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Dry Period in Cattle: I. Influence on Milk Yield and Reproductive Performance

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ABSTRACT
Purpose of this study was to investigate the relations of dry period lengths (DPL) with subsequent lactation (305-d) milk yield (MY) and reproductive performance of Holstein cattle. Data were obtained from 800 Holstein cows raised in a private dairy operation and which were in different parity (2nd, 3rd and ≥4th). DPL was classified in 5 categories as; ≤40, 41-50, 51-60, 61-70 and ≥71 days. The differences in lactation milk yields of experimental DPL groups were not significant. The highest MY (7808.6±135.1 Lt) was obtained from ≥71 days DPL group and the lowest MY (7529.4±159.8 Lt) was obtained from ≤40 days DPL group. DPL had significant effect on the number of inseminations resulted in pregnancy (P<0.01). The greatest pregnancy ratio (53.0%) in the first insemination was obtained from ≤40 days DPL group and the lowest pregnancy ratio (30.8%) was obtained from 61-70 days dry period group. There was a positive correlation (0.056) between DPL and 305-d MY and a highly significant positive correlation (0.141) between DPL and the number of insemination resulted in pregnancy. Present findings revealed that longer DPL might have positive effects on lactation MY, but shorter DPL practices might have better outcomes for pregnancy ratios of the first insemination for this farm.

Keywords: Dairy cattle; Dry period length; Herd management; Milk yield; Reproductive performance

1. Introduction

Herd management practices together with recent developments in dairy cattle genetics increased milk yield (MY) per cattle (Bachman & Schairer 2003). Dry Period Length (DPL) has significant effects on MY. DPL plays an important role in regeneration of old mammary epithelium cells and increases mammary gland epithelium cell components for the next lactation (Capuco et al 1997). As a common herd management practice in several dairy operations, DPL is usually applied as between 51 and 60 days (Bachman & Schairer 2003). This duration is sometimes practiced as between 40 and 60 days. However, previous researches indicated that DPL of less than 40 days reduced MY of subsequent lactation by 10-30% (Annen et al 2004). In case MY was sustained after a shorter dry period than the current standard dry period, then such a standard period may loss the validity (Bachman & Schairer 2003). While no yield losses were reported for dairy cattle with dry periods shorter than 30 days in a study (Annen et al 2004), lower lactation performance values were reported for the cows with shorter dry periods than the cows with a normal standard (conventional) dry periods in another study (Atashi et al 2013).

Reproductive performance (RP) of dairy cattle is also influenced by DPL. However, genetic factors, management and feeding practices are the primary factors influencing RP of cattle (Beever 2006). Dairy facilities can develop alternative management strategies to improve reproductive efficiency of the dairy cattle. Elimination of long dry periods or shortening these periods may improve RP and thus improve energy balance of the organism (Grummer 2007). Following the parturition, a negative energy balance is developed in dairy cows and losses are observed in body condition to support the milk synthesis. With the alternative management systems, such losses can be prevented in

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prenatal dry period and early postnatal period (de Feu et al 2009). Shortened dry periods have recently attracted the attentions of dairy operations. However, effects of this management practice on RP of the cattle haven not been well elucidated, yet (Gumen et al 2005). The studies carried out to determine minimum DPL were mostly included visual data and retrospective analyses (Bachman & Schairer 2003).

In the present study, the effects of different DPL on subsequent lactation MY and RP of 800 Holstein cow at different parities were investigated.

2. Material and Methods

Data obtained from a commercial dairy farm were used in the study thus measurement of phenotypic characteristics was performed under the routine management and breeding procedure for cattle at farm, no animal experiment and additional handling was involved in the study. Therefore, no ethics approval was necessary.

In the study, data obtained from dairy cattle raised in an intensive commercial dairy breeding operation located in Central Anatolia region of Turkey (Latitude:38°.34’66.79, Longitude: 35°.47’84.66) were used. Data were gathered for 800 heads Holstein cow at different parity (2nd, 3rd and ≥4th). The cattle used in the present study did not have clinical mastitis symptoms and milk from these cattle had somatic cell counts (SCC) of<250.000 cell mL^{-1}. Parities and calving body weights (kg) of multiparous cattle used in this study are provided based on DPL in Table 1.

