

## **THE EFFECT OF DRY PERIOD LENGTH ON THE COURSE OF MILK PRODUCTION OF POLISH HOLSTEIN-FRIESIAN VAR. BLACK-AND-WHITE COWS**

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**Abstract.** Based on the results of milk performance of lactating cows, 15 659 Black-and-White with varied addition of HF genes was evaluated in the course of lactation milk production depending on the length of the dry period before the full lactations investigated. Breast plotted curves according to selected groups of animals Wood's model. The average milk yield of ECM, the study population was: 6 573 kg of standard lactation and 7 063 kg in the lactation lasted an average of a full 352 days. It also showed that these cows, calving over the years 1995–2008 were marked by very high persistence of lactation. The average monthly decline in milk production after peak lactation was 3.52% (LPI = 31.7%). Of the four genetic groups rated highest in the persistence of lactation (the lowest rate of LPI) had a cow with the shortest period of the dry, less than 45 days in three groups of genes, Black-and-White animals which, in its genotype from 50.1 to 75% HF, from 75.1 HF to 99.9% and cows Polish Holstein-Friesian (100%). Monthly average daily milk yield decrease in ECM from 1 month of lactation, for these groups of animals ranged from 1.9% to 3.4%.

**Keywords:** dairy cattle, dry period, lactation curve, persistence of lactation

### **INTRODUCTION**

The course of lactation is a trait that reflects the reaction of cows to environmental conditions and depends on the basic reproduction indicators: calving-to-conception and calving intervals. A low heritability of lactation persistency ( $h^2 = 0.17$  [Strabel et al. 2001]) indicates an enormous effect of environmental factors on the shape of lactation curve. From a breeding point of view, cows should reach the peak of lactation fast, at high milk yield and then maintain it as long as possible at high level [Knight 2005]. Lactation is maintained by regular suckling or milking. Without these stimuli, secretion stops and the apoptosis of the existing secretory cells as well as cessation of the production of new ones occur [Wilde et al. 1999].

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For the normal functioning of the milk-producing cells in the udder, female must be effectively dried off approx. 45–60 days before the expected parturition. Temporary cessation of milk production is essential for the creation of conditions in an organism that are suitable for the fast growth of foetus, normal course of parturition and puerperal period as well as good fertility and high milk yield in a subsequent lactation [Malinowski 2006]. Dry period in the cow lasts for 40 to 60 days, ranging from 30 to 80 days [Athie et al. 1996, Bachman and Schairer 2003, Annen et al. 2004] and begins with the involution of glandular tissue [Malinowski 2006].

The aim of the study was the evaluation of an effect of dry period length prior to the evaluated lactation on the lactation curve shape in Black-and-White cows with different proportion of Holstein-Friesian genes.

## MATERIAL AND METHODS

The analysis involved the milk performance of 6 198 cows of the active breeding population calved between 1995 and 2008, kept in the area of the Węgrów administrative district (the Lublin Province). A total of 15 659 whole lactations were evaluated in terms of milk performance for the standard and whole lactation, whole lactation length, value of the lactation persistency index as well as the course of milk production in lactation depending on the dry period length prior to the evaluated lactation. The data on over half of the evaluated lactations (9691 lactations) were derived from the database of the SYMLEK system and concerned cows calved between 2004 and 2008.

In order to perform the analyses, cow population was divided into 4 animal groups depending on the dry period length: 1)  $\leq 45$  days; 2) 46–60 days; 3) 61–90 days and 4)  $\geq 91$  days. Moreover, the animals were divided according to the percentage of Holstein-Friesian genes into 4 genetic groups: 1)  $\leq 50\%$  HF; 2) 50.1–75.0% HF; 3) 75.1–99.9% HF; 4) 100% HF.

For a detailed description of the evaluated population of Black-and-White cows with different proportion of Holstein-Friesian genes, the actual milk yield with actual fat and protein content was converted into ECM containing 3.50% of fat and 3.20% of protein according to the formula [Bernard 1997]:

$$ECM \text{ (kg)} = (0.3246 \cdot \text{kg of milk}) + (12.86 \cdot \text{kg of fat}) + (7.04 \cdot \text{kg of protein}).$$

Lactation persistency was calculated as a percentage difference between daily ECM production (kg) at 10 months and that at 1 month of lactation, according to the following formula:

$$LPI = \frac{ECM_{10} - ECM_1}{ECM_1} \cdot 100,$$

where:

LPI – lactation persistency index, %,

ECM<sub>1</sub> – daily ECM yield (kg) at 1 month of lactation (peak of lactation),

ECM<sub>10</sub> – daily ECM yield (kg) at 10 months of lactation.

