

Original study

Dry period length in Montbéliarde cows and its association with selected production and functional characteristics

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Abstract

The study evaluated the effects of selected factors (dry period number, milk yield in standard lactation and length of full lactation) on the length of dry periods. The effect of dry period length on milk yield and composition, the frequency of milk samples with different somatic cell counts (SCC) and the course of lactation were also analysed. The study included 491 cycles (dry period and lactation) and 4998 results of test-day milking conducted in a herd of 230 Montbéliarde cows. The cows were kept in a free-stall barn and fed total mixed rations (TMR). The average length of the dry period was found to be 85 days. The first dry period was 34-45 days longer than subsequent ones, which may have been due to the cows becoming acclimated after having been brought to the farm as in calf heifers. Increasing milk yield in standard lactation was accompanied by significantly shorter dry periods. The most beneficial dry periods in terms of milk yield were those lasting 22-41 days. The lowest yield was noted in lactations preceded by a dry period reduced to 0-21 days. However, this milk contained the most fat, protein and dry matter and the SCC did not exceed 400 000 cells/ml in 73.3% of cases. The decrease in daily milk yield from its peak in the 2nd month to the 10th month after calving was smallest in cows with dry periods of 57-84 days, which may suggest that lactations in these cows were the most persistent.

Keywords: Montbéliarde cows; dry period; milk yield and composition; course of lactation

Abbreviations: SCC: somatic cell count, TMR: total mixed rations

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Introduction

During the dry period, epithelial cells in the mammary gland, associated with milk yield in the following lactation, are replaced (Capuco *et al.* 1997, Annen *et al.* 2004, Church *et al.* 2008). This appears to be the main reason for looking for a connection between dry period length and milk yield in the subsequent lactation. Studies conducted in dairy cow populations indicate that the most beneficial length for the dry period in terms of milk yield in the following lactation is 40-60 days (Kuhn *et al.* 2005, Borkowska *et al.* 2006, Janus & Borkowska 2010, Sawa *et al.* 2012a, 2012b) or 60-90 days (Węglarzy 2009). Kuczaj *et al.* (2009) demonstrated that the most suitable dry period length is about 6 weeks. These studies indicated that both shortening and lengthening of the dry period were harmful as was the lack of a dry period. Sorensen & Enevoldsen (1991) found that reducing the dry period from 10 or 7 weeks to 4 weeks led to a loss in milk yield in dual-purpose Danish cows. Gulay *et al.* (2005) found no evidence that shortening the dry period to 30 days reduced milk production in the following lactation. Rémond & Bonnefoy (1997) demonstrated that the milk yield in the second and third 300-day lactation in cows milked without drying off was similar to that of cows dried off for 7 weeks before calving.

In recent years, there has been increasing interest in Montbéliarde cattle in Poland, a dual-purpose breed from France. Its coloration is red and white, with a characteristic white head and white stripe on the side and rump. According to the French standard, the cattle should be of high calibre with a body weight reaching 650-800 kg for cows and 1 000-1 200 kg for bulls (Trela 2003). The popularity of this breed is due to such traits as high milk production, high content of protein and fat, good fertility, longevity (24% of cows live for 5 lactations) and easy calving (Trela 2003, Walsh *et al.* 2008, Koç 2011). The composition of the milk (high frequency of kappa-casein variant B) makes it suitable for the production of high-quality cheeses (Agabriel *et al.* 2001, Martin *et al.* 2009). Cattle of this breed are also distinguished by their meat performance (Chládek *et al.* 2005, Gołębiewski & Brzozowski 2011). Slaughter performance ranges from 52 to 60% and the carcasses have a low fat and bone content. The breed is considered to be very healthy and resistant to changes in climate. A study by Walsh *et al.* (2007) found a lower SCS of Montbéliarde breed compared to Holstein-Friesian cows. Koç (2011) showed that Montbéliarde cows had a SCC that was 60 378 cells/ml lower than that of the Holstein-Friesian cows. The environmental requirements of Montbéliarde cattle are considerably lower than those of other breeds, including Holstein-Friesians. Moreover, the animals are calm, trusting, have a gentle temperament and rarely exhibit nervous behaviour (Trela 2003).

