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Effects of Dry Period Length on Milk Production and Health of Dairy Cattle

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ABSTRACT

Holstein cows (n = 781) in a commercial dairy herd were used in a randomized design to evaluate 2 dry period (DP) management strategies on milk production, milk components, milk quality, colostrum quality, and incidence of metabolic disorders. Cows were randomly assigned to a traditional 55 d (T) or shortened 34 d (S) DP. Cows assigned to T were fed a low-energy diet until 34 d before expected calving at which time all cows were fed a moderate-energy transition diet until calving. Postpartum, cows assigned to T produced more milk and tended to produce more solids-corrected milk than cows on S. Treatment differences in milk and solids-corrected milk yield were accounted for by cows in their second lactation. Milk fat percentage did not differ between treatments, but milk protein percentage was greater for cows assigned to S. Colostrum quality measured as IgG concentration did not differ between management strategies. Somatic cell score and cases of mastitis were not affected by management strategy. There was a tendency for prepartum nonesterified fatty acid (NEFA) to be lower for cows assigned to T compared with S. However, postpartum, cows assigned to S had significantly lower NEFA concentrations than those assigned to T. The incidences of ketosis, retained placenta, displaced abomasum, and metritis did not differ between treatments. Postpartum energy balance, as indicated by plasma NEFA, may have been improved for cows assigned to S; there was no detectable effect on animal health.
Key words: dry period length, animal health, milk yield, milk composition

INTRODUCTION

Recently, there has been an interest in shortening the non-income-producing dry period (**DP**). Retrospective analysis of farm data and planned experiments both indicate about a 5 to 6% loss in milk yield during the subsequent lactation when the DP is reduced by approximately 30 d (Bachman and Schairer, 2003; Rastani and Grummer, 2006). Additional milk produced during the extra 30 d of lactation can compensate for some of the loss in the subsequent lactation (Bachman and Schairer, 2003; Gulay et al., 2003; Rastani et al., 2005). However, the decision to shorten the DP should depend on factors beyond maximization of milk yield. Effects of DP length on economically important parameters such as cow health and reproduction must also be considered (Gümen et al., 2005).

Length of the DP affects the energy status of periparturient cows (Rastani, 2005; Rastani et al., 2005). Postpartum energy balance (**EB**) was increased and plasma NEFA and liver triglyceride concentrations were lower when the length of the DP was shortened from 56 to 28 d (Rastani et al., 2005). Negative energy balance (**NEB**) may be related to incidences of health disorders such as fatty liver and ketosis (Bertics et al., 1992; Goff and Horst, 1997). Some studies have associated BCS, an indicator of energy status, with the risk of disease (Gearhart et al., 1990; Ruegg et al., 1992). Factors that reduce DMI and compromise energy intake around calving increase the risk for metabolic diseases (Goff and Horst, 1997; Hayirli and Grummer, 2004).

There is limited information on the effect of DP length on incidences of health disorders because large animal numbers are required to have sufficient statistical power to detect treatment differences. To assess the effect of shortening the DP on animal health requires the use of a large commercial dairy or several dairies because university herds are typically small and do not facilitate needed replication (Kuhn and Hutchison, 2005). Only one study has utilized multiple farms to determine the effect of DP length on animal health (Coppock et al., 1974). Coppock et al. (1974) indicated that DP lengths of 20, 30, 40, 50, and 60 d had no effect on the incidence of ketosis, milk fever, or retained placenta. However, this study was conducted over 30 yr ago on what today would be considered low-produc-

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ing cows (<7,000 kg/yr). Therefore, the objective of this experiment was to determine the effect of a short DP management strategy on milk production and animal health in a large commercial dairy herd. It was hypothesized that shortening the DP would improve animal health status by reducing the incidence rate of ketosis, metritis, retained placenta (**RP**), and displaced abomasum (**DA**).

