



Milk production during the colostrum period is not related to the later lactational performance in dairy cows

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ABSTRACT

In dairy cows, milk yield increases rapidly after parturition until a peak at around wk 6 of lactation. However, the description of the shape of the lactation curve is commonly based on weekly average milk yields. For a more detailed analysis of the milk production curve from the very beginning of lactation including the colostrum period and the effect of colostrum yield on further lactational performance, the first 10 milkings after parturition, daily milk yields from d 1 to 28 of lactation, and the cumulative milk production on d 100 to 305 of lactation were investigated in 17 primiparous and 39 multiparous cows milked twice daily. Milk yield at the first milking after parturition (colostrum) ranged from 1.3 to 20.7 kg ($\Delta = 19.4$ kg) in multiparous and from 1.8 to 10.9 kg in primiparous animals ($\Delta = 9.1$ kg). At the tenth milking, milk production ranged from 9.2 to 21.5 kg ($\Delta = 12.3$ kg) in multiparous and from 7.0 to 15.2 kg ($\Delta = 8.2$ kg) in primiparous animals. Immediately after parturition, daily milk production increased rapidly, but after approximately 1 wk in lactation, the slope of the daily milk production curve flattened and continued more linear. A nonlinear regression equation was used to determine this timely change, which occurred earlier in primiparous (d 6.9 ± 0.3) than in multiparous cows (d 8.2 ± 0.2). The correlation between the amount of first colostrum and milk production during further lactation decreased already from 0.47 on d 5 to 0.32 on d 14. In multiparous cows, the correlation between total milk production of the previous 305 d standard lactation and the amount of first colostrum was not significant (correlation = 0.29), whereas the correlation with the daily production increased from 0.45 on d 5 to 0.69 on d 14. However, in primiparous animals, correlations between first-colostrum yield and daily milk yields up to d 28 of lactation were not significant, possibly due to the smaller sample size compared with multiparous animals. First-colostrum yield and cumulative milk production of 100, 200, and

305 lactation days were not significantly correlated in multiparous and primiparous cows. In conclusion, the milk production during the first few milkings is widely independent from the overall production level of a cow. Potentially, genetic selection toward lower milk yield during the very first days after parturition at a simultaneously high lactational performance may be a tool to ensure sufficient colostrum quality and to reduce the metabolic load around parturition.

Key words: colostrum, lactation curve, milk yield, dairy cow

INTRODUCTION

Since the beginning of the last century, the lactation curve of dairy cows has been repeatedly investigated (Brody et al., 1923; Gaines, 1926) but is still the subject of current research (Macciotta et al., 2005; Madouasse et al., 2012). The description of the shape of the lactation curve is commonly based on daily (after the colostrum period) or weekly average milk production, whereas the milk production of individual milkings immediately after parturition has not yet been investigated in terms of effects on later lactation performance. The lack of information may be due to the fact that during the colostrum period, milk cannot be delivered and, consequently, milk yield is not automatically recorded during the first few days of lactation.

Nevertheless, parturition and the onset of lactation impose great physiological changes in dairy cows (Goff and Horst, 1997). To meet the demands of the mammary gland at the beginning of abundant milk production, tremendous homeorhetic changes take place during the periparturient period (Bauman and Currie, 1980). Thus, the transition period is crucial for the development of metabolic disorders such as hypocalcemia and is associated with peak incidence of production diseases (Mulligan and Doherty, 2008). Besides, these metabolic disorders have effects on health and productivity far into the following lactation. Moreover, optimal health status of the periparturient cow is also crucial for high colostrum quality (Dardillat et al., 1978). Ingvarsen et al. (2003) and Hansen et al. (2006) pointed out the accelerating pattern in milk yield after parturition and its relation to the occurrence of health disorders following

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metabolic stress. Because of the potential advantage of moderate milk production during the very first milkings for optimal colostrum quality and reduced risk of metabolic disturbances, the aim of this study was to investigate the variation in colostrum yield and milk production during the first days of lactation and their correlation with the overall production level based on individual milkings at the onset of lactation and thereafter, on the basis of daily milk yields.