The first heifers of this race arrived in Poland in 1995 and herd books for Montbéliarde cattle were opened in 2001. The average effective population size of cows of this breed was 1888 in 2011 with an average milk yield of 7 093 kg containing 3.97% fat and 3.43% protein (PFCB&DF 2012). Studies have shown that Montbéliarde cows in Poland have high production capacity, while their milk has a good chemical composition and high cytological quality (Borkowska & Janus 2010, Janus & Borkowska 2011, Kuczyńska *et al.* 2012). A study by Gołębiewski & Brzozowski (2009) showed that Montbéliarde heifers attained reproductive maturity considerably later than Polish Holstein-Friesian heifers. The average first calving age was 912 in Montbéliarde heifers compared to 837 days in Polish Holstein-Friesian

heifers. Moreover, the authors found that reproduction parameters (services per conception, service period, length of the interval between services, calving-to-first-service interval and calving-to-conception interval) in Montbéliarde cows were comparable to those of Polish Holstein-Friesians. Due to their calmer temperament, however, it can be more difficult to detect oestrus in this breed. The undeniable assets of the Montbéliarde breed have made it increasingly popular. Due to the increasing population of Montbéliarde cattle in Poland, it seems essential to conduct research on various aspects of their performance.

The aim of the study was to analyse the effect of selected factors on the length of the dry period in Montbéliarde cows. The association of dry period length with milk yield and composition after the next calving, somatic cell content in the milk and the course of lactation were also evaluated.

Material and methods

The results of a use value assessment conducted in a herd of Montbéliarde cows were used for the study. The herd, which belonged to MONTAGRO sp. z o.o., was located in the village of Wierzbica in the Tomaszów Lubelski district in Poland. In 2011, the farm had about 248 cows with an average annual milk yield of 9 782 kg (3.36% fat and 3.49% protein; PFCB&DF 2012). The cows were kept in a free-stall barn on deep litter and fed total mixed rations (TMR). The analysis included 491 cycles (dry period and lactation) and 4 998 results of test-day milking from the years 2006-2011. Dry period length for individual cows was calculated based on dates of dry periods and subsequent calvings taken from breeding documentation. Five groups were distinguished based on the dry period's length: 0-21, 22-41, 43-56, 57-84 and over 84 days.

Variance analysis (PROC GLM) with SAS 9.1 (SAS Institute Inc., Cary, NC, USA) was used to evaluate the effect of dry period number (1, 2, 3, 4), milk yield (kg milk) in standard lactation preceding the dry period (up to 7 000, 7 001-8 500, 8 501-10 000, >10 000) and length of complete lactation (up to 305 days, 306-365, 366-455, >455 days) on dry period length. Variance analysis was also used to evaluate the effect of different dry period lengths on milk yield (kg in complete lactation and per day in standard and complete lactation), milk composition and the course of lactation. Significance of differences was determined using Duncan's test. The χ^2 test of independence was used to analyse the frequency of samples with different SCCs (up to 100 000, 101 000-400 000, 401 000-1 000 000 and >1 000 000 cells/ml) depending on dry period length.

Results and discussion

The average length of the dry period in the cow herd analysed was 85 days (Table 1). A high degree of variability in dry period length was noted as the standard deviation averaged 64 days. Factors found to significantly affect dry period length were dry period number and milk yield in standard lactation. The first dry period was 34-45 days longer than subsequent ones. The prolonged first dry periods may have been due to the cows becoming acclimated after having been brought to the farm as in calf heifers. The shortest average length was calculated for the dry period following the fourth calving. This, however, occurred in the case of only 18

cows. Behmaram & Aslaminejad (2010) showed that the longest dry periods occurred after the first calving (on average 76 days). These were 4-21 days longer than subsequent periods between lactations. However, these differences were statistically insignificant. In a study by Vaněk (2004), the average length of the rest period was in the range of 72.34 to 77.18 days. Sawa *et al.* (2012b) found that longer dry periods (particularly the first) significantly decreased the percentage of cows that survived the next lactation.