On the basis of the daily milk yields (test-day milkings) expressed as ECM (kg), lactation curves for the selected groups of animals were plotted. Mathematica software was used for plotting the course of milk production (lactation curves).

These curves were determined according to Wood's model [1969] of the following form:

$$y = a \cdot t^b \cdot e^{-c \cdot t}$$

where:

y – milk yield at day in milk t,

a, b, c – function parameters,

e  $\approx$  2.71 – the basis of the exponential function.

In the statistical analysis, the two-way analysis of variance with least squares method was used. The significance of differences was tested with Duncan's test at  $P \leq 0.01$  and  $P \leq 0.05$ . The statistical analysis of results was performed using the SAS statistical package.

## RESULTS AND DISCUSSION

On the basis of the data presented in Table 1, the statistically significant effect ( $P \leq 0.01$ ) of dry period length on the examined milk performance traits was found. The mean ECM yield obtained from 15 659 lactations was 6 573 kg in the standard lactation and 7 063 kg in the whole lactation lasting, on average, for 352 days. It was also shown that the examined population of cows calved between 1995 and 2008 was characterized by very high lactation persistency. The mean monthly decrease in milk production after the peak of lactation was 3.52% (LPI = 31.7%).

A detailed analysis of the results presented in Table 1 justifies the statement that the biggest effect of dry period length on the milk yield and the course of its production was visible in a group of Black-and-White animals with the lowest proportion of Holstein-Friesian genes (up to 50%). The highest ECM yield for the 305-day lactation (8 346 kg) was obtained by pure-bred Polish Holstein-Friesian cows of Black-and-White variety, whose dry period length was between 61 and 90 days. The highest yield of milk (10 002 kg) containing 3.50% of fat and 3.20% of protein for the whole lactation lasting for 394 days was characteristic of pure-bred Polish Holstein-Friesian cows but with the shortest dry period lasting less than 45 days. However, the differences within this genetic group depending on the dry period length were not statistically significant.

The results of many studies [Annen et al. 2003, Fernandez et al. 2003, Gulay et al. 2003a, b, Pytlewski et al. 2009] show that cows dried off approx. 60 days before calving produce more milk in a subsequent lactation than those dried off between 30 and 40 days. The highest milk yield in the study by Pytlewski et al. [2009] was obtained from Polish Holstein-Friesian cows of Black-and-White variety dried off 50–70 days before calving. Also from the research conducted by Soleimani et al. [2010] on the evaluation of an effect of the dry period length on the yield and composition of milk obtained from 29 Holstein cows, it appears that the cows dried off 60 days before subsequent lactation were characterized by the highest daily yield until 60 days after calving.

Table 1. Characteristics of milk performance of Polish Holstein -Friesian cows variety of black and white depending on the length of the dry period

Tabela 1. Ogólna charakterystyka użyteczności mlecznej krów rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej w zależności od długości okresu zasuszenia

