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Improving Productive and Reproductive Performance of Holstein Dairy Cows through Dry Period Management

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ABSTRACT: To determine the effects of dry period (DP) length on milk yield, milk composition, some blood metabolites, complete blood count (CBC), body weight and score and follicular status, twenty five primiparous and multiparous Holstein cows were assigned to a completely randomized design with DP-60 (n = 13) and DP-20 (n = 12) dry period lengths. Cows in the DP-60 produced more milk, protein, SNF, serum non-esterified fatty acids (NEFA) and beta hydroxyl butyrate acid (BHBA) compared with cows in DP-20 ($p\leq0.05$). Serum glucose, blood urea nitrogen (BUN), urea, and glutamic oxaloacetic transaminase (GOT) were all similar among the treatments. Body Condition Score (BCS), body weight (BW), complete blood count (CBC) and health problems were similar between the treatments. Diameter of the first dominant follicle and diameter of the dominant follicle on d 14 were different among the treatments. Thus, results of this study showed that reducing the dry period length to DP-20 had a negative effect on milk production, milk composition and reproductive performance in Holstein dairy cows. (**Key Words:** Dry Period, Milk Yield, Complete Blood Count, Follicular Dynamic, Reproductive Performance, Holstein Dairy Cows)

INTRODUCTION

Regulation of milk production records with factors based on the heritability assessments of previous days open, previous dry period, or contemporary days open was not guaranteed because those variables are largely controlled through management decisions, not via genetics (Schaeffer and Henderson, 1972; Funk et al., 1987).

Dry period is one of the important management strategies. Previous studies reported that to maximize milk yield in the next lactation in dairy cows, a 50 to 60 d dry period (DP) is necessary (Sorensen and Enevoldsen, 1991; Smith and Becker, 1995). Recently researches argue that reduction of dry period can improve cow performance regarding milk production and composition, metabolic status and fertility (Bachman, 2002; Gulay et al., 2003; Gümen et al., 2005; Pezeshki et al., 2007; De Feu et al., 2009; Watters et al., 2009). A dry period is a requirement for mammary gland repose to maximize milk yield in the subsequent lactation (Cameron et al., 1998; Rastani et al., 2005). Past research (Funk et al., 1987; Sorenson and Enevoldsen, 1991; Remond et al., 1992; Makuza and McDaniel, 1996) support the conclusion that dry periods less than 60 d can reduce milk production in the subsequent lactation. Recently, several experiments have estimated dry period lengths. These studies reported a decrease in the dry period length from 50-57 d to 30-34 d reduced the milk yield up to 10%.

However, a shortened dry period has several benefits. First, cows produce milk in the far-off period (marginal milk) that can add to milk yield. Second, better management strategy for cows transfer and nutrition because the need for a “far-off” dry cow group may be eliminated (Grummer and Rastani, 2004).

Nowadays, one of the most important economic problems in dairy herds is poor reproductive efficiency. So, improvement in reproductive efficiency may lead to enhanced performance in dairy characteristics. Therefore, reducing dry period length may affect fertility efficiency (Gulay et al., 2003; Gumen et al., 2005; De Feu et al., 2009; Watters et al., 2009).

The objective of this study was to determine whether shortening the dry period would affect performance and reproductive status of dairy cows.

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MATERIAL AND METHODS

Cows, treatment, and feeding

Twenty five primiparous and multiparous Holstein cows were assigned to a completely randomized design with DP-60 (n = 13) and DP-20 (n = 12) dry period lengths. Holstein cows were blocked by parity (2nd and 3rd to 5th), their previous 305-d milk yield and expected calving dates. Cows were housed in common pens. Dry cows were housed in 2 pens: a far-off group (from 60 to 35 d before expected calving) and a close-up group (35 d before expected calving). Diets had changes including late lactation diet to far-off diet, far-off diet to close-up diet, and close-up diet to early lactation diet. Immediately after calving, cows were moved to the fresh-cow pen and fed the lactation ration. All cows were fed a ration as total mixed diet twice a day at 0800 and 1800 h and had at all times free access to water.

Body condition scoring and body weight

Body condition score and body weight were recorded every week from entering to experiment to 60 d after parturition. The same assessor assigned BCS to each cow on a scale of (emaciated cows) to 5 (Edmonson et at., 1989) with 0.25-unit increments. The method was based on a visual and tactile appraisal of body fat reserves in the back and pelvic regions.