Table 1
Dry period length in Montbéliarde cows taking into account the effect of the factors analysed

Factor		Number of periods	Dry period length (days)	
			Mean	SD
Dry period number	1	221	104 ^A	80
	2	156	70 ^B	36
	3	96	70 ^B	50
	4	18	59 ^B	24
Milk yield in standard lactation, kg	up to 7,000	149	119 ^A	81
	7,001-8,500	144	81 ^{Ba}	60
	8,501-10,000	96	64 ^{Bcb}	37
	>10,000	102	60 ^C	30
Duration of lactation, days	up to 305	113	86	65
	306-365	189	77	67
	366-455	106	93	68
	>455	83	91	46
Total and average		491	85	64

Mean values within a factor designated with different letters differ significantly: capital letters – at $P \leq 0.01$; lower case letters – at $P \leq 0.05$

It is commonly known that selection for increased milk production is connected with unfavourable reproduction and health disorders. It also causes a decline in functional traits (Vaněk 2004, Vacek *et al.* 2007, Ptak *et al.* 2011). In the own studies, increasing milk yield in standard lactation was accompanied by a significant decrease in dry period length (119, 81, 64 and 60 days). A significant association between milk yield in standard lactation and dry period length was observed in another study by Janus & Borkowska (2010), conducted in a population of Black-and-White Polish Holstein-Friesian cows. However, the shortest dry period was associated with average milk yield in standard lactation.

Prolonged lactation was not accompanied by significant changes in dry period length. The shortest dry period (77 days) was observed in the case of lactations lasting from 306 to 365 days, while the longest (93 days) was noted for lactations of 366-455 days.

The data in Table 2 show that the most frequently represented ones were dry periods lasting 42-56 days (29.3%) and the longest dry periods (>84 days – 30.8%). In 3.3% of cases, lactations were not preceded by a dry period or the preceding dry period was not longer than 21 days. The most beneficial dry periods in terms of milk yield, both from calving to drying off and per day of standard lactation and complete lactation, were those lasting 22-41 days. The lowest milk yield was noted in the case of dry periods of 0-21 days. The differences between these two groups (*i.e.* dry periods of 22-41 and 0-21 days) were 2 679 kg

for milk yield per lactation and 5.8 and 4.4 kg in the case of milk yield per day of standard and complete lactation, respectively. In a study by de Feu *et al.* (2009), the lack of a dry period was associated with lower milk yield in the first twelve months after calving and a negative effect of continuous milking on milk yield in the early lactation period was noted by Andersen *et al.* (2005). According to Pinedo *et al.* (2011), dry periods that were too short (0-30 days) or prolonged compared to those lasting 53-76 days had a negative effect on milk yield both in the early lactation period and over the course of 305 days. Sawa *et al.* (2012a) found that the cows whose calving was not preceded by a dry period had lower lactation yield, lower daily milk yield and also gave birth to dead calves more frequently. Andersen *et al.* (2005) observed a significant decrease in milk yield in the case of continuous lactation but also a significant increase in milk protein content. Watters *et al.* (2008) noted higher daily yield both up to the 100th day and up to the 300th day of milking in cows that calved following a dry period lasting on average 55 days (43.6 and 39.5 kg, respectively) than in the case of dry periods of 34 days (41.5 and 37.7 kg). Rastani *et al.* (2005) also noted that yield was lowest in lactations following a shortened dry period.

Table 2
Duration of lactation and milk yield in Montbéliarde cows following dry periods of different lengths

Dry period length, days	Dry periods		Duration of lactation, days	Milk yield during lactation, kg	Milk yield, kg per day of lactation		Content in milk, %		
	N	%			standard	complete	fat	protein	dry matter
0-21	16	3.3	324 ^a	9 117 ^{Aa}	29.4 ^{Aa}	28.3 ^A	4.24	3.66 ^a	13.41
22-41	55	11.2	365 ^b	11 796 ^{Bb}	35.2 ^{Bb}	32.7 ^{Ba}	4.08	3.61	13.18
42-56	144	29.3	343	10 468 ^c	32.2 ^c	30.6	4.13	3.60	13.19
57-84	125	25.5	357	10 628 ^{bc}	31.8 ^c	29.7 ^b	4.15	3.57 ^b	13.21
>84	151	30.8	352	10 375 ^c	31.4 ^B	29.5 ^b	4.16	3.62	13.29
Total and average	491	100.0	351	10 584	32.1	30.2	4.14	3.60	13.23

