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INFLUENCE OF THE AGE ON THE DAY OF FIRST CALVING AND THE LENGTH OF CALVING INTERVALS ON THE MILK YIELD OF COWS

WPŁYW WIEKU KRÓW W DNIU PIERWSZEGO WYCIENIA ORAZ DŁUGOŚCI OKRESU MIĘDZYWYCIENIOWEGO NA PRODUKCYJNOŚĆ MLECZNĄ KRÓW

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Streszczenie. Badaniami objęto 264 krowy rasy holsztyńsko-fryzyskiej, o wydajności wynoszącej ponad 10 000 kg mleka, które utrzymywane były w jednym z największych gospodarstw na terenie województwa wielkopolskiego – w Sano Agrar Instytut w Lubiniu. Oszacowano wpływ wieku krów w dniu pierwszego wycielenia na produktywność w kolejnych trzech 305-dniowych laktacjach. Analizę poszczególnych cech użytkowych wykonano na podstawie analizy wariancji, uwzględniając wpływ laktacji oraz wieku pierwszego wycielenia, jak również okresu międzywycieleniowego. Obliczono także współczynnik korelacji prostej pomiędzy badanymi cechami a wiekiem pierwszego wycielenia oraz długością okresu międzywycieleniowego. Najwyższą wydajność mleka, tłuszczu i białka w pierwszej i drugiej laktacji osiągały krowy, których wiek pierwszego wycielenia przypadał na okres powyżej 26 miesięcy. W laktacji trzeciej najwyższą wydajność mleka i białka stwierdzono w grupie krów wycielonych najwcześniej, tj. w wieku poniżej 23 miesięcy. Największą zawartość białka w pierwszej, drugiej i trzeciej laktacji stwierdzono w mleku krów wycielonych po raz pierwszy w wieku poniżej 23 miesięcy. Najkorzystniejszym okresem międzywycieleniowym dla badanego stada był okres powyżej 401 dni.

Key words: dairy cows, lactation, age of first calving, calving intervals.

Słowa kluczowe: krowy mleczne, laktacje, wiek pierwszego wycielenia, okres międzywycieleniowy.

INTRODUCTION

In Poland, as in many countries, in terms of dairy farming more and more attention is paid to the characteristics associated with reproduction. For this purpose, selection index are subjected to modification, which increases their functional characteristics. Achieving good results in the breeding of high-yielding cows is not an easy task and depends on many factors. Implications of errors resulting from improper breeding are not always visible. The task of the breeder is a constant care regarding reproduction in the herd, because failure in this area can adversely affect the profitability of production. The breeder bears the costs of not calving the cows and of veterinary care. Additional costs of reproductive disorders result

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also from slow breeding progress and fatness in cattle (Mordak 2008; Kowalski 2010). The problems with reproduction appear in Poland more often, especially in high-output herds. The problem is present not only in our country, but also in many European countries and in the USA. It is therefore necessary to conduct constant monitoring of breeding dairy cows (Bogucki et al. 2006).

The purpose of the study was to evaluate the influence of age on the day of first calving and length of calving intervals on milk yield of cows with high efficiency (>10 000 kg) in one of the largest farms in the Wielkopolskie voivodeship.

MATERIAL AND METHODS

The study was carried out in Sano Agrar Institut w Lubią in one of the biggest farms in the Wielkopolskie voivodeship, which keeps a highly productive dairy Holstein-Friesian cattle herd. The cows are kept in free-stall cowsheds and fed with Total Mixed Ration (TMR).

The study covered 264 individuals, which in 2009–2013 were kept in the analysed herd and in case of which the third lactation was completed. The data on milk yield, fat and protein content in milk as well as the age of first calving and the length of calving intervals were obtained on the basis of breeding documentation run by the Polish Federation of Cattle Breeders and Dairy Farmers. Due to the age of first calving, three age classes were specified (I – < 23.0, II – 23.1–26.0, III – > 26.1 months). Taking into account the calving intervals, also three classes were specified (I – < 360.0, II – 361–400, III – > 401 days).