Postpartum ultrasound evaluation

To monitor follicular parameters, ultrasound measurements of follicular activity were made on alternate days from 10 to 35 d to ascertain the characteristics and fate of the 1st follicular wave, using a 7.5 MHz rectal transducer (Medison SA 600V, Seoul, Korea). Measurements were made on a single frozen image of the apparent maximal area of each follicle, using the average diameter in 2 directions at right angles. Transrectal ultrasound scanning to monitor follicles was performed thrice weekly (i.e., Sunday, Tuesday and Thursday). Dominant follicle development was characterized by follicular mapping of records ultrasound images (Heravi Moussavi et al., 2007c). Follicular recruitment during the 1st follicular wave after parturition was evaluated by quantification of the numbers of 5 to 10 mm follicles on day 10 and 14 (Robinson et al., 2002). A dominant follicle was defined as a follicle that was >10 mm in diameter in the absence of other large (>9 mm) growing follicles.

Sample collection

Blood samples: Approximately 15 ml of blood was sampled weekly from d 1 to 60 after calving via venipuncture of coccygeal vessels before the morning feeding and placed in vacutainer tubes without anticoagulant to monitor serum metabolites. Samples were allowed to clot and kept cold on ice until they were transferred to the laboratory and centrifuged at 3,000×g for 15 min at 4°C for separation of serum. Serum was harvested, and each sample was divided into 3 aliquots and stored at -20°C for further analyses. Also to monitor complete blood count (CBC), about 1.5 ml from the blood samples poured in vacutainer tubes with EDTA. These samples were kept in room temperature until analysis for CBC. Complete blood counts were automatically determined with a hematology analyzer (Symex K 1000, TOA Ltd., and Tokyo, Japan).

Milk samples and record

After parturition, cows were milked 3 times per day at 0400, 1200 and 1800 h and yields were recorded until 50 days postpartum. Milk samples were collected from each milking once per week and composited for analysis of milk composition (Micro Scan; FOSS Electric A/s, Denmark).

Statistical analyses

Milk yield and composition, BW, BCS and blood metabolites were analyzed using a mixed model (PROC MIXED, SAS Inst. Inc., Cary, NC, USA) and follicular data were analyzed using a mixed model (PROC GLM, SAS Inst. Inc., Cary, NC, USA) for a completely randomized design with repeated measures using the following model:

$$Y = \mu+Ti+A(i)j+Dk+(T\times D)ik+Rijk$$

Where,
Y = Dependent variable.
μ = Overall mean.
T = Treatment effects.
A = Random effects of animal within treatments.
D = Effects of sampling day or time.
T×D = Interaction effects of treatment and sampling day or time.
R = Residual error associated with the ijk observation

RESULTS

The effects of treatment on milk yield and milk composition are shown in Table 1. There were significant differences in postpartum milk yield between treatments ($p<0.05$). Also, there was a significant difference ($p<0.01$) between treatments for increased milk protein percentage in postpartum for cows on the shortened dry period compared with cows on the traditional dry period (60 d). But milk protein yield was lower in the shortened dry period treatment (DP-20) compared with the DP-60 treatment, which may be related to more production in the traditional treatment.

Milk lactose percentage and milk SNF percentage were greater for cows on the shortened dry period compared with

Table 1. Least square means of milk yield and composition

	Dry periods (Day)		SEM	p-value		
	60	20		Dry period	Week	Dry period×week
Milk yield[1] (kg)	36.23	28.85	2.07	0.017	0.0008	0.483
Milk fat (%)	3.89	3.93	0.12	0.817	0.0002	0.161
Milk protein (%)	3.05	3.20	0.03	0.005	0.219	0.735
Milk lactose (%)	4.56	4.72	0.05	0.042	0.51	0.231
Milk SNF (%)	8.38	8.65	0.09	0.035	0.307	0.225
Fat yield (kg)	1.39	1.14	0.07	0.021	0.233	0.79
Protein yield (kg)	1.11	0.91	0.06	0.041	0.001	0.647
Lactose yield (kg)	1.66	1.36	0.099	0.374	0.002	0.485
SNF yield (kg)	3.05	2.491	0.18	0.036	0.002	0.485

[1] To 60 days in milk.

cows on the DP-60 ($p<0.05$, 4.72 vs 4.56; 8.65 vs 8.36 respectively), but milk SNF yield was greater in traditional dry period compared with the shortened dry period ($p<0.05$; 3.05 vs 2.49, respectively). There was no difference in milk lactose yield for cows on the treatments.