Table 1- Parities and calving body weights (kg) of multiparous cattle based on dry period length

Lactation	*Dry period length (days)*											
	≤40 (days)		*41-50 (days)*		*51-60 (days)*		*61-70 (days)*		*≥71 (days)*		*General*	
	n	*BW (kg)*	*n*	*BW (kg)*	*n*	*BW (kg)*	*n*	*BW (kg)*	*n*	*BW (kg)*	*n*	*BW (kg)*
2	30	613	47	610	106	597	33	579	15	614	231	603
3	34	609	58	627	156	613	84	623	72	609	404	616
≥4	19	617	23	616	65	600	29	604	29	617	165	611
General	83	613	128	618	327	603	146	602	116	613	800	610

BW, body weight (kg)

The procedure for drying off the cows were carried out by reducing the number of daily milking frequency of 3 gradually to 2 and 1 when the daily milk yield of the cattle decreased to 10 liters (10 Lt/cow) or below. The time between full termination of milking and parturition was monitored as dry period. Mastitis checkups (California Mastitis Test) were conducted and dry period antibiotics (Benzathine Cloxacilin) were administered to the cows. A special feeding was not practiced, all cattle were fed with rations suitable for their physiological stages. Cattle were fed after each milking and 3 times in a day with TMR (Total Mixed Ration) to meet their pregnancy, yield and maintenance requirements (NRC 2001). Composition of TMR given to the cows at dry period and different stages of lactation, is provided in Table 2.

Water was provided *ad libitum*. Cows were housed in partially open sheltered barns from drying off to parturition. Then, the ones showing parturition symptoms were taken into the parturition rooms and the parturition was performed. Lactation started right after parturition. Cows were milked 3 times in a day (at 07:00, 15:00 and 23:00). Milk yields of the individual cows were recorded with computerized herd management system and the total lactation period was considered as 305 days.

Animal health was inspected daily by the veterinarian of the dairy operation and health monitoring records were kept for each animal.

Following the parturition, vaginal secretion-mucous, uneasiness, hyperactivity, frequent roaring and etc. estrous symptoms were observed in every 12 hours (morning/evening) and monitored through pedometer data in a computer. Almost of all 800 cows presented estrous symptoms (visual symptoms+pedometer data) on average 50 days after parturition (45-55 days) and their first insemination (artificial insemination) was performed. Pregnancy tests were carried out 70 days after insemination through rectal palpation. Health inspections were performed for non-pregnant cows and insemination was repeated at next estrous.

Table 2- Composition and nutrient contents of TMR given to cows at dry periods and different stages of lactation

Physiological stage	*Dry period 1*	*Dry period 2*	*Early lactation*	*Milk yield*	
	Drying of 20 days ahead of parturition	*20 days to parturition-parturition*	*Initial 30 days of lactation*	*> 25 Lt*	*< 25 Lt*
Concentrate feed[1], kg	1.5	3	0	0	0
Concentrate feed[2], kg	0	0	8	8	4.5
Maize silage, kg	5	7	18	20	20
Dry alfalfa fodder, kg	2	2.5	4	2	2
Dry vetch fodder, kg	1	2.5	0	0	0
Kernel corn, kg	1	2	4	5	4
Vetch silage, kg	3	0	0	0	0
By-pass fat, kg	0	0	0.4	0.5	0.1
Malt pulp, kg	0	0	3	4	4
Propylene Glycol, kg	0	0.2	0.4	0	0
Alfalfa silage, kg	2.5	0	0	1	2
Hay, kg	2	0	0	0	0
Total[3], kg	18	17.2	37.7	40.5	36.6
Composition[4]	*Dry period 1*	*Dry period 2*	*Early lactation*	*MY > 25 Lt*	*MY < 25 Lt*
Roughage, DM%	22.4	39.5	46.2	48.1	37.3
Concentrate feed, DM%	776	60.5	35.8	51.9	62.7
Dry matter, kg	9.9	11.2	23.1	23.9	20.1
Crude protein, DM%	10.3	12.2	13.5	13.4	13.2
ME, Mcal kg^{-1} DM	2.1	2.4	2.5	2.5	2.4