MATERIALS AND METHODS

Experimental Protocol

Seven hundred eighty-one (n = 781) Holstein cows from a 3,000-cow commercial dairy were enrolled in this experiment. At 170 d of gestation, cows were selected for the experiment if they were producing ≥18 kg of milk/d and were less than 400 DIM. Cows were randomly assigned to a traditional 55-d DP (**T**) or a shortened 34-d DP (**S**) management strategy. Previous lactation 305-d mature-equivalent (**305ME**) milk yield was not different between animals assigned to treatments T and S (13,615 ± 137 vs. 13,707 ± 180 kg/yr; $P = 0.69$), respectively. All cows were in their second gestation (i.e., in their first lactation and approaching their first DP) or greater at the time of selection. There were 426 cows that were in their first lactation and 355 in their second or greater lactation at the time they were assigned to the trial. Bovine somatotropin was administered to cows on both treatments. Visual inspection, primarily for BCS, was used to determine which cows would receive bST; cows did not receive bST past 170 d of gestation. All cows were milked 3 times each day except during the first 30 DIM when they were milked 4 times daily. Cows assigned to the trial were monitored from dry-off through parturition and until 300 DIM, when the trial ended. The University of Wisconsin-Madison, College of Agriculture and Life Sciences, Animal Care and Use Committee approved the experimental protocol.

Cows were dried off over a 24-h period that involved 2 milkings. Cows were milked once and then returned to a pen with no access to water. The diet was altered by adding straw and was lower in energy than the diet fed to lactating cows. Twenty-four hours after the first milking, cows returned to the parlor for a final milking and dry cow treatment. The dry treatment was an intramammary antibiotic designed for cows (10 mL/quarter of Cepharin Benzathine; Fort Dodge Animal Health, Fort Dodge, IA) and an internal teat sealant (Orbeseal; 65% bismuth subnitrate/quarter; Pfizer Pharmaceuticals Group, Pfizer Inc., New York, NY).

Cows were fed a TMR formulated by the herd manager to meet or exceed nutrient requirements as indicated by NRC (2001; Table 1). Dry matter content of corn silage and alfalfa silage was determined twice weekly to keep the DM ratios of feeds constant. Diets were fed at 0900, 0945, 1200, and 1300 h. At 55 d before expected calving, cows assigned to T were fed a low-energy diet until 35 d before expected calving. Cows assigned to S were fed a lactation diet from 55 to 35 d before expected calving because they were still milking. Starting at 34 d before expected calving, all cows were fed a moderate energy diet until calving. At calving, all cows were moved to a postfresh pen and fed a postfresh lactation diet. The postfresh diet was fed until 30 DIM when a lactation diet was fed for the remainder of the trial.

Sampling and Analysis

Milk yield was measured twice monthly from calving through 100 DIM and once monthly from 100 to 300 DIM during a single milking on each day, and a daily milk volume was calculated (Fox Valley DHIA Milk Analysis Laboratory, Appleton, WI). Milk samples were collected once a month at 1 milking from calving until 100 DIM and analyzed for fat, protein, lactose, total solids, and SCC using infrared spectrometry (AOAC, 1999; Fox Valley DHIA Milk Analysis Laboratory). Colostrum was sampled at the first milking, stored at −20°C, and later analyzed for IgG concentration by single radial immunodiffusion using a commercial kit (VMRD Inc., Pullman, WA; Fleenor and Scott, 1981).

Samples of TMR were taken every other week and dried at 60°C for 48 h in a forced air oven to determine DM. Samples were ground in a Wiley mill (1-mm screen; Arthur H. Thomas, Philadelphia, PA), composited, and analyzed by wet chemistry for CP, ether extract, NDF, and ADF (University of Wisconsin Soils and Forage Analysis Laboratory, Marshfield, WI; National Forage Testing Association, 1993; Table 2). Feed samples were taken every other week and 100 g of each sample was composited to make one final feed sample for analysis.

Body condition scoring was performed weekly for each cow by the same individual starting at 3 wk before expected calving and continuing until 10 wk postpartum. A scale value of 1 (very thin) to 5 (obese) with quarter increments was assigned to each cow (Wildman et al., 1982).

One blood sample was collected at 3 wk (−21 ± 5 d) before expected parturition and another at 3 wk (22 ± 4 d) after parturition. Samples were collected at the time of feed delivery from cows restrained in feed-line headlocks at 0900 h prepartum and 1300 h postpartum. Blood samples were collected into Vacutainer tubes (Becton Dickinson, Franklin Lakes, NJ) that contained potassium oxalate and sodium fluoride as a glycolytic in-

