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# OCCURRENCE OF MASTITIS IN POLISH HOLSTEIN-FRIESIAN BLACK-AND-WHITE COWS OF DIFFERENT AGE AND MILK PRODUCTION CAPACITY AND ITS EFFECT ON THE CYTOLOGICAL QUALITY OF MILK AND THE COURSE OF LACTATION

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**Abstract.** The aim of the study was to evaluate the effect of age and milk production capacity of cows in standard lactation on the frequency of lactations with noted cases of mastitis. The effect of occurrence of mastitis on somatic cell count in milk and on the course of lactation was also determined. The study was carried out in a herd of Polish Holstein-Friesian cows with production capacity > 8000 kg milk. The study included 496 lactations and 5405 results from test-day milking. Both lactation number and milk production level were found to affect the frequency of mastitis. Lactations in which mastitis occurred at least once between calving and the dry period were noted more frequently in multiparous cows than in primiparous cows. Udder health status significantly affected the somatic cell count in milk. Occurrence of mastitis did not affect the course of lactation of cows with low or average milk production capacity. Higher daily milk yield over the course of lactations with mastitis in cows with the highest production potential suggests that highly productive cows are most susceptible to mastitis.

**Key words:** health state of the udder, lactation, multiparous cows, primiparous cows, somatic cell count

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## INTRODUCTION

Of all health disorders affecting dairy cows, most often noted are diseases of the mammary glands and infertility. Mastitis is regarded as the costliest disease in dairy cows [Shim et al. 2004, Kocak 2006]. In Great Britain, losses due to mastitis are the highest of any disease, exceeding 160 million pounds a year [Mordak et al. 2009]. Goff [2006] noted a successive increase in clinical cases of mastitis in the United States.

Apart from financial losses, mastitis is also one of the main reasons for culling of cows. Varisella et al. [2007] found that since 1935 the percentage of cows culled in Poland due to diseases of the udder had increased from 3.51% to 11.04%. A study by Januś and Borkowska [2004] showed that the percentage of cows culled for this reason increases with their milk production in first lactation.

The aim of the study was to evaluate the effect of age and production capacity in a standard lactation (305 days) on the frequency of lactations with noted cases of mastitis. The effect of mastitis in lactation on somatic cell count in milk and on the course of lactation was also determined.

## MATERIAL AND METHODS

The source of the data was documentation carried out on a farm with 222 Polish Black-and-White Holstein-Friesian cows whose yield was higher than 8000 kg of milk a year. The herd was kept in free-stall housing on deep litter. The cows were fed total mixed rations (TMR). They were divided into 6 groups based on feeding requirements and were under constant veterinary care.

Data for analysis were obtained from the Animal Treatment Register in which, in 2007–2009, cases of animal illness and treatment had been recorded, and from the results of evaluation of milk performance (RW–2 reports). The reports provided data concerning the cows' successive calvings, milk production and composition in test-day milking and in standard lactations, and somatic cell count (converted to a natural logarithm). From the Animal Treatment Register all lactations were noted in which mastitis had occurred at least once.

A total of 496 lactations (of which the number of first lactation was 177, 2nd – 153, 3rd – 100, 4th – 52 and 5th – 14) and 5405 results from test-day milking were included in the study. The analysis took into account the following effects:

– the level of milk production (kg ECM in standard lactation) in primiparous and multiparous cows on the frequency of lactation with noted cases of mastitis;

– the health status of the mammary glands and production capacity on the cytological quality of milk (based on somatic cell count) and on the course of lactation.

Lactations were divided into 3 groups according to production level. The first included 166 standard lactations with milk yield up to 7000 kg ECM. The second group consisted of 190 lactations in which milk yield was from 7001 to 9000 kg, and the third comprised 140 lactations with milk production exceeding 9000 kg ECM. Milk production was converted to ECM (energy corrected milk) according to the following formula [Sjaunja et al. 1990]:

$$\text{ECM} = \text{milk yield (kg)} \times [(0.383 \times \% \text{ of fat}) + (0.242 \times \% \text{ of protein}) + 0.7832]/3.140.$$

Data were analysed using the SAS statistical package [SAS® User's Guide 2006]. To evaluate the significance of the effect of the factors considered in the study on the characteristics analysed, Duncan's test (GLM procedure) and the $\chi^2$ test were used.