The analysis of individual characteristics was performed using analysis of variance taking into account the influence of lactation and the age of first calving as well as the calving intervals on the basis of the model:

$$Y_{ijk} = \mu + a_i + b_j + ab_{ij} + \varepsilon_{ijk}$$

where:

Y_{ijk} – tested feature;

μ – general mean (LSM);

a_i – influence of lactation ($i = 1,2,3$);

b_j – influence of age on the day of first calving (< 23.0, 23.1–26.0, > 26.1) or influence of calving intervals (< 360, 361–400, > 401);

ab_{ij} – influence of the interaction – lactation x age on the day of first calving or calving intervals;

ε_{ijk} – influence of error.

The significance of differences was determined using the Tukey's test. We also calculated the coefficient of simple correlation between the measured feature and the age of first calving and calving interval's length. Statistical analysis was performed in the Statistica®10 PL (StatSoft, Inc. 2011).

RESULTS AND DISCUSSION

The highest milk, fat and protein yield in the first and second lactation of cows, whose age at first calving (EAF) amounted to > 26.1 months (Table 1). This corresponds to the results obtained by Sitkowska et al. (2009), who points out that the most preferred age of first

calving of heifers varies between 26 months and 30 months. Juszczak et al. (2001) as optimal recognizes the age ranging from 26 to 29 months. Ruiz-Sánchez et al. (2007) suggest that the age of first calving between 23–24 months has a beneficial effect on milk yield in lactation. The work of Salamończyk and Guliński (2010) indicate that the age at first calving significantly affected milk yield results, the cows calving for the first time after 30th month of age have produced 597 kg more milk during 305-day lactation compared to cows calving at the earliest ≤ 25 months of age. Hare et al. (2006) reported that almost half of heifers in the US calve for the first time at the age of 23–27 months. Similarly, in Poland it can be seen that the average age at first calving in 2014 was 27.4 months (Polish Federation of Cattle Breeders and Dairy Farmers 2014).

Table 1. Least squares means (LSM) with standard error (SE) depending on lactation and age group of the first calving

Tabela 1. Średnie najmniejszych kwadratów (LSM) z błędem standardowym (se) w zależności od laktacji i grupy wieku pierwszego wycielenia

Lactation Laktacja	Age at first calving Wiek pierwszego wycielenia [months]		<i>n</i>	Milk yield Wydajność mleka [kg]	Fat yield Wydajność tłuszczu [kg]	Fat content Zawartość tłuszczu [%]	Protein yield Wydajność białka [kg]	Protein content Zawartość białka [%]
1	< 23.0	LSM	55	8819.42	344.07	3.93	303.64	3.46
		se		227.01	8.41	0.06	7.11	0.03
	23.1–26.0	LSM	69	8808.26	339.67	3.87	300.22	3.41
		se		202.67	7.50	0.05	6.35	0.02
	> 26.1	LSM	5	9911.80	379.20	3.87	339.00	3.42
		se		752.90	27.88	0.19	23.58	0.09
2	< 23.0	LSM	36	10 566.03	409.00	3.90	364.61	3.46
		se		280.59	10.39	0.07	8.79	0.03
	23.1–26.0	LSM	43	10 199.35	398.00	3.94	350.88	3.46
		se		256.74	9.51	0.07	8.04	0.03
	> 26.1	LSM	33	11 215.48	426.52	3.84	373.94	3.35
		se		293.07	10.85	0.08	9.18	0.03
3	< 23.0	LSM	3	11 438.00	418.67	3.56	400.00	3.50
		se		971.99	35.99	0.25	30.45	0.11
	23.1–26.0	LSM	10	11 001.70	429.60	3.98	371.50	3.39
		se		532.38	19.71	0.14	16.68	0.06
	> 26.1	LSM	10	10 402.70	423.10	4.03	361.80	3.48
		se		532.38	19.71	0.14	16.68	0.06

LSM – least squares means – średnie najmniejszych kwadratów.

Se – standard error – błąd standardowy.