Dry period length, days Długość okresu zasuszenia, dni	Genotype, % HF Genotyp, % hf				Total / average Razem/ średnia
	≤ 50	50.1–75	75.1–99.9	100	
Number of lactation – Liczba laktacji					
≤45	1 265	532	881	150	2 828
46–60	2 224	1 016	1 634	250	5 124
61–90	2 597	1 129	1 628	231	5 585
≥91	1 089	382	577	74	2 122
Total Razem	7 175	3 059	4 720	705	15 659
ECM milk yield in 305-day lactation, kg Wydajność mleka ECM za laktację 305-dniową, kg					
≤45	5 907 <sup>ab</sup>	6 503	7 007	8 181	6 542 <sup>AB</sup>
46–60	6 060 <sup>a</sup>	6 744	7 046	8 110	6 663 <sup>A</sup>
61–90	5 985 <sup>ab</sup>	6 698	6 877	8 346	6 554 <sup>AB</sup>
≥91	5 799 <sup>b</sup>	6 513	7 008	7 790	6 441 <sup>B</sup>
Average Średnia	5 969 <sup>4</sup>	6 654 <sup>3</sup>	6 678 <sup>2</sup>	8 168 <sup>1</sup>	6 573
Full lactation length, days – Długość laktacji pełnej, dni					
≤45	341 <sup>a</sup>	356 <sup>AB</sup>	366 <sup>B</sup>	394 <sup>ab</sup>	354 <sup>B</sup>
46–60	334 <sup>ab</sup>	348 <sup>B</sup>	361 <sup>B</sup>	382 <sup>b</sup>	348 <sup>C</sup>
61–90	334 <sup>ab</sup>	355 <sup>AB</sup>	370 <sup>B</sup>	399 <sup>ab</sup>	351 <sup>BC</sup>
≥91	331 <sup>b</sup>	364 <sup>A</sup>	404 <sup>A</sup>	423 <sup>a</sup>	360 <sup>A</sup>
Average Średnia	335 <sup>4</sup>	354 <sup>3</sup>	370 <sup>2</sup>	395 <sup>1</sup>	352
ECM milk yield in full lactation, kg Wydajność mleka ECM za laktację pełną, kg					
≤45	6 316 <sup>A</sup>	7 206	7 964 <sup>B</sup>	10 002	7 192 <sup>A</sup>
46–60	6 316 <sup>A</sup>	7 304	7 879 <sup>B</sup>	9 571	7 169 <sup>A</sup>
61–90	6 112 <sup>B</sup>	7 263	7 828 <sup>B</sup>	9 967	7 004 <sup>B</sup>
≥91	5 699 <sup>C</sup>	7 030	8 322 <sup>A</sup>	9 647	6 789 <sup>C</sup>
Average Średnia	6 149 <sup>4</sup>	7 238 <sup>3</sup>	7 931 <sup>2</sup>	9 800 <sup>1</sup>	7 063
Lactation persistency index, % – Wskaźnik wytrwałości laktacji, %					
≤45	34.1 <sup>B</sup>	30.7	25.6 <sup>b</sup>	16.8	29.0 <sup>C</sup>
46–60	33.0 <sup>B</sup>	31.9	26.8 <sup>ab</sup>	27.0	30.0 <sup>BC</sup>
61–90	36.9 <sup>B</sup>	36.1	29.0 <sup>ab</sup>	27.8	33.3 <sup>AB</sup>
≥91	43.1 <sup>A</sup>	35.0	32.4 <sup>a</sup>	24.6	36.6 <sup>A</sup>
Average Średnia	35.9 <sup>1</sup>	33.5 <sup>1</sup>	28.0 <sup>2</sup>	25.0 <sup>2</sup>	31.7

Means in columns, within traits, marked by different big letters differ significantly at  $P \leq 0.01$ . Średnie w kolumnach, w obrębie cech, oznaczone różnymi dużymi literami różnią się istotnie przy  $P \leq 0.01$ . Means in columns, within traits, marked by different small letters differ significantly at  $P \leq 0.05$ . Średnie w kolumnach, w obrębie cech, oznaczone różnymi małymi literami różnią się istotnie przy  $P \leq 0.05$ .

Means in rows, within groups of genotype, marked by different number differ significantly at  $P \leq 0.01$ . Średnie w wierszach, w obrębie grup genotypowych, oznaczone różnymi cyframi różnią się istotnie przy  $P \leq 0.01$ .

A significant effect of dry period length was also observed for the whole lactation length following this period (Table 1). The longest whole lactations were recorded in a group of cows dry for 3 months and longer ( $\geq 91$  days). Lactations of these cows lasted, on average, 360 days and were 6 days longer than the shortest lactations, obtained by cows whose dry period was shorter than 46 days. A detailed analysis of this trait, i.e. whole lactation length allows one to notice that the longest lactations were obtained by cows with a high proportion of Holstein-Friesian genes (75.1–99.9%) as well as pure-bred Polish Holstein-Friesian cows with a dry period of at least 91 days. Lactations of these groups of cows lasted 404 and 423 days, respectively.

Miciński [2007] showed that the longest whole lactations were characteristic of the high yielding cows, that is, such cows whose highest daily yield was over 30 kg of milk. Lactations of these cows lasted, on average, for 326 (first lactations), 342 (second, fourth and further lactations) and 338 days (third lactations).

Lactation persistency of cows from different genetic groups was also analysed by calculating lactation persistency index (Table 1). Cows with the shortest dry period (less than 45 days) from three genetic groups (50.1–75% HF; 75.1–99.9% HF and pure-bred Polish Holstein-Friesians) were characterised by the highest lactation persistency (the lowest LPI). The value of this index for the aforementioned groups of animals ranged from 16.8% to 30.7%. So, the mean monthly decrease in daily ECM yield ranged from 1.9% to 3.4%.