## RESULTS AND DISCUSSION

Mastitis was noted at least once between calving and the dry period in over half of the lactations analysed (Table 1). The frequency of lactations with mastitis was significantly affected by the level of production in standard lactation expressed in kg ECM. The percentage of lactations with mastitis increased with ECM yield – it was 18.8% higher where milk yield was 7001–9000 than for yield $\leq$ 7000, and 12.7% higher for yield > 9000 kg than for yield 7001–9000. Lactations with mastitis occurred in primiparous cows 9.9% less frequently than in multiparous cows. The $\chi^2$ test showed that in addition to milk yield, calving number also affected the frequency of lactations with mastitis. In primiparous cows, the value for the $\chi^2$ test was significant at $P \leq 0.05$, while in multiparous cows it was significant at $P \leq 0.01$. An increase in the mastitis morbidity rate in successive lactations was demonstrated by Kocak [2006]. Sawa et al. [2007 b] showed that both higher production capacity of the herd and successive lactations significantly increased the frequency of recurrent mastitis. Gröhn et al. [1995] determined that higher milk yield in a previous lactation can also be a predisposing factor for mastitis.

The somatic cell count increased significantly in lactations in which mastitis was noted (Table 2). This effect was greatest in multiparous cows and in primiparous cows with the lowest production capacity in standard lactation. In these

cows the somatic cell count (in $10^3 \cdot ml^{-1}$) in lactations without mastitis was over twice as low as in those in which mastitis was noted. Nearly all differences in log somatic cell count (LSCC) between groups were statistically significant. These results indicate that occurrence of mastitis reduces milk quality, determined based on SCC, during lactations. For this reason mastitis prevention in dairy cow herds is extremely important [Hagnestam-Nielsen et al. 2009]. Other studies have also found an association between higher somatic cell count in milk and past occurrence of mastitis [Sawa et al. 2007 b, Halasa et al. 2009]. Haas et al. [2002] report that in lactations in which no clinical or subclinical forms of mastitis were noted, the somatic cell count was elevated ($370 \times 10^3 \cdot ml^{-1}$) for a short period after calving only. By day 50 of lactation it had decreased to a minimum ($98 \times 10^3 \cdot ml^{-1}$), after which it rose slightly up (to $139 \times 10^3 \cdot ml^{-1}$) to the end of lactation. The effect of clinical mastitis on changes in somatic cell count during lactation depended on the etiological agent.

Table 1. Mastitis occurrence at primiparous and multiparous characterized by different milk yield (kg of ECM) of standard lactation

Tabela 1. Występowanie mastitis u pierwiastek i wieloródek o różnej wydajności mleka (kg ECM) w standardowej laktacji

| Group of cows Grupa krów | Mastitis in lactation Mastitis w laktacji | Milk yield level of standard lactation (kg of ECM) Poziom wydajności w laktacji standardowej (kg ECM) | | | | | | Overall Ogółem | | $\chi^2$ value* Wartość testu $\chi^{2*}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | ≤ 7000 | | 7001–9000 | | > 9000 | | | | |
| | | n | % | n | % | n | % | n | % | |
| Primiparous Pierwiastki | no – nie | 39 | 52.0 | 41 | 51.3 | 4 | 18.2 | 84 | 47.5 | 8.54$^{x}$ |
| | yes – tak | 36 | 48.0 | 39 | 48.7 | 18 | 81.8 | 93 | 52.5 | |
| | primiparous in total pierwiastki łącznie | 75 | 42.4 | 80 | 45.2 | 22 | 12.4 | 177 | 100.0 | |
| Multiparous Wieloródki | no – nie | 56 | 61.5 | 32 | 29.1 | 32 | 27.1 | 120 | 37.6 | 31.10$^{xx}$ |
| | yes – tak | 35 | 38.5 | 78 | 70.9 | 86 | 72.9 | 199 | 62.4 | |
| | multiparous in total wieloródki łącznie | 91 | 28.5 | 110 | 34.5 | 118 | 37.0 | 319 | 100.0 | |
| Overall Ogółem | no – nie | 95 | 57.2 | 73 | 38.4 | 36 | 25.7 | 204 | 41.1 | 32.19$^{xx}$ |
| | yes – tak | 71 | 42.8 | 117 | 61.6 | 104 | 74.3 | 292 | 58.9 | |
| | ∑ | 166 | 33.5 | 190 | 38.3 | 140 | 28.2 | 496 | 100.0 | |