[1], 2750 Kcal kg^{-1} ME and 16% CP; [2], 2750 Kcal kg^{-1} ME and 16% 25; [3], Ca, P, K, NaCl, trace elements and vitamins A, D, and E were supplemented at concentrations to meet or exceed NRC recommendations; [4], contents calculated based on analysis results; DM, dry matter; ME, metabolic energy; CP, crude protein; MY, milk yield

Statistical analyses were performed with IBM SPSS Statistics 22.0 software. The 305-day milk yield was tested by taking the Least Square Means into consideration in accordance with General Linear Model procedure and results were presented in means ± standard error. The fallowing model is used;

$$Y_{ijklm}= \mu + a_i + b_j + c_k + d_l + e_{ijklm}$$

Where; Y_{ijklm}, milk yield; μ, overal mean; a_i, treatment effects (DPL); b_j, parity (2, 3, ≥4); c_k, calving year (1-2); d_l, calving season (1, 2, 3, 4); e_{ijklm}, residual random errors.

In the model, the dependent variable was MY and independent variables (fixed effect) were DPL, parity, calving year and calving season.

The relationships between DPL and categorical variables (number of inseminations resulted in pregnancy) were tested with Pearson Chi-Square Test and the results were presented in number and ratio (n, %). Differences among the group means were assumed to be significant at P<0.05. Also, the correlations among DPL, lactation (305 days) milk yield and number of insemination ended up with pregnancy (1st, 2nd and ≥3rd) parameters were calculated with SPSS (2013) software.

3. Results and Discussion

The relationships between DPL and subsequent lactation (305-d) milk yield (MY) based on parities are provided in Table 3. Lactation MY of the dry period groups did not differ (P>0.05). Considering the general results (Table 3), the greatest milk yield (7808.6±135.1 Lt) was obtained from ≥71-day dry period group and the lowest milk yield (7529.4±159.8 Lt) was obtained from ≤40-day dry period group. The cows with ≤40-day dry period had an average of 279 Lt less milk yield than the cows with ≥71-day dry period.

Table 3- The relations of DPL with lactation MY (305-d)

Parity	*Dry period length (days)* ≤40 (n= 83)	41-50 (n= 128)	51-60 (n= 327)	61-70 (n= 146)	≥71 (n= 116)	Total	*Fixed Factors* Calving year	season	Parity
	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$			
	Lactation milk yield (Lt)								
2	7380.6±257.3	7558.4±205.6	7422.2±136.9	7745.5±245.3	7822.5±363.9	7585.7±113.1			
3	7543.6±251.7	7732.1±192.7	7782.9±117.5	7694.6±160.1	7885.6±173.0	7727.8±82.4			
≥4	7741.3±342.6	7577.2±311.4	7331.3±185.2	8019.5±277.3	7609.9±277.3	7655.8±126.9			
General	7529.4±159.8	7640.5±128.7	7576.2±80.5	7770.6±120.5	7808.6±135.1	7665.9±57.0	**	**	ns

**, P<0.01; ns, not significant

The reason for low milk yield in cows with short DPL may be due to less number of breast epithelial cells in these cows. Because, the DPL provides an opportunity to repair the damage to the mammary gland of the cow, the cells of both the alveolar and canal system, and the damage to the lactation period. Cows store mineral and vitamin for the next lactation during dry period, mammary epithelial cells are rested and prepared for lactation period. Dry period was necessary to replace mammary epithelial cells, thus providing one biological basis for the lower milk yield that has been observed with shortened dry periods.