In our study concerning the percentage of protein in the milk, the cows with the best results were those that calved under the age 23.0 months, both in first (3.46%), second (3.46%) and third lactation (3.50%). The work of Salamończyk and Guliński (2010) indicated that the highest protein content (3.23%) confirmed by statistically significant results was observed in the milk of cows that calved much later, at the age of 851 days (28 months). This content, however, was significantly lower.

In own study (Table 1) the highest milk yield (11 438 kg) in the third lactation was reached by cows aged < 23.1 months. In case of the analysis of the age groups, the differences were observed for milk yield between lactation groups: 1st and 2nd lactation (0.0002) and the 1st

and 3rd lactation (0.0003). The yield of fat (kg) and the protein yield (kg) were similar, the differences between the first and second along with third lactation (0.0000) (Table 3). The work of Cioch et al. (2015) the highest yields of milk, fat and protein in the third lactation was reached by cows, the age of which age at first calving was 26–29 months. The highest content of fat and protein were found in the milk of cows in third lactation calving after 29 months of age. Czerniawska-Piątkowska et al. (2005) have found the highest fat content in second (4.95%) and in third lactation (4.28%) in cows' group genotype between 50.1 and 75% of hf genes, which age at first calving was less than 28.1 months. The differences were significant ($P \leq 0.01$).

In examining the impact of the length of calving interval on milk yield of cows in each lactation (Table 2), it was observed that the highest average milk yield in cows was received in second and third lactation, respectively 11493.38 and 11401.33 kg, the calving intervals of which was > 401 days.

Table 2. Least squares means (LSM), standard error (SE) of attributes associated with lactation yield, depending on the length of calving interval

Tabela 2. Średnie najmniejszych kwadratów (LSM) z błędem standardowym (se) dla cech związanych z wydajnością laktacyjną, w zależności od długości okresu międzywycieleniowego

Lactation Laktacja	Calving interval Okres między- wycieleniowy		<i>n</i>	Milk yield Wydajność mleka [kg]	Fat yield Wydajność tłuszczu [kg]	Protein yield Wydajność białka [kg]	Fat content Zawartość tłuszczu [%]	Protein content Zawartość białka [%]
2	< 360	LSM	21	9658.38	390.24	335.86	4.07	3.49
		se		406.98	15.37	12.36	0.09	0.04
	361–400	LSM	19	9825.11	380.74	341.74	3.91	3.50
		se		427.86	16.16	12.99	0.10	0.05
	> 401	LSM	40	11 493.38	433.68	387.60	3.80	3.39
		se		294.88	11.14	8.95	0.07	0.03
3	< 360	LSM	10	10 031.60	411.80	345.30	4.12	3.46
		se		589.77	22.28	17.91	0.14	0.06
	361–400	LSM	10	11 383.80	441.50	394.40	3.89	3.48
		se		589.77	22.28	17.91	0.14	0.06
	> 401	LSM	3	11 401.33	416.67	378.67	3.56	3.31
		se		1076.76	40.67	32.70	0.25	0.12

Expanations see Table 1 – Objasniena oznaczeń zob. tab. 1.

The data presented in Table 2 indicate that the extension of calving interval is followed by a slight increase in milk yield. With prolonged calving intervals increases the yield of the fat (433.68 kg) and protein (387.60 kg) in milk of cows in first lactation. Similar relationships were found in the work Sitkowska et al. (2010), along with prolonged calving interval (up to 510 days), increased milk yield, fat and protein, and the percentage of fat in the milk. In our study (Table 2) in the second lactation, the highest yield of fat (441.50 kg), proteins (394.40 kg) as well as the highest percentage of fat content (3.89%) and protein (3.48%) of milk was found in case of calving interval lasting from 361 to 400 days. Statistical analysis of calving interval length revealed differences for milk yield in cows from the group < 360 and over 401 days for the whole (0.0015). There were no differences between lactations. Similarly, in case of the fat content [%], there were differences between < 360 and > 401 days (0.0193) – Table 3.