MATERIALS AND METHODS

Animals and Milk Recording

Seventeen primiparous and 39 multiparous (2.9 ± 0.2 parities; mean \pm SEM) Holstein dairy cows, housed at the Agroscope Liebefeld-Posieux Research Station ALP-Haras (Posieux, Switzerland), were followed during the entire lactation. The milk yield of the previous standard lactations (305 d) of the multiparous cows was $8,137 \pm 232$ kg.

Cows were fed according to their energy and nutrient requirements. Until parturition, animals received hay for ad libitum intake, plus 1 kg of cereal-based concentrate and 0.5 kg of mineral supplement for dry cows. After parturition, the amount of concentrate was increased and after the peak of lactation amounts were adjusted weekly according to the current milk production. No samples were taken from the diets.

Multiparous cows were milked for the first time 2 h and 15 min \pm 15 min (range: 30 min to 5 h and 15 min) and primiparous cows 4 h and 50 min \pm 26 min (range: 2 h and 30 min to 9 h and 45 min) after parturition. The time interval between the first and the second milking after parturition averaged 10 h and 35 min \pm 29 min (range: 3 h and 30 min to 19 h and 30 min). From the second milking after parturition onwards, cows were milked twice daily at the scheduled milking times around 0500 and 1600 h in the milking parlor. Milk yields of individual a.m. and p.m. milkings as well as daily milk yield were recorded electronically.

Data Analysis

Data presented are means \pm standard error of the mean. The development of milk yield during the first 10

milkings after parturition and 28 d of lactation between multiparous and primiparous cows was compared by using the MIXED procedure of SAS (version 9.2; SAS Institute Inc., Cary, NC). The model included group (primiparous or multiparous) as fixed effect and *P*-values <0.05 were considered to be significant.

A nonlinear regression (Equation [1]) was used for the characterization of the lactation curve up to d 28 and its coefficients were calculated individually for each cow with SigmaPlot 11 (Systat Software Inc., San José, CA):

$$f(x) = [A \times x]/[B + x], \quad [1]$$

where x = day of lactation, $f(x)$ = milk yield at day x , A = maximum milk yield in lactation, and B = day of lactation with 50% of maximum milk yield. The time point when the lactation curve passed from a steep to a steady linear slope was determined with the first derivative of Equation [1]:

$$f'(x) = (A \times B)/(B + x)^2. \quad [2]$$

The slope threshold was defined as the first day with $f'(x) < 1$ kg/d. The mean values for multiparous cows (and primiparous cows) were $A = 42.76$ (29.29) and $B = 2.34$ (2.22).

Hourly milk production was calculated as milk yield divided by the interval since the last milking. Pearson correlation coefficients between the amount of colostrum and milk yields at different time points, time spans in between the first 3 milkings, and milk yield in the previous lactation were evaluated using the CORR procedure of SAS.

RESULTS

Multiparous cows showed a wide range of milk yields at the first milking ($\Delta = 19.4$ kg; Figure 1). At the tenth milking, an obvious range ($\Delta = 12.3$ kg) was still present, but considerably decreased compared with the first milking. In primiparous cows, the variation between the milk yields at the first ($\Delta = 9.1$ kg) and tenth milking ($\Delta = 8.2$ kg) was also huge, but decreased less compared with multiparous cows (Figure 1).

Table 1. Pearson correlation coefficients between milk yield of the first 3 milkings and time since the respective previous milking

Item	Multiparous cows			Primiparous cows		
	r	<i>P</i> -value	n ¹	r	<i>P</i> -value	n
First milking/time between parturition and first milking		NS	39		NS	17
Second milking/time between first and second milking	0.77	<0.01	39	0.44	0.08	17
Third milking/time between second and third milking		NS	39		NS	17

¹n = number of animals/observations.

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