Table 1. Ingredient composition of diets

	Diet[1]			
Ingredient, % of DM	LE	ME	Postfresh	Lactation
Corn silage	14.13	24.77	28.83	37.24
Alfalfa silage	0.0	17.11	19.83	16.79
Ground corn	0.0	12.16	8.89	12.93
Corn gluten feed	0.0	0.0	10.96	9.36
SBM, 48% CP	0.0	9.41	8.33	6.84
Alfalfa hay	0.0	7.5	7.96	3.02
Bakery byproduct	0.0	7.6	4.97	3.81
Blood meal	0.0	0.0	0.32	1.3
Cottonseed	0.0	0.0	8.09	6.89
Wheat straw	31.14	19.91	0.0	0.0
Weighbacks[2]	54.19	0.0	0.0	0.0
Commercial mineral mix[3]	0.5	0.36	0.96	0.9
Commercial protein supplement	0.0	0.8	0.0	0.0

[1]LE = low-energy, far-off diet; ME = moderate-energy, close-up diet; Postfresh = postfresh diet from 1 to 30 DIM; Lactation = lactation diet beginning at 30 DIM.

[2]Weighback from all lactating groups.

[3]Commercial mineral mix contained Rumensin (CP Feeds, Valders, WI) at the level of 0.15% of DM for the LE, ME, and postfresh diets.

hibitor. Samples were centrifuged (915 × g) at room temperature for 5 min immediately after collection; plasma was decanted and stored at –20°C until analysis. Initially, 30 random plasma samples (15 from each treatment group) were analyzed for NEFA (NEFA-C kit, Wako Chemical USA, Richmond, VA; Johnson and Peters, 1993). Then, a power calculation was done to determine the necessary sample size (n = 57 per treatment to detect a treatment difference of 100 μEq/L with $\beta = 0.20$); consequently, a larger subset of samples was randomly selected for analysis.

Disorders and diseases were defined and determined by the management of the farm by using a combination of industry and farm definitions. Retained placenta was defined as the visible presence of fetal membranes at the vulva or identified in the uterus by vaginal examination more than 24 h after parturition. Metritis was defined as inflammation of the lining of the uterus as identified by vaginal examination and/or the presence of abnormal cervical or vaginal discharge. Metritis diagnosis took place between d 4 and 15 after parturition. Cows were considered to be ketotic if milk production was less than 10 kg at the morning milking during the first 30 DIM. Decreased appetite, manure consistency, and milk yield were also used in the diagnosis of ketosis. KetoCheck powder (Great States Animal Health, St. Joseph, MO), which detects acetoacetate in milk, was the final of 3 criteria used to determine if a cow would be dosed with propylene glycol. Dosing a cow with propylene glycol was the determinant for a cow being called ketotic. Displaced abomasum was diagnosed as decreased appetite accompanied by an audible, high-pitched tympanic resonance of the left abdominal wall. Mastitis was defined as visually abnormal milk secretions such as clots, flakes, or watery consistency from one or more quarters. Inflammation of a quarter was also used to diagnosis mastitis. Mastitis was diagnosed by the milkers, whereas all other disorders were diagnosed by the herd manager. A cull cow was one that died or was sold during the experiment. The cull rates for the treatments were obtained by dividing the number of cows removed from a treatment during the 300-d lactation phase of the study by the total cows assigned to a treatment. Data collected before the culling event were included in the statistical analysis.

Statistical Analysis

The SAS (SAS Institute, 1999) procedure LIFETEST was used for survival analysis and determination of median days dry. Differences in time-dependent data of median days dry were analyzed by Kaplan-Meier survival curve. The nonparametric test of 2 samples

Table 2. Chemical composition of diets

	Diet[1]			
Composition	LE	ME	Postfresh	Lactation
DM, % as-fed	58.0	57.0	54.0	51.0
NE_L, Mcal/kg of DM[2]	1.34	1.56	1.58	1.65
CP, % of DM	13.9	15.2	18.8	17.8
NDF, % of DM	52.0	47.2	33.6	34.3
NFC, % of DM	25.9	28.6	37.8	39.2
Fat, % of DM	2.3	1.8	4.7	4.4
Ash, % of DM	8.5	9.7	7.7	6.8

[1]LE = low-energy, far-off diet; ME = moderate-energy, close-up diet; Postfresh = postfresh diet from 1 to 30 DIM; Lactation = lactation diet beginning at 30 DIM.