The study also involved the evaluation of the course of milk production of Polish Holstein-Friesian cows of Black-and-White variety depending on the dry period length prior to the evaluated lactation. Four different lactation curves were plotted for the whole evaluated population of cows depending on the dry period length (Fig. 1) and for different genetic groups whose dry period prior to the evaluated lactation was:  $\leq 45$  days (Fig. 2); 46–60 days (Fig. 3); 61–90 days (Fig. 4) and  $\geq 91$  days (Fig. 5).

The course of milk production presented in Fig. 1 for the whole evaluated population of Polish Holstein-Friesian cows of Black-and-White variety indicates that the most favourable dry period ranged from 46 to 60 days. Lactation curve in this group of animals was characterized by the highest peak and relatively slow decrease in milk production after the peak. A detailed analysis of the shape of lactation curves for individual genetic groups depending on dry period length (Figs. 2–5) allows us to conclude that the pure-bred Polish Holstein-Friesian animals were characterized by the highest peak of lactation (30.8–32.8 kg ECM), irrespective of their dry period length.

Chmielnik et al. [1998] analysed the course of three successive lactations of Black-and-White cows improved with the Holstein-Friesian breed. The results obtained by these authors show that there are differences in the level of milk yield and course of lactation of cows belonging to individual genetic groups. The curve for cows with the highest proportion of Holstein-Friesian genes had the most irregular shape. The graph for pure-bred Black-and-White cows was only somewhat less irregular. The most favourable, flat shape of the lactation curves plotted in the study by Brzozowski et al. [1989] and indicating a considerable lactation persistency was characteristic of lactation curves of Holstein-Friesian cows of Swedish variety.

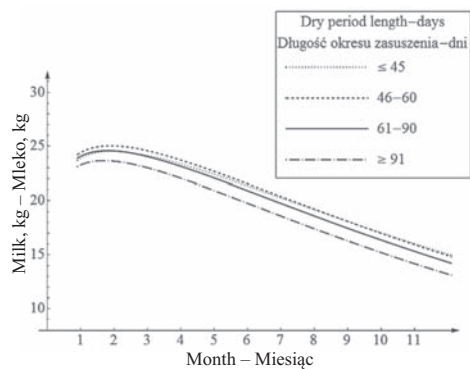


Fig. 1. Lactation curves of Polish Holstein-Friesian varieties of Black-and-White cows, depending on the length of dry period, days

Rys. 1. Krzywe laktacji krów rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej w zależności od długości okresu zasuszenia, dni

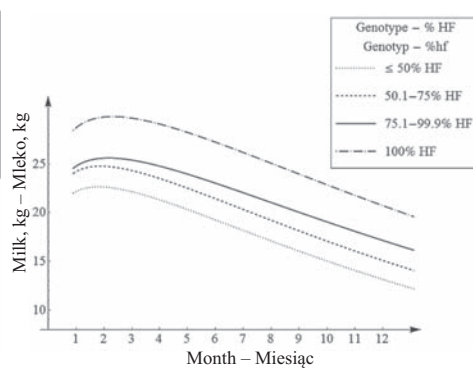


Fig. 2. Lactation curves for cows with different proportion of Holstein-Friesian genes dried off up to 45 days before the evaluated lactation

Rys. 2. Krzywe laktacji u krów z różnym udziałem genów hf zasuszonych do 45 dni przed ocenianą laktacją

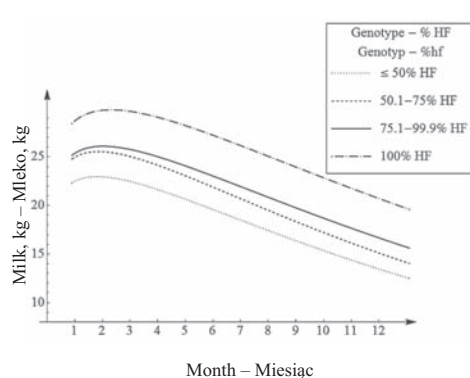


Fig. 3. Lactation curves for cows with different proportion of Holstein-Friesian genes dried off 46-60 days prior to the evaluated lactation

Rys. 3. Krzywe laktacji u krów z różnym udziałem genów hf zasuszonych pomiędzy 46. a 60. dniem przed ocenianą laktacją