It is commonly estimated that a two month dry period provides a complete regeneration of udder glandular tissue and is favorable for the high production in the forthcoming lactation (Annen et al 2004; Andersen et al 2005). However, more controlled studies are warranted to examine cellular mechanisms that are involved in this process.

In a similar study, van Knegsel et al (2014) reported that the cows with 0 and 30-day dry periods had less milk yield than the cows with 60-day dry period. Similarly, Pezeshki et al (2008) indicated the reasons for less milk yield of the cows with shorter dry periods (≤40 days) as the differences in endocrine systems, decrease in number of mammary epithelium cells and recession in mammary epithelium functions. However, there is still a need for further studies to investigate mammary cell mechanisms in detail. Some other previous researchers also assessed the negative effects of short dry periods on lactation MY (Pezeshki et al 2007; Pezeshki et al 2008; Watters et al 2008; Bernier-Dodier et al 2011). However, different from these studies, Gulay et al (2003) and Jolicoeur et al (2009) investigated the effects of shorter and longer dry periods on MY and indicated that short duration of dry periods could reliably be practiced without significant losses in subsequent lactation MY. In present study, DPL had no effect on milk yield of the cows in their 2nd, 3rd and ≥4th lactations, were not found to be significant. Santschi et al (2011a) in a previous study with Holstein cows applied different DPL (35 and 60 days) and reported that while the effects of DPL on lactation MY were not significant in ≤3rd lactation cows, effects of dry periods on MY of 2nd lactation cows were significant. Researchers (Santschi et al 2011a), also reported significantly reduced milk yield for 35-day dry period.

There is limited published research on the effect of DPL on reproduction and fertility. In the present study, the relationships between DPL and number of inseminations resulted in pregnancy were also investigated. The results for such relations are provided in Table 4. The results were not significant in the 2nd and ≥4th lactations, but significant in the 3rd lactation (P<0.01). The general results including together assessment of 2nd, 3rd and ≥4th lactations were also significant (P<0.01) and such significance was mainly resulted from the 3rd lactation. According to general results, the highest pregnancy ratio in the first insemination (53.0%) was obtained from ≤40-day dry period group and the lowest value (30.8%) was obtained from 61-70-day dry period group.

The shortening or complete removal of the dry time will probably reduce the energy spent on milk production with a decrease in milk yield and may lead to an increase in reproductive efficiency. Generally, the ration is changed in dry time of cows and dry matter consumption is reduced. However, the consumption of dry matter consumed increases when dry time is shortened. As a result, this situation is positively reflected on reproductive activities.

The highest pregnancy ratios in the 1st insemination for on 2., 3. and ≥4 lactation cows were obtained from ≤40-day (56.7%), 41-50 (43.1%) and ≤40-day (68.4%) dry periods cows, respectively. However the lowest pregnancy ratios in the 1st insemination for on 2., 3. and ≥4 lactation cows were obtained from ≥71-day (40.0%), 61-70-day (55.2%) and ≥71-day (55.2%) dry periods cows, respectively.

Table 4- The relations of DPL with number of insemination ended up with pregnancy