[2]Assumes 13.6 kg of DMI/d prefresh and 22.7 kg of DMI/d postfresh.

obtained from survival analysis was tested for homogeneity by the Wilcoxon test (Wilcoxon, 1945). Data from milk yield, composition, and BCS were analyzed as repeated measures using the SAS procedure MIXED. To account for repeated measures, a SAS AR(1) error structure was used to adjust for autocorrelation (SAS Institute, 1999). Body condition scores were analyzed from 3 wk prepartum until 10 wk and data from pre- and postpartum were analyzed as separate data sets. The same statistical model was used for calving interval, previous lactation 305ME, and NEFA concentration, except that time and any interaction with time were dropped from the model because there were no repeated measures. Additionally, cows were divided into 7 categories based on their actual days dry (<21, 21–27, 28–34, 35–41, 42–48, 49–55, and >55 d) to compare postpartum yields for the categories. The respective n for each category was 19, 38, 154, 149, 61, 138, and 213. A mixed effects model was used to statistically analyze SCM for differences between DP categories. Fixed effects in the statistical model included parity, time, category, and interaction of parity by category. Cow was treated as a random effect. For milk production parameters (n = 391 vs. 390 for T and S, respectively) and NEFA (n = 57 vs. 57 for T and S, respectively), time was DIM and for BCS (n = 391 vs. 390 for T and S, respectively), time was week.

Differences between treatments for the number of cows culled, the usage of bST, and the incidences of ketosis, displaced abomasum, metritis, retained placenta, and mastitis were examined by the SAS procedure PROC LOGISTIC. The model for each of these parameters involved the fixed effects of treatment, parity, time, interaction of parity by treatment and interaction of treatment by time.

All values are reported as least squares means ± standard error (LSM ± SE) unless noted otherwise. Significant differences were declared at $P < 0.05$ for main effects and interactions and a tendency was declared at $0.05 \le P < 0.1$.

RESULTS AND DISCUSSION

Actual DP lengths were 55.8 ± 6.7 for T (n = 391) and 34.0 ± 7.5 d for S (n = 390), respectively. Survival analysis indicated that median days dry were 57 and 34 d for T and S, respectively, and that 90% of cows on T had a DP length between 44 and 65 d (range = 6 to 77 d), whereas 90% of cows on S had a DP length between 20 and 45 d (range = 4 to 69 d).

Prepartum milk yield was 22 ± 1.07 kg/d during the additional 21 d of lactation for cows on S. Furthermore, primiparous cows (n = 216) assigned to S produced more milk than multiparous cows (n = 174) during the final 3 wk before dry off (24.1 ± 0.72 vs. 19.8 ± 0.80 kg/d; $P < 0.001$), which probably reflects greater persistency of lactation. It has been reported that milk yield during the last 30 d before dry off is lower for multiparous cows than for primiparous cows when continuously milked (Annen et al., 2004; Rastani et al., 2007). However, in these studies, the parity difference was not observed when comparing the additional milk yield resulting from shortening the DP from 60 to 30 d. Milk samples were not obtained for component analysis during the 21 d extended lactation. The additional milk from milking for 21 extra days averaged 466 ± 15.8 kg, which is similar to previous research. Gulay et al. (2003) and Rastani et al. (2005) reported, respectively, that reducing the DP from 60 to 30 d resulted in 510 and 422 kg of additional milk. Additional milk gained during the extended lactation needs to be taken into consideration when determining the optimal length of the DP.

Table 3. Postpartum milk production from 1 to 300 DIM and milk composition from 1 to 100 DIM for cows assigned to a shortened (S) or traditional (T) dry period management strategy

	Treatments[1]			
Item	S	T	SE	*P*-value
Milk,[1] kg/d	41.5	43.6	0.77	0.007
Milk,[2] kg/d	37.7	39.5	0.53	0.001
SCM,[1] kg/d	37.4	38.6	0.69	0.06
Fat,[1] kg/d	1.42	1.46	0.02	0.14
Fat,[1] %	3.52	3.45	0.05	0.17
Protein,[1] kg/d	1.14	1.15	0.02	0.62
Protein,[1] %	2.83	2.68	0.03	<0.001
IgG, mg/dL	5,616	5,849	229.6	0.31
SCS[3]	3.12	3.27	0.2	0.47
Mastitis,[2] cases	153	147		0.94

[1]1 to 100 DIM.

[2]1 to 300 DIM.

[3]SCS = log 2 (SCC/100,000) + 3.