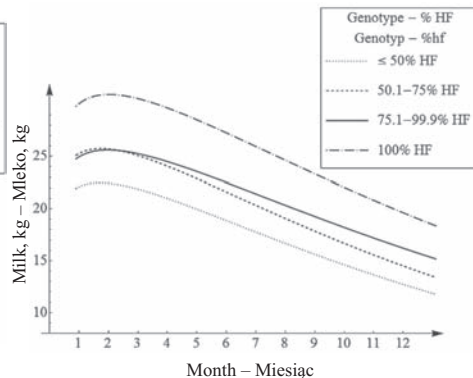


Fig. 4. Lactation curves for cows with different proportion of Holstein-Friesian genes dried off 61-90 days prior to the evaluated lactation

Rys. 4. Krzywe laktacji u krów z różnym udziałem genów hf zasuszonych od 61 do 90 dni przed ocenianą laktacją

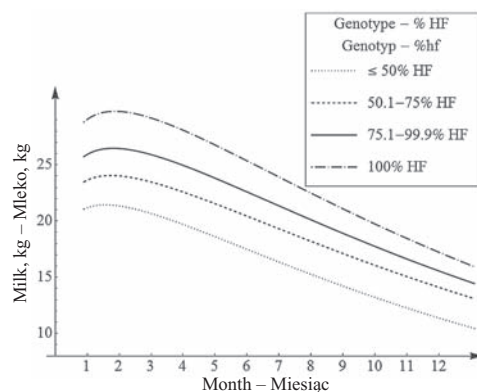


Fig. 5. Lactation curves for cows with different proportion of Holstein-Friesian genes dried off  $\geq 91$  days prior to the evaluated lactation

Rys. 5. Krzywe laktacji u krów z różnym udziałem genów hf zasuszonych  $\geq 91$  dni przed ocenianą laktacją

## CONCLUSIONS

The dry period for cows lasting for 46–60 days and recommended so far is justified due to the fact that these animals had the highest ECM yield in the standard lactation and high lactation persistency. It should be also noticed that the cows from the evaluated population dry for less than 46 days were characterized by the highest lactation persistency evaluated for the whole population (LPI = 29%) as well as for the individual genetic groups (LPI = 16.8%–34.1%). However, cows with the shortest dry period compared to cows dry for 46–60 days produced less milk, by 121 kg on average (from 39 to 241 kg – in individual genetic groups).

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## WPLYW DŁUGOŚCI OKRESU ZASUSZENIA NA PRZEBIEG PRODUKCJI MLEKA KRÓW RASY POLSKIEJ HOLSZTYŃSKO-FRYZYJSKIEJ ODMIANY CZARNO-BIAŁEJ

**Streszczenie.** Na podstawie wyników użytkowości mlecznej z 15 659 laktacji krów czarno-białych z różnym udziałem genów rasy holsztyńsko-fryzyjskiej przeprowadzono ocenę przebiegu produkcji mleka w laktacji w zależności od długości okresu zasuszenia przed badanymi laktacjami pełnymi. Wykreślono krzywe laktacyjne wybranych grup zwierząt według modelu Wooda. Średnia wydajność mleka ECM badanej populacji wynosiła: 6 573 kg w laktacji standardowej oraz 7 063 kg w laktacji pełnej trwającej przeciętnie 352 dni. Wykazano także, że krowy



wycielone w latach 1995–2008 odznaczały się bardzo wysoką wytrzymałością w laktacji. Średni miesięczny spadek produkcji mleka, po szczycie laktacji, wyniósł 3,52% (WWL = 31,7%). Spośród ocenianych 4 grup genetycznych najwyższą wytrzymałością laktacji (najniższy wskaźnik WWL) charakteryzowały się krowy z najkrótszym okresem zasuszenia (poniżej 45 dni) w trzech grupach genetycznych: od 50,1 do 75% hf; od 75,1 do 99,9% hf oraz czystorasowe krowy rasy polskiej holsztyńsko-fryzyjskiej. Średni miesięczny spadek dobowej wydajności mleka ECM, począwszy od 1. miesiąca laktacji, dla wymienionych grup zwierząt wynosił od 1,9% do 3,4%.

**Słowa kluczowe:** bydło mleczne, krzywa laktacji, wytrzymałość laktacji, zasuszenie

Accepted for print – Zaakceptowano do druku: 25.07.2011