Table 3. Simple correlation coefficient between the tested milk performance traits and age of cows at the first calving and calving interval length in the next lactations

Tabela 3. Współczynnik korelacji prostej pomiędzy badanymi cechami użytkowości mlecznej a wiekiem krów w dniu pierwszego wycielenia oraz długością okresu międzywycieleniowego w kolejnych laktacjach

Lactation Laktacja	Trait Cecha	Age at first calving Wiek pierwszego wycielenia	<i>p</i>	Calving interval Okres międzywycieleniowy	<i>p</i>
1	Milk yield – Wydajność mleka [kg]	0.0352	0.6942	–	–
	Fat yield – Wydajność tłuszczu [kg]	–0.0004	0.9971	–	–
	Protein yield – Wydajność białka [kg]	0.0114	0.8994	–	–
	Fat content – Zawartość tłuszczu [%]	–0.0515	0.5649	–	–
	Protein content – Zawartość białka [%]	–0.0849	0.3422	–	–
	Milk yield – Wydajność mleka [kg]	0.1845	0.0521	0.3203	0.0038
	Fat yield – Wydajność tłuszczu [kg]	0.1058	0.2667	0.2685	0.0157
2	Protein yield – Wydajność białka [kg]	0.0929	0.3304	0.3053	0.0061
	Fat content – Zawartość białka [%]	–0.1239	0.1924	–0.1668	0.1382
	Protein content – Zawartość białka [%]	–0.2629	0.0049	–0.1876	0.0954
	Milk yield – Wydajność mleka [kg]	0.1142	0.6041	0.2929	0.1753
3	Fat yield – Wydajność tłuszczu [kg]	0.3385	0.1142	0.0765	0.7282
	Protein yield – Wydajność białka [kg]	0.1628	0.4582	0.2567	0.2371
	Fat content – Zawartość białka [%]	0.3897	0.0657	–0.4711	0.0226
	Protein content – Zawartość białka [%]	0.1427	0.5163	–0.2911	0.178

Juszczak and Hibner (2000) reported that normal calving interval should range from 360 to 400 days. Its extension indicates disturbances in reproduction of cows, while shortening – lowers the effectiveness of the conception rate and milk production in current and next lactation.

The correlations calculated (Table 3) had a negative value between the age of first calving and the content of protein in second lactation ($r = -0.2629$) as well as between the calving intervals and the content of fat in the third lactation ($r = -0.4711$) and a positive value between the calving intervals and milk yield ($r = 0.3203$), a fat yield ($r = 0.2685$) and protein yield ($r = 0.3053$) but only in second lactation. Also Miciński (2007) in his study observed no significant effect on the length of calving interval of cows on the milk yield. On the other hand, Januś and Borkowska (2006) stated positive correlation ($r = 0.097^{**}$) between milk yield and calving interval length.

CONCLUSIONS

The highest yields of milk, fat and protein in the first and second lactation were reached by cows, the age of which, at first calving, was more than 26.0 months. In the third lactation, the milk and protein yield were found in the group of cows that calved at the earliest age, i.e. less

than 23.0 months. The highest content of protein and fat was found in milk of cows during third lactation with the age of first calving < 23.0 and between 23.1 and 26.0 months. The most favourable period for the flock tested was > 401 days. Our results indicate no clear correlation between age of first calving date and the studied characteristics of milk production in the analyzed lactations. Between the calving intervals and the characteristics of milk, fat and protein yield were found statistically significant positive correlations in the second lactation, while in the third lactation they were statistically irrelevant.

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Abstract. The study involved 264 Holstein-Friesian cows with a performance of more than 10 000 kg of milk that were kept in one of the largest farms in Wielkopolskie voivodeship in Sano Agrar Institute in Lubień. One determined the influence of age at first calving on the performance in the next three 305-day lactations. Analysis of individual traits was performed through analysis of variance considering the effect of lactation and age at first calving and calving interval. One also calculated the coefficient of simple correlation between the measured trait and the age at first calving and calving interval length. The highest yields of milk, fat and protein in the first and second lactation were reached by cows, the age of which, at first calving, was 26.0 months. In the third lactation, the highest milk and protein yield were found in the group of cows calved at earliest i.e., at the age of 23.0 months. The highest protein content of the first, second and third lactation of cows was identified in the milk of cows calved for the first time at the age of 23.0 months. The most favourable calving interval for the tested herd was more than 401 days.