Mean postpartum milk production was 2.1 kg/d greater for management strategy T compared with S (43.6 vs. 41.5 kg/d; $P = 0.007$) for the first 100 DIM (Table 3). Milk production was monitored through 300 DIM, and cows assigned to T produced more milk than cows assigned to S (39.5 vs. 37.7 kg/d; $P < 0.001$). The use of bST was not equal between treatments; more cows assigned to S received bST than cows assigned to T (42 vs. 33%; $P < 0.001$); however, there was no treatment by bST interaction. Funk et al. (1987) indicated that cows given a DP between 60 and 69 d produced 459 kg more milk in the subsequent lactation than those given a DP <40 d. Others have reported a loss in milk yield when the DP is reduced to less than 40 d (Coppock et al., 1974; Remond et al., 1997; Rastani et al., 2005). For example, Rastani et al. (2005) reported that cows given a 28-d DP produced significantly less milk (37.9 vs. 42.2 kg/d for 28- and 56-d DP, respectively) than

Table 4. Postpartum milk production according to parity when cows are assigned to a shortened (S) or traditional (T) dry period management strategy

	Parity 2				Parity 3 +				Treatment × parity interaction
Item	T	S	SE	*P*-value	T	S	SE	*P*-value	*P*-value
n	210	216			181	174			
Milk,[1] kg/d	42.3	39.0	1.02	0.001	44.8	44.0	1.12	0.47	0.08
SCM,[1] kg/d	37.50	35.20	0.91	0.01	39.8	39.5	0.99	0.77	0.13
Fat,[1] kg/d	1.41	1.32	0.04	0.04	1.52	1.52	0.05	0.85	0.19
Fat,[1] %	3.40	3.47	0.07	0.26	3.51	3.58	0.08	0.40	0.88
Protein,[1] kg/d	1.14	1.1	0.03	0.17	1.17	1.19	0.03	0.57	0.17
Protein,[1] %	2.71	2.88	0.03	<0.001	2.64	2.77	0.04	0.005	0.50
SCS[2]	3.09	3.9	0.25	0.45	3.44	3.45	0.73	0.65	0.65

[1]1 to 100 DIM.

[2]SCS = log 2 (SCC/100,000) + 3.

those cows assigned to a 56-d DP. Sorensen and Enevoldsen (1991) also reported that when the DP was reduced from 10 or 7 wk to 4 wk there was a loss in milk yield by dual-purpose Danish cows. In contrast, Gulay et al. (2003) reported that milk yield did not differ when comparing a 30- to 60-d DP (38.4 vs. 38.7 kg/d, respectively).

There was a tendency for a parity by treatment interaction for postpartum milk production ($P = 0.08$) and SCM ($P = 0.13$; Table 4). Treatment differences were not observed for cows in their third or greater lactation, but were detected for cows in their second lactation. Our data agreed with that of Annen et al. (2004) who reported that reducing DP length from 60 to 30 d significantly affects second-lactation cows but not third and greater lactation cows. A recent retrospective analysis of farm records indicated that milk yields from cows in their third lactation or greater are not affected by DP length whereas those in their second lactation are affected by DP length (Kuhn et al., 2006). Dias and Allaire (1982) determined that as age during the preceding lactation increased, the length of DP necessary to achieve maximum milk yield over 2 consecutive lactations decreased. Sorensen and Enevoldsen (1991) and Rastani et al. (2005) did not detect a treatment by parity interaction for milk production. Our research supports the idea that as cows increase in lactation number, fewer days dry are required to maximize milk yield during the subsequent lactation.

Our study was designed to compare 2 different DP management strategies, but it also allowed us to examine milk production of cows that experienced different dry period lengths. Our categorical analysis of data from all cows indicated that there was no loss in SCM yield until days dry was less than 21 (Table 5). Within parity 2, significantly less SCM was produced when days dry were less than 21 (Table 5). For parity 3+ cows, SCM yield was also lowest for cows less than 21 d dry, although not significantly different from all categories. Categorical analysis for milk yield showed similar results (data not shown). Previous research (Kuhn et al., 2006) indicated that when days dry are less than 56, a loss in milk production occurs during the subsequent lactation.

Previous research (Dias and Allaire, 1982) indicated DP length might affect the level of milk production differently depending on length of the calving interval. It was reported that when the calving interval was less than 340 d, a DP of at least 55 d was required to maximize milk production during 2 consecutive lactations (Dias and Allaire, 1982). There was a tendency for the calving interval to be longer for cows assigned to T compared with S (375 ± 1.97 vs. 370 ± 1.98; $P < 0.10$).