Mean values in the columns designated with different letters differ significantly: capital letters – at $P \leq 0.01$; lower case letters – at $P \leq 0.05$

Milk obtained in lactations that began after a dry period lasting 0-21 days contained significantly ($P \leq 0.05$) more protein (by 0.09%) compared to milk obtained from cows that calved after a dry period of 57-84 days. No significant dependence was found between dry period length and the percentage of fat and dry matter in the milk but the highest percentages were noted in lactations that took place after the shortest dry periods (0-21 days). Rastani *et al.* (2005) noted significantly higher fat content (4.08%) in milk obtained during the early lactation period after a 28-day dry period compared to a dry period of 56 days (3.86%). This milk was also richer in protein (2.97 and 2.83%, respectively). Watters *et al.* (2008) noted higher protein content in cows whose dry period was shortened to 34 days compared with an average of 55 days (2.83 and 2.68%, respectively).

Dry period length was significantly ($P \leq 0.01$) associated with the frequency of different SCCs in the milk (Table 3). The results showed that a total of 3 568 milk samples, 71.4% of the samples analysed, contained up to 400 000 somatic cells in 1 ml of milk. The percentage of such samples was lowest (66.0%) in the case of dry periods of 22-41 days. In the case of

dry periods of 42-56 days, the frequency of samples with high cytological quality (*i.e.* up to 400 000 somatic cells in 1 ml of milk) was 69.4%. The highest percentages of such samples (73.5 and 73.4%) were noted in the case of dry periods of 57-84 days and >84 days. The highest percentage (21.0%) of milk samples with SCCs from 401 000 to 1 million was noted for dry periods of 0-21 days. The percentage of such samples ranged from 14.5% to 15.4% for different dry period lengths. Milk samples containing more than 1 million somatic cells per ml were most frequently noted (18.6%) in lactations preceded by a dry period of 22-41 days. The percentage of such samples decreased (to 15.3, 12.0% and 11.9%) as dry period length increased. Węglarzy (2009) noted the highest positive dependence between these parameters in the oldest cows (4th lactation or later). The association between dry period length and SCC in milk has been analysed in many studies (Rémond *et al.* 1997, Rastani *et al.* 2005, Watters *et al.* 2008) but the results are not unambiguous. Rémond *et al.* (1997) observed a tendency for SCC to increase in cows with a shorter dry period or no dry period but this increase was not associated with an increase in cases of clinical mastitis. According to these authors, milking cows continuously can reduce the number of cases of clinical mastitis by eliminating new infections associated with cessation of milking and drying off. Rastani *et al.* (2005) found that shortening of the dry period from 56 to 28 days was associated with reduced SSC. Watters *et al.* (2008) found that shorter dry periods were not associated with SSC during the first 100 days of lactation or with occurrence of mastitis within 300 days of lactation.

Table 3
Frequency of milk samples with different somatic cell counts following dry periods of different lengths

Dry period length, days	Number and % of milk samples with somatic cell count, 1,000/ml								Total	
	up to 100		101-400		401-1,000		>1,000		N	%
	N	%	N	%	N	%	N	%		
0-21	75	47.8	40	25.5	33	21.0	9	5.7	157	3.1
22-41	199	33.4	194	32.6	92	15.4	111	18.6	596	11.9
42-56	456	31.8	539	37.6	219	15.3	219	15.3	1 433	28.7
57-84	415	31.9	542	41.6	189	14.5	157	12.0	1 303	26.1
>84	554	36.7	554	36.7	221	14.7	180	11.9	1 509	30.2
Total	1 699	34.0	1 869	37.4	754	15.1	676	13.5	4 998	100.0

$\chi^2 = 62.9$ – test value significant at $P \leq 0.01$

In cows in which lactations were preceded by no dry period or by a dry period of no more than 21 days, the highest daily yield (38.4 kg) was noted as early as the first month of lactation (Figure 1). Peak daily milk yield in the remaining groups occurred in the second month after calving. It should be emphasized that the increase in daily yield between the first and second month was highest (3.5 kg) in the case of cows whose lactations were preceded by a dry period lasting 22-41 days. From months 1 to 10 of lactation the highest daily milk yield accompanied dry periods of 22-41 days, while the lowest was noted in the case of dry periods of 0-21 days. The differences between these groups (*i.e.* dry periods of 22-41 and 0-21 days) were statistically significant ($P \leq 0.01$) up to the 8th month after calving and ranged

from 9.2 kg (month 2) to 6.2 kg (month 8). Also, up to the 8th month after calving, milk yield in lactations not preceded by a dry period or preceded by a dry period of no more than 21 days was significantly ($P \leq 0.01$ and $P \leq 0.05$) lower than in the groups with dry periods lasting over 41 days. In month 9 of lactation the differences between groups did not exceed 4.6 kg and were statistically insignificant.