Parity	*Number of Insemination*	*Dry period length (days)* ≤40 (n= 83) n (%)	41-50 (n= 128) n (%)	51-60 (n= 327) n (%)	61-70 (n= 146) n (%)	≥71 (n= 116) n (%)	*Total* n (%)	
		Number and ratio of pregnant animals (n (%))						
2	1	17 (56.7)	24 (51.1)	52 (49.1)	14 (42.4)	6 (40.0)	113 (48.9)	
	2	7 (23.3)	11 (23.4)	22 (20.8)	7 (21.2)	5 (33.3)	52 (22.5)	
	≥3	6 (20.0)	12 (25.5)	32 (30.2)	12 (36.4)	4 (26.7)	66 (28.6)	
Total		30 (100)	47 (100)	106 (100)	33 (100)	15 (100)	231 (100)	
3	1	14 (41.2)	25 (43.1)	37 (23.7)	15 (17.9)	18 (25.0)	109 (27.0)	**
	2	12 (35.3)	15 (25.9)	73 (46.8)	38 (45.2)	22 (30.6)	160 (39.6)	
	≥3	8 (23.5)	18 (31.0)	46 (29.5)	31 (36.9)	32 (44.4)	135 (33.4)	
Total		34 (100)	58 (100)	156 (100)	84 (100)	72 (100)	404 (100)	
≥4	1	13 (68.4)	14 (60.9)	39 (60.0)	16 (55.2)	16 (55.2)	98 (59.4)	
	2	5 (26.3)	7 (30.4)	13 (20.0)	9 (31.0)	6 (20.7)	40 (24.2)	
	≥3	1 (5.3)	2 (8.7)	13 (20.0)	4 (13.8)	7 (24.1)	27 (16.4)	
Total		19 (100)	23 (100)	65 (100)	29 (100)	29 (100)	165 (100)	
General	1	44(53.0)	63(49.2)	128(39.1)	45(30.8)	40(34.5)	320(40.0)	
	2	24(28.9)	33(25.8)	108(33.0)	54(37.0)	33(28.4)	252(31.5)	**
	≥3	15(18.1)	32(25.0)	91(27.8)	47(32.2)	43(37.1)	228(28.5)	
Total		83 (100)	128 (100)	327 (100)	146 (100)	116 (100)	800 (100)	

**, P<0.01

It can be recommended based on these results that ≤40-day dry period should be practiced for cows in their 2nd and ≥4th lactations and 41-50 days dry period should be practiced for the cows in their 2nd lactation. There are quite a few studies investigating the relations between DPL and number of inseminations. Different from the present findings, in a study investigating the effects of DPL on RP of dairy cattle, Pezeshki et al (2008) reported that there were no significant differences in RP of different dry periods. Researchers reported pregnancy ratios of 28 and 49-d dry periods respectively as 66.91 and 62.34%. In a similar study, Santschi et al (2011b) indicated that dry period treatments did not have significant effects on pregnancy ratios of the 1st and 2nd inseminations. Hossein-Zadeh & Mohit (2013) reported that the cows with short dry periods had shorter calving interval than the cows with long dry periods. Similar to the results of this study, Kuhn et al (2007) and Watters et al (2009) indicated an improvement in reproductive performance of Holstein dairy cattle when dry period length was reduced. Re´mond et al (1992) reported similar results for number of cows resulted in pregnancy after the 2nd insemination for two different groups (0 days dry period and 60 days dry period), but the researchers also pointed out quite a few number of animals included in their study.

The traits considered in this study were DPL, lactation (305 days) milk yield and number of insemination ended up with pregnancy (1st, 2nd and ≥3rd). Among these traits correlation coefficients are provided in Table 5.

Table 5- Correlations among DPL, 305-d MY and number of inseminations ended up with pregnancy

	DPL	305-d MY
DPL	1	
305-d MY	0.056	1
Number of Insemination	0.141**	0.024

**, P<0.01

There was a positive correlation between DPL and 305-d MY (0.056) and there was a highly significant positive correlation between DPL and number of inseminations ended up with pregnancy (0.141). There was also a positive correlation between 305-d MY and number of inseminations ended up with pregnancy (0.024).

4. Conclusions

As conclusions, the present findings revealed that DPL did not have significant effects on subsequent lactation MY. However, quantitative decreases were observed in lactation MY with shortening DPL. Dry period lengths on the other hand had significant effects on the number of inseminations ended up with pregnancy. Decreasing number of inseminations ended up with pregnancy were observed with shortening dry period durations for this farm. This research is one of the few studies to examine DPL effects on subsequent lactation, for traits other than MY, and in particular percentage traits and reproduction.

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Abbreviations and Symbols	
DPL	Dry period lengths
BW	Body weight
DM	Dry matter
HP	Crude protein
kcal	Kilocalories
kg	Kilogram
Lt	Liter
ME	Metabolic energy
mL	Mililiter
MY	Milk yield
SA	Siyah Alaca
SCC	Somatic cell counts
TMR	Total mixed ration

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