Milk fat yield did not differ ($P = 0.14$) between DP management strategies (Table 3). Other studies have shown either no difference or a slight decrease in milk fat yield when the DP is reduced (Sorensen and Enevoldsen, 1991; Gulay et al., 2003; Rastani et al., 2005). Recent retrospective analysis (Kuhn et al., 2006) indicated that milk fat yield was not affected by DP length unless the DP was less than 20 d, at which point second-lactation cows are more negatively affected than third or greater lactation cows.

Milk fat percentage was not affected by DP management strategy ($P = 0.17$; 3.45 ± 0.04 vs. $3.52 \pm 0.04\%$ for T and S, respectively) during the initial 100 DIM (Table 3). This agrees with most previous data (Lotan and Adler, 1976; Gulay et al., 2003; Annen et al., 2004) but is in contrast to Rastani et al. (2005), who observed that milk fat percentage increased from 3.86 to 4.08% during early lactation when the DP was reduced from 56 to 28 d. There was no treatment by parity interaction for either milk fat yield or milk fat percentage in this experiment.

Milk protein yield did not differ ($P = 0.62$) between DP management strategies; however, milk protein per-

Table 5. Solids-corrected milk by days dry category of (<21, 21–27, 28–34, 35–41, 42–48, 49–55, and >55 d) for cows assigned to a shortened 34-d (S) or traditional 55-d (T) dry period

	All cows			Parity 2			Parity 3+		
Category	Milk yield	SE	n = (Total/T/S)[1]	Milk yield	SE	n = (Total/T/S)	Milk yield	SE	n = (Total/T/S)
<21	30.8[a]	2.43	19/1/18	29.1[a]	2.58	13/1/12	32.6[a]	3.9	6/0/6
21–27	39.2[b]	1.82	38/2/36	38.6[b]	2.04	24/2/22	39.8[ab]	2.75	14/0/14
28–34	39.8[b]	1.14	154/2/152	37.2[b]	1.29	88/1/87	42.3[b]	1.41	66/1/65
35–41	38.8[b]	1.13	149/6/143	36.0[b]	1.32	81/2/79	41.7[b]	1.37	68/4/64
42–48	38.3[b]	1.21	60/28/32	37.1[b]	1.56	33/20/13	39.6[ab]	1.86	27/8/19
49–55	37.6[b]	1.18	137/133/4	37.2[b]	1.32	81/78/3	38.3[ab]	1.48	56/55/1
>55	38.8[b]	1.09	213/208/5	37.6[b]	1.27	97/97/0	39.9[ab]	1.22	116/111/5

[a,b]Means with different letters within column differ at $P < 0.05$.

[1]Number of total cows or cows assigned to S or T dry period.

centage was greater ($P < 0.001$) for cows assigned to S compared with those assigned to T (2.68 ± 0.02 vs. 2.83 ± 0.02%; Table 3). Sorensen and Enevoldsen (1991) reported that milk protein yield was increased when cows were given a traditional DP compared with a shortened DP. Losses in milk protein yield were seen when DP was >60 d or <20 d, with the greatest reduction in yield seen when DP was <20 d (Kuhn et al., 2006). Rastani et al. (2005) reported an increase in milk protein percentage when the DP was reduced from 56 to 28 d. One possible reason for the increase in protein percentage could be an improved EB, which spares amino acids and energy for protein synthesis (Remond and Bonnefoy, 1997).

There was a tendency ($P = 0.06$) for cows assigned to T to produce more SCM than cows assigned to S (38.6 vs. 37.4 kg/d, respectively; Table 3). Recently, Rastani et al. (2005) reported no difference in SCM yield when comparing 28- to 56-d DP (37.6 vs. 39.9 kg/d for 28 and 56 d, respectively). Gulay et al. (2003) reported no difference in 3.5% FCM yield when cows were given a 30- or 60-d DP; however, Sorensen and Enevoldsen (1991) indicated that 4% FCM yield decreased when the DP was reduced from 7 or 10 wk to 4 wk. It should be noted that our data indicated that there was a tendency for a decrease in SCM even though the treatment difference in SCM yield was less than that of Rastani et al. (2005), who reported no difference. The increased animal numbers on our experiment allowed greater sensitivity to detect treatment differences.