Milk fat yield was lower for cows on the shortened dry period compared with cows on the DP-60 ($p<0.05$). But there was no difference between treatments for milk fat percentage.

Body Weight and BCS changes were not different between treatments (Table 2). The effect of week on body weight ($p<0.01$) at pre and postpartum and body condition score ($p<0.05$) at postpartum was significant between treatments.

Serum metabolites are presented in Table 3. Numerically higher concentrations of NEFA (16%) were found in cows in DP-60 dry period compared with the DP-20 dry period. Despite there being no statistically difference between treatments in postpartum serum NEFA concentration ($p = 0.18$); the effect of week in NEFA concentration at postpartum was significant between treatments ($p<0.01$). Postpartum serum BHBA concentrations like NEFA were similar between treatments ($p = 0.31$), however, cows in DP-60 had greater (20%) serum BHBA concentrations compared with DP-20.

There were no prepartum and postpartum differences in serum glucose concentrations for cows in treatments. Nevertheless, the effect of week on serum glucose

Table 2. Least square means of body weight and body condition score (BCS)

	Dry periods (Day)		SEM	p-value		
	60	20		Dry period	Week	Dry period×week
Body condition score						
Prepartum[1]	2.86	2.96	0.221	0.77	0.15	0.15
Postpartum[2]	2.49	2.57	0.205	0.791	0.044	0.793
Body weight (kg)						
Prepartum	726.93	703.21	20.54	0.422	<0.0001	0.378
Postpartum	644.27	621.97	18.56	0.403	<0.0001	0.048

[1] -3 wk to 0 relative to calving. [1] 1 wk to 7 wk relative to calving.

Table 3. Least square means of NEFA[1], BHBA[2], Glucose, BUN[3], Urea and GOT[4]

	Dry periods (Day)		SEM	p-value		
	60	20		Dry period	Week	Dry period×week
NEFA (mmol/L)	0.793	0.666	0.06	0.188	0.007	0.134
BHBA (mmol/L)	0.726	0.581	0.09	0.315	0.076	0.594
Glucose (mg/dl)						
-3 wk to 0 wk[5]	54.34	54.78	2.27	0.893	<0.0001	0.636
1 wk to 7 wk	45.89	49.38	1.55	0.119	0.0009	0.971
BUN (mg/dl)	14.92	15.54	1.23	0.729	0.213	0.104
Urea (mg/dl)	31.947	33.271	2.63	0.729	0.213	0.104
GOT (U/I)	88.357	97.214	11.662	0.598	0.281	0.983

[1] NEFA = Non-estrified fatty acid. [2] BHBA = Beta hydroxy butyrate acid. [3] BUN = Blood urea nitrogen.
[4] GOT = Glutamic oxaloacetic transaminase. [5] wk = Week relative to calving.

Table 4. Least square means of complete blood count[1] (CBC)

	Dry periods (Day)		SEM	p-value		
	60	20		Dry period	Week	Dry period×week
WBC[2] (/μl)	12,278	14,571	2,022	0.428	0.66	0.573
RBC[3] (/μl)	5,285,745	5,329,421	117,491	0.794	0.001	0.154
HGB[4] (g/dl)	8.09	8.12	0.19	0.921	<0.0001	0.396
HCT[5] (%)	27.98	28.19	0.62	0.815	0.0003	0.499
PLT[6] (/μl)	250,464	257,726	15,983	0.749	0.017	0.348
Neutrophils (no)	3,438.56	3,729.32	254.47	0.423	0.136	0.783
Lymphocytes (no)	7,697.00	9,587.67	1,910.15	0.489	0.853	0.319
Monocytes (no)	683.33	673.51	121.12	0.954	0.983	0.096
Eosinophils (no)	1.449	1.058	0.131	0.039	0.661	0.958

[1] From -1 wk to 7 wk relative to calving. [2] WBC = White blood cell. [3] RBC = Red blood cell. [4] HGB = Hemoglobin. [5] HCT = Hematocrit. [6] PLT = Platelet.

concentrations was significant (p<0.01) at prepartum and postpartum between treatments.

Effect of dry period lengths on complete blood count is summarized in Table 4. There was no statistical difference between treatments. The effect of week was significant between treatments for Red Blood Cells, Hemoglobin, Hematocrit and platelets (p<0.01).

