Breeding Center of Iran (Karaj, Iran). The herds evaluated were purebred Holsteins, managed under conditions similar to those used in most developed countries, and were under official performance and pedigree recording. The diet was fed as a TMR

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and consisted of corn silage, alfalfa hay, barley grain, fat powder, beet pulp, and feed additives. Monthly milk recording was performed by trained technicians of the Iranian Animal Breeding Center, according to the guidelines of the International Committee for Animal Recording (ICAR, 2011). Farmers, upon observing parturition, subjectively assigned a calving ease score according to the degree of assistance provided. Recognized dystocia scores were as follows: 1 = no problem, 2 = slight problem, 3 = needed assistance, 4 = needed considerable force, and 5 = extreme difficulty. In this study, dystocia scores of 1 or 2 were coded as easy calving, and scores of ≥3 were coded as difficult calving.

Cows with missed birth date, calving date, breeding date, drying date, and parity number were deleted. Cows were required to have a minimum of 5 test-day records per lactation. Tests before 6 d or after 320 d were excluded. First calving age was calculated as the difference between birth date and calving date at first parity and was restricted to the range of 540 to 1,200 d. Dry period length was calculated as the time length between previous drying off date and the subsequent calving date. Days dry were required to be between 0 and 160 d in length. Ultimately, the data set used to describe lactation curve included 789,254 test-day records from 85,816 lactations on 52,421 cows distributed in 64 herds.

To describe the lactation curve, an incomplete gamma function proposed by Wood (1967) was used. The function was as follows: $y_t = at^b e^{-ct}$, where y_t is the daily milk yield (kg/d) at DIM t, the variable t represents the length of time since calving, e is the Neper number, a is a parameter representing yield at the beginning of lactation, and b and c are factors associated with the upward and downward slopes of the lactation curve, respectively. The incomplete gamma function was transformed logarithmically into a linear form as $\ln(y_t) = \ln(a) + b\ln(t) - ct$, and was fitted to 789,254 test-day milk records corresponding to 85,816 lactations, using a simple program written in Visual Basic (Microsoft Corp., Redmond, WA). The time at which peak lactation occurred ($T_{\max}$) was defined as $T_{\max} = (b/c)$, expected maximum yield ($y_{\max}$) was calculated as follows: $y_{\max} = a(b/c)^b e^{-b}$, persistency ($s$) was calculated as follows: $s = -(b + 1)\ln(c)$, and total yield from the time of calving up to 100, 200, and 305 DIM was calculated as $y = a\int_1^n t^b e^{-ct} \mathrm{d}t$, where n = 100, 200, and 305, respectively. Typical lactation curves had positive a, b, and c, and curves with negative a, b, or c were considered atypical. Of 85,816 lactations, 19,845 (23.12%) had atypical lactation curves and were excluded. Finally, a total of 607,814 test-day milk records corresponding to 65,971 lactations on 41,842 in 64 herds, were used to determine the association between DPL and lactation performance, lactation curve, calf birth weight, and the incidence of calving difficulty during the subsequent parity.

The effect of level of 305-d milk yield on the subsequent DPL was determined using a mixed linear model through the inclusion of herd-calving year-calving season combination (**HYS**), parity (1, 2, 3, and ≥4), age at first calving (**FCA**), and random effect of the dam's sire.

The effect of DPL on subsequent lactation performance, lactation curve parameters, birth weight, and dystocia was determined using a categorical variable for DPL, as suggested by Kuhn and Hutchison (2005). The DPL was classified into 7 categories: 0 to 35 d, 36 to 50 d, 51 to 60 d, 61 to 70 d, 71 to 85 d, 86 to 110 d, and 111 to 160 d. The corresponding number of animals in each category was 3,427, 5,197, 15,929, 21,204, 11,253, 4,824, and 4,137. Cows were also grouped by parity: primiparous (n = 30,558) and multiparous (n = 35,413) cows. The effect of DPL on parameters describing the subsequent lactation curve, as well as partial and 305-d lactation performance, was determined using multiple regression mixed models using PROC MIXED (SAS Institute, 1999) through the inclusion of DPL in a 2-way interaction with parity (primiparous vs. multiparous), fixed effect of HYS, covariate effect of FCA, and random effect of the dam's sire.

The effect of DPL on calf birth weight at subsequent calving was determined using the explained model, but the fixed effect of calf sex and the random effect of service sire were included, and the random effect of the dam's sire was excluded from the model. The effect of DPL on calving difficulty was investigated using a multivariable logistic regression model through the maximum likelihood method of PROC GENMOD (SAS Institute, 1999). In the model, the dependent variable, dystocia score, was 0 for easy and 1 for difficult calving, and the independent variables were herd, calving year, calving season, DPL, parity, FCA, calf sex, calf birth weight, and random effect of service sire. Reference categories for comparison of odds ratios for each effect were as follows: spring, primiparous, male, and DPL of 51 to 60 d. Because cows with higher production tend to have shorter dry period compared with lower producing cows, previous 305-d milk yield was included in the models as a covariate effect (Kuhn and Hutchison, 2005).

RESULTS

DPL

The distribution of DPL is presented in Table 1. The mean (SD) dry period length was 67.3 (23.7) d. About 5.19 and 6.27% of all dry period records lasted 35 d or