Colostrum quality was measured by IgG concentration and no differences (5,849 vs. 5,616 mg/dL for cows assigned to T and S, respectively; $P = 0.31$) were detected between treatments (Table 3). Similar results were obtained by others (Annen et al., 2004; Rastani et al., 2005) when DP was reduced from 60 and 56 d to 30 and 28 d, respectively. When cows are continuously milked, increased milk production at parturition may negatively affect colostrum quality by diluting IgG in colostrum (Rastani et al., 2005). This does not seem to be the case when there is at least a 4-wk DP. Therefore, a traditional and a reduced DP should result in colostrum that supplies sufficient amounts of IgG to the calf.

Shortening the DP to 34 d did not affect SCS through 100 DIM ($P = 0.47$) or the incidence of mastitis through 300 DIM in the subsequent lactation ($P = 0.94$; Table 3), which agrees with previous research (Enevoldsen and Sorensen, 1992; Remond et al., 1992; Gulay et al., 2003; Annen et al., 2004). Rastani et al. (2005) indicated a tendency ($P < 0.15$) for lower SCS when the DP was reduced from 56 to 28 d (3.37 vs. 2.56). Retrospective analysis of data from commercial farms has shown that a DP of 60 d or less resulted in a higher overall SCS in the subsequent lactation (Kuhn et al., 2006). Kuhn et al. (2006) also reported that a DP of less than 20 d had a more adverse effect on SCS for cows in their second lactation compared with those in their third or greater lactation. However, in planned research experiments, shortening the DP seems to have no negative effect on SCS in the subsequent lactation.

Energy Balance and Health Parameters

During the entire course of the study, mean BCS did not differ ($P = 0.40$) between cows assigned to T or S (3.23 ± 0.02 vs. 3.25 ± 0.01; Figure 1). Mean BCS for wk –4, 0, and 9 were 3.75 ± 0.03 vs. 3.65 ± 0.03, 3.37 ± 0.02 vs. 3.38 ± 0.03, and 2.89 ± 0.03 vs. 2.93 ± 0.03 for cows assigned to T and S, respectively. Prepartum, there was a difference in BCS among cows assigned to T and S (3.75 ± 0.01 vs. 3.69 ± 0.01, respectively; $P < 0.01$). Postpartum, there was also a difference detected in BCS among cows assigned to T and S (3.01 ± 0.02 vs. 3.07 ± 0.01, respectively; $P = 0.03$). Although there was a significant difference detected in BCS among treatments during the prepartum and postpartum periods, it should be noted that the difference was less than one-tenth of a point during each time period. The

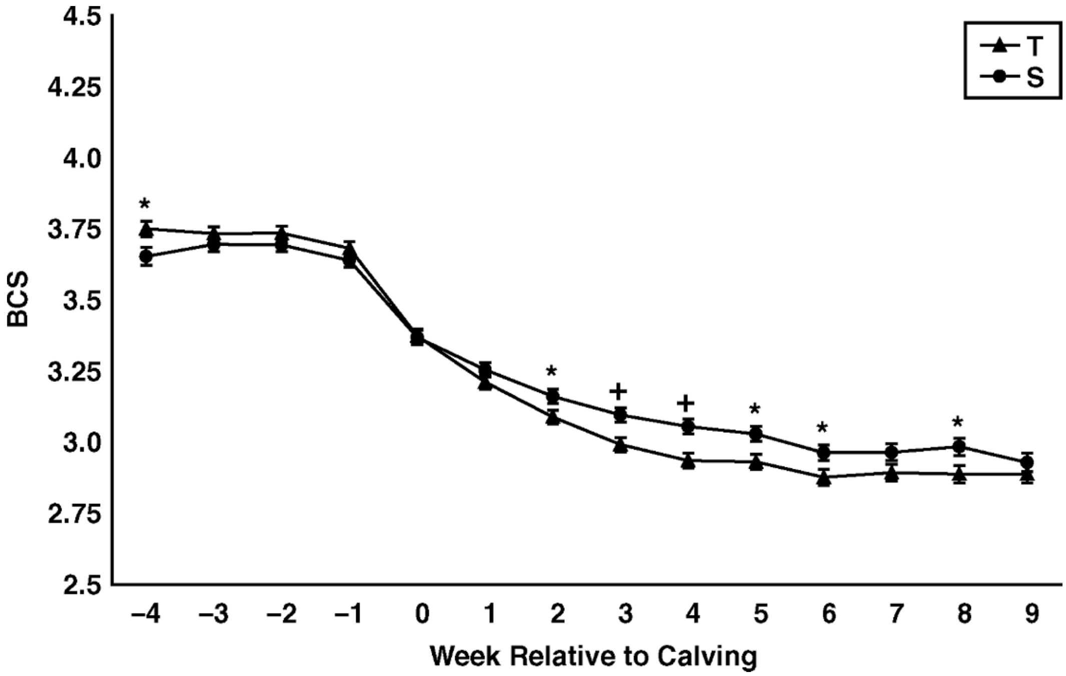

Figure 1. Body condition scores for cows assigned to a shortened (S; ●) or traditional (T; ▲) dry period management strategy. * and + indicate differences between treatments at $P < 0.05$ and $P < 0.01$, respectively.