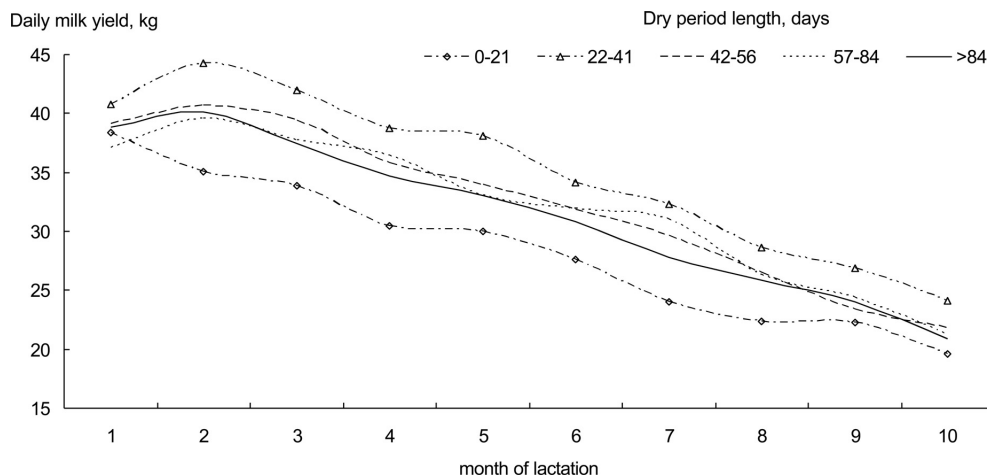


Figure 1
Daily milk yield during lactation in Montbéliarde cows following dry periods of different lengths

In the case of lactations preceded by dry periods of 22 days or longer, average milk yield per day decreased in successive months after the second month of lactation. The decrease in milk production from the peak of lactation to the 10th month after calving was greatest (20.2 kg) in cows that calved following a dry period of 22-41 days. The difference in daily milk yield between the 2nd and 10th month of lactation was 19.2 kg in cows that calved after the longest dry periods (>84 days) and 18.9 kg in the case of lactations following a dry period of 42-56 days. The smallest loss in production (by 18.3 kg) was noted after dry periods of 57-84 days. This may indicate that lactations in these cows were the most persistent as the decrease in daily yield in successive months after its peak is one of the indicators used in evaluating lactation persistency (Guliński *et al.* 2004). Watters *et al.* (2008) demonstrated that primiparous cows whose dry period was reduced, produced more milk than multiparous cows in the last 3 weeks of lactation (24.1 vs. 19.8 kg/d), which probably indicates greater lactation persistency. According to Grummer (2008), a suitable concentration of energy (1.56-1.69 MJ NEL/kg DM) in the feeding ration before calving is essential and a slightly different intake of dry matter and energy balance in cows with dry periods of different lengths may influence the lactation curve.

To sum up, the dry period in the herd analysed lasted 85 days in average. The first dry period was 34-45 days longer than subsequent ones, which could be due to the cows becoming acclimated after having been brought to the farm as in calf heifers. Increased milk yield in standard lactation was accompanied by significantly shorter dry periods. The most beneficial dry periods in terms of milk yield both from calving to drying off and per

day of standard and full lactation were those lasting 22-41 days. The lowest yield was noted in lactations preceded by a dry period reduced to 0-21 days. However, this milk contained the most fat, protein and dry matter and SCC did not exceed 400 000 cells/ml in 73.3 % of cases. The decrease in daily milk yield from its peak in the 2nd month to the 10th month after calving was smallest in cows with dry periods of 57-84 days, which may suggest that lactations in these cows were the most persistent ones. The results obtained can serve as guidelines in dairy cattle husbandry.

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