Length of dry period had no effect on days postpartum to first ovulation, number of days until detection of a follicle ≥10 mm in diameter and diameter of the largest follicle at first ultrasound. Also, numbers of follicles on days 10 and 14 postpartum (≥5 mm in diameter) were similar among the groups. Diameter of the first dominant follicle (p<0.05) and diameter of the dominant follicle on d 14 (p<0.05) were different among the treatments (Table 5). Also, days open, days to first AI and number of services per conception were similar among the groups (Table 5).

DISCUSSION

Differences in postpartum milk production between cows on the treatments is consistent with the findings of Sorensen and Enevoldsen (1991), Rastani et al. (2005) and Watters et al. (2008) who suggested that managing cows for dry periods of less than 40-d resulted in decreased milk yield during the subsequent lactation compared to cows given DP-60. But, Scharier (2001), Bachman (2002), Pezeshki et al. (2007) and Gulay et al. (2003) demonstrated that reduction of dry period had no effect on milk production between treatments. In addition, Coppock et al. (1974) reported a decrease in milk production during the subsequent lactation for cows with a dry period <40 d. Secretory activity of mammary epithelial cells in cows that had been DP-60 increased during dry period until parturition (0%, 78% and 98% for days -35, -20 and -7 respectively). However, at 7 d prepartum, only 62% of mammary epithelial cells demonstrated secretory activity in cows with no dry period, while 98% of the epithelial cells had secretory activity in cows with a DP-60 (Capuco et al., 1997).

The changes in milk yield with a shortened DP are variable, suggesting an interaction between the animals physiology, health and management. However, some researchers believe that short dry periods reduce milk production in the subsequent lactation in several species, including cattle, rats, and humans; in cattle, this occurs because of reduced mammary epithelial cell turnover and secretory capacity (Annen et al., 2004). Based on these data

Table 5. Least square means of follicular dynamic and reproductive measures

	Dry periods (Day)		SEM	p-value
	60	20		
Diameter of the first dominant follicle, mm	18.76[a]	14.46[b]	1.207	0.018
Number of follicles (>= 5 mm in diameter) on d 10	4.23	4.08	0.77	0.895
Number of follicles (>= 5 mm in diameter) on d 14	5.00	4.08	0.51	0.217
Days postpartum to first ovulation (d)	27.76	22.30	2.72	0.195
Number of days until detection of a follicle ≥10 mm in diameter	11.53	13.23	1.165	0.314
Diameter of first dominant follicle on d 14 (mm)	13.65[a]	9.95[b]	0.83	0.004
Diameter of the largest follicle at first ultrasound (mm)	10.80	13.11	0.974	0.107
Days open	150.63	172.22	26.27	0.569
Days to first AI	107.18	82.00	8.78	0.057
Services/conception[1] (no)	1.81	2.66	0.42	0.171

[1] Services/conception = Number of services per conception

and milk production data from our experiment and that of others (Swanson, 1965; Smith et al., 1967; Remond et al., 1997), a dry period (at least 35 d) is necessary to achieve maximal milk production in the subsequent lactation. Our data on milk protein percentages are in agreement with Rastani et al. (2005). Some researchers believe that there is an inverse relationship between milk protein percentage and milk yield response when altering dry period length (Grummer and Rastani, 2004) and also Remond et al. (1997) believe that an increase in milk protein percent may be the result of reduced milk yield, improving energy balance and thereby sparing amino acids and energy for protein synthesis.

Watters et al. (2008) and Gulay et al. (2003) did not report any significant differences between milk protein percentage between a 30 d dry period and a 60 d dry period. However, Sorensen and Enevoldsen (1991) reported that milk protein yield was increased when cows were given a traditional dry period compared with a shortened dry period (calculated milk protein percentage was 3.4 and 3.5%, respectively). Rastani et al. (2005) reported a decrease in milk lactose yield in subsequent lactation for cows with shortened dry period (DP-28). Also, Remond et al. (1992) reported a tendency for an increased lactose yield in cows with a DP-60 compared with cows with no dry period. Our data is not consistent with De Feu et al. (2009) and Madsen et al. (2008) who reported no significant difference between treatments about milk lactose percentage, of course they compared 7-wk or 8-wk dry period with no planned dry periods.