maximum difference in BCS seen between treatments was during wk 4 after calving and the difference was 0.12 points. There was a significant treatment by time interaction ($P = 0.001$) when data from the entire period from wk 4 prepartum until wk 9 postpartum was analyzed. When BCS data from prepartum and postpartum were analyzed separately, there were no treatment by time interactions. Body condition score was highest during wk 4 before expected calving (3.75) and lowest during wk 6 postpartum (2.88) for cows assigned to T. Cows assigned to S displayed the highest BCS score during wk 3 before expected calving (3.70) and the lowest BCS during wk 9 postpartum (2.93).

Plasma NEFA concentration is an indicator of fat mobilization (Whitaker et al., 1999; Ingvartsen and Andersen, 2000; Seifi et al., 2007); 3 wk before expected parturition it tended to be lower for cows assigned to T relative to cows assigned to S (155 vs. 185 μEq/L; $P = 0.09$). Rastani et al. (2005) reported that prepartum NEFA concentrations increased from 5 to 1 wk prepartum with the greatest increase occurring in cows with a 56-d DP (128, 34, and 27 μEq/L increase for 56, 28, and 0 d dry, respectively). Postpartum NEFA concentrations were lower for cows assigned to S compared with T (337.4 vs. 428.8 μEq/L; $P = 0.02$). Rastani et al. (2005) reported that postpartum plasma NEFA concentration did not differ when the DP was reduced from 56 to 28 d; however, concentrations were lower for cows with 0-d DP compared with 28-d DP (235 vs. 394 μEq/L). The greater postpartum NEFA concentration seen for T suggests a greater rate of fat mobilization and perhaps greater NEB. Because cows on both treatments were housed together in group pens, it was not possible to measure DMI or estimate EB. Lower postpartum milk yield for cows on S may have affected EB and contributed to the lower NEFA concentration.

The incidences of ketosis (18.6 vs. 18.5%), metritis (19.6 vs. 15.6%), retained placenta (8.9 vs. 9.5%), and displaced abomasum (5.5 vs. 6.2%) for T and S, respectively, were not affected by treatment ($P > 0.15$). This experiment is 1 of only 2 studies that have assessed the effect of DP length on the incidence rates of metabolic disorders. Coppock et al. (1974) evaluated DP lengths of 20, 30, 40, 50, and 60 d and found no difference in the incidence rate of over 20 different disorders. There was a trend for a decrease in cases of ketosis as the DP was decreased (Coppock et al., 1974). For the entire lactation, more cows on T were culled than cows on S (22 vs. 13%; $P < 0.004$). The majority of cows culled from the experiment were culled for mastitis, reproduction, or feet and leg problems (35% mastitis, 18% reproduction, and 14% feet and leg). Percentage of cows culled during the first 30 DIM did not differ between treatments (4.7 vs. 5.1%; $P = 0.87$). Metabolic status as indicated by postpartum plasma NEFA concentration was improved in cows on S, but this did not translate into a reduction in metabolic disorders or 30-d cull rate.

CONCLUSIONS

Reducing targeted DP length from 55 to 34 d decreased milk yield, had a tendency to decrease SCM and increased milk protein percentage during the subsequent lactation. The reductions in milk and SCM yield were accounted for by cows in their second lactation, with no effect of DP management strategy on yield for cows in their third or greater lactation. Analysis of SCM yield by different categories of DP length indicated that it was not compromised until DP length fell below 21 d, irrespective of parity. Colostrum quality was not influenced by DP length. In general, the effects of reducing the DP length on lactation performance were consistent with previous trials. Reducing the DP length decreased NEFA concentration at 3 wk postpartum; however, incidence of metabolic disorders was not affected. Reducing the DP did not appear to improve or reduce animal health during the subsequent lactation. Results indicate that dairy producers have flexibility in managing DP length, especially when the additional milk obtained through the extension of the current lactation is also considered.

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