Lotan and Adler (1976), Gulay et al. (2003), Watters et al. (2008) and Pezeshki et al. (2007) also reported no difference in milk fat percentage and milk fat yield in the subsequent lactation for cows with 35-d and 60-d DP. However, Sorensen and Enevoldsen (1991) and Rastani et al. (2003) reported a decrease in milk fat yield in the subsequent lactation for cows with a 4 wk dry period compared with a 7 wk dry period.

Metabolic disorders have been associated with BW or BCS loss. As might be expected, in experiments in which eliminating (Swanson, 1965; Remond et al., 1997) or shortening (Farries and Hoheisel, 1989) the dry period reduced milk production in the subsequent lactation, BW losses were concurrently reduced. However, based on our data, during the entire course of the study (prepartum and postpartum), cows BW and BCS changes were not affected by treatments. Decreased post calving body condition score demonstrated that cows experienced negative energy balance**.** In contrast to our data, reduction in BCS loss after parturition by giving short dry periods is reported by others (Farries and Hoheisel, 1989; Gulay et al., 2003). Rastani et al. (2005) and Gulay et al. (2005) demonstrated that BCS at calving was similar among experimental groups (28-d vs 56-d and 30-d vs 70-d dry periods, respectively), but Rastani et al. (2005) found that postcalving BCS loss for the DP-56 group was greater than that of DP-28 group. So our data explained that BW and BCS changes had no relation to energy status between treatsments. Although a greater milk yield produced by DP-60 indicated that these cows experienced more of a negative energy balance than cows in the DP-20. Our results agree with Pezeshki et al. (2007) who demonstrated that cows in shortened dry periods had less negative energy balance than cows with longer dry periods producing higher milk yields.

Our findings regarding postpartum serum NEFA concentrations are consistent with those of Watters et al. (2008) who reported postpartum NEFA concentrations were lower for cows assigned to a shortened 34-d dry period compared with DP-55. This data does not agree with Lotan and Adler (1976) who reported concentrations of NEFA were similar between cows with a shortened or a 60-d dry period. Rastani et al. (2005) also reported that postpartum plasma NEFA concentration did not differ when the dry period was reduced from 56 to 28 d. Andersen et al. (2005) and De Feu et al. (2009) showed that postpartum NEFA concentrations were significantly higher in cows with 7 or 8 week dry period than in those with no planned dry period ($p<0.05$). During the periparturient period, cows undergo dramatic physiological changes associated with parturition and the initiation of lactation and experience numerous changes in feeding and management (Grummer and Rastani, 2004). Serum NEFA concentration is an indicator of fat mobilization (Whitaker et al., 1999; Ingvartsen and Andersen, 2000; Seifi et al., 2007). The higher NEFA concentration reflects a higher rate of lipolysis in the adipose tissue (Mashek et al., 2001). The NEFA are potential substrates for ketogenesis in the liver (Heitmann and Fernandez, 1986). These data suggested that cows with a 7 or 8-wk dry period were in a greater negative energy balance in the early postpartum period, most likely due to higher milk yields. Pezeshki et al. (2007) demonstrated that cows in a shortened dry period produced less milk and for this reason were likely in better energy balance than cows in the longer dry periods. This result is consistent with our data indicating lesser milk production leads to a lower negative energy balance.

In the starting phase of lactation, especially, in the first 3 to 5 weeks and up to 2 or 3 months after parturition and even more so in high-yielding dairy cows, feed intake is insufficient to cover the requirements for energy (Blum et al., 1983; Chilliard et al., 1998). The amount of energy required for maintenance of body tissue function and milk production exceeds the amount of energy cows can obtain from dietary sources. In this period, high yielding dairy cows are typically in a state of negative energy balance (Baird, 1982). Long chain fatty acids mobilized from adipose tissues are a major source of energy to the cow during this period. Indeed, during the first month of lactation, the energy in stored lipids that are mobilized by the cow maintains the milk yield (Brumby et al., 1975; Bell, 1980). The intense lipid mobilization probably is necessary for the cow to achieve maximal milk yield. In the case of excessive fat mobilization, associated with marked formation of acetyl-coenzyme A, the tricarboxylic acid cycle cannot fully metabolize fatty acids. As a consequence, acetyl coenzyme A is converted to acetoacetate which is then reduced to BHBA by BHBA dehydrogenase or spontaneously decarboxylized to acetone (Brumby et al., 1975; Baird, 1982). Rastani et al. (2005) also reported that there are no treatment effects on postpartum plasma BHBA. De Feu et al. (2009) compared a standard 8 week dry period with no planned dry period and reported that there were no differences in plasma BHBA concentrations between the dry period treatments from wk -3 to 3 and from week 4 to 12 relative to parturition. Madsen et al. (2008) reported similar results regarding plasma BHBA concentrations when cows were assigned either a 7-week dry period or no planned dry period treatments. However, our results with serum BHBA concentrations indicate a 20% increase in DP-60 compared with DP-20 and are in agreement with Andersen et al. (2005) who reported that the significant difference in postpartum plasma BHBA concentrations ($p = 0.04$) between treatments (7-wk dry period vs. no planned dry period).

For serum glucose concentrations, our data are in agreement with the observations of Pezeshki et al. (2007) who reported no difference in prepartum and postpartum serum glucose between 56-d, 42-d and 35-d dry period lengths. Rastani et al. (2005) also showed no difference in prepartum serum glucose between DP-28 and DP-56. We also observed no differences in postpartum BUN (Blood Urea Nitrogen), urea and GOT (Glutamic oxaloacetic transaminase) concentrations among the treatments. Andersen et al. (2005) reported no difference in prepartum and postpartum plasma urea nitrogen between treatments (49-d vs omission of the dry period). Serum glucose concentration decreases during wk 1 and 2 postpartum. This transient fall in glucose levels in the first weeks of lactation can be interpreted to be the consequence of high demands for lactose synthesis and of insufficient gluconeogenesis (Baird, 1982; Doepel et al., 2002), mainly because energy losses could not be fully compensated by energy intakes. This explains why the effect of week in serum glucose concentrations was significant ($p<0.01$) at prepartum and postpartum between treatments in our study.

There is no research on the effect of dry period lengths on the immune system. The high incidence of health problems during the transition period contributes to the variation in DMI, milk yield, and responses to imposed treatments (Drackley, 1999). However, our data showed that imposed treatments in this study (dry period lengths) had no effect on health problems and metabolic disorders.

Our data are consistent with Watters et al. (2009) that reported there is a significant difference in days to first ovulation between treatments. However, our results are in contrast to De Feu et al. (2009) and Grummer (2007) studies that showed reducing dry period increased fertility. Gumen et al. (2005) reported average diameter of follicles at first ultrasonography was greater ($p<0.05$) in no planned dry period (N) than in DP-56 cows (T), with no significant difference between DP-56 and DP-28 (S) cows. They reported also that average days from calving until first detection of a 10 mm follicle were less ($p<0.05$) in N and S than T cows. Our data are consistent with Watters et al. (2009) who reported there is no significant difference in days to first AI between 34-d dry period and DP-55 cows. However, our results are in contrast to Pezeshki et al. (2007) report that reducing dry period improved reproductive measures such as days open, days to first AI and number of services per conception; despite that the milk production in the two studies are similar, the reason for lower reproductive efficiency in DP-20 cows in our study was due to a decrease in circulating NEFA concentrations in this treatment (De Feu et al., 2009).

Lotan and Adler (1976) and Annen et al. (2004) reported apparently similar services per conception between cows with traditional (60-d) and shortened (30) dry periods but they did not make statistical comparisons. There is considerable evidence that increasing the number of estrous cycles before breeding is correlated with a decrease in services per pregnancy, indicating that earlier onset of first ovulation may increase reproduction efficiency (Thatcher and Wilcox, 1973; Lucy et al., 1992; Darwash et al., 1997). Indeed Darwash et al. (1997) reported that increasing days to first postpartum ovulation reduced fertility and increased days to pregnancy. Also Lucy et al. (1992) observed that when the postpartum day to first ovulation was less than 42 days, services per pregnancy were less than if it was greater than 42 days. In contrast, some researchers have reported reduced conception rate in cows having early postpartum ovulation (Ball and McEwan, 1998; Smith and Wallace, 1998) or no detectable relationship between early luteal activity and fertility (Royal et al., 2000).

CONCLUSIONS

This study suggests that shortening the dry period from 60 to 20 days has a negative effect on milk production, however, milk SNF, protein and lactose percentage increased. Shortening DP length to 20 d had no negative influence on BW, BCS, BUN, GOT and Glucose but NEFA, BHBA, complete blood count and the immune system were affected by dry period length. Reduced dry period had no effect on days postpartum to first ovulation and number of follicles; however the follicular diameter was affected. Follow-up research should be done to study the effect of short dry periods on long-term health and longevity in the herd.

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