* $\chi^2$ value significant: $^{xx}$ – at $P \leq 0.01$; $^{x}$ – at $P \leq 0.05$.

* wartość testu $\chi^2$ istotna: $^{xx}$ – przy $P \leq 0{,}01$; $^{x}$ – przy $P \leq 0{,}05$.

Table 2. Average somatic cell count in milk of primiparous and multiparous characterized by different level of milk production as well as health state of udders in the course of lactation

Tabela 2. Średnia liczba komórek somatycznych w mleku pierwiastek i wieloródek o różnym poziomie produkcji i statusie zdrowotnym wymion w trakcie laktacji

| Somatic cell count<br>Liczba komórek somatycznych | Group of cows<br>Grupa krów | Mastitis in lactation<br>Mastitis w laktacji | Milk yield level of standard lactation (kg of ECM)<br>Poziom wydajności w laktacji standardowej (kg ECM) | | | Overall<br>Ogółem |
|---|---|---|---|---|---|---|
| | | | ≤ 7000 | 7001–9000 | > 9000 | |
| $10^3 \cdot ml^{-1}$ | primiparous<br>pierwiastki | no – nie | 261 $^{A}$ | 309 | 538 | 299 $^{A}$ |
| | | yes – tak | 723 $^{B}$ | 566 | 852 | 680 $^{B}$ |
| | multiparous<br>wieloródki | no – nie | 448 $^{A}$ | 561 | 513 $^{A}$ | 495 $^{A}$ |
| | | yes – tak | 1271 $^{B}$ | 1060 | 1111 $^{B}$ | 1117 $^{B}$ |
| | overall<br>ogółem | no – nie | 373 $^{A}$ | 415 $^{A}$ | 516 $^{A}$ | 415 $^{A}$ |
| | | yes – tak | 992 $^{B}$ | 896 $^{B}$ | 1071 $^{B}$ | 984 $^{B}$ |
| LSCC<br>LLKS | primiparous<br>pierwiastki | no – nie | 11.88 $^{A}$ | 11.98 $^{a}$ | 12.15 | 11.94 $^{A}$ |
| | | yes – tak | 12.33 $^{B}$ | 12.20 $^{b}$ | 12.56 | 12.32 $^{B}$ |
| | multiparous<br>wieloródki | no – nie | 12.37 $^{A}$ | 12.41 $^{A}$ | 12.25 $^{A}$ | 12.35 $^{A}$ |
| | | yes – tak | 12.90 $^{B}$ | 12.92 $^{B}$ | 12.97 $^{B}$ | 12.94 $^{B}$ |
| | overall<br>ogółem | no – nie | 12.17 $^{A}$ | 12.16 $^{A}$ | 12.24 $^{A}$ | 12.18 $^{A}$ |
| | | yes – tak | 12.61 $^{B}$ | 12.68 $^{B}$ | 12.91 $^{B}$ | 12.75 $^{B}$ |

Means within the group of cows marked with different letters differ significantly: capital letters – at $P \leq 0.01$; lower-case letters – at $P \leq 0.05$.

Średnie w obrębie grupy krów oznaczone różnymi literami różnią się istotnie: wielkie litery – przy $P \leq 0{,}01$; małe litery – przy $P \leq 0{,}05$.

Schulz et al. [1990] found that during lactation of Guernsey, Holstein and Jersey cows, daily milk yield was highest on days 32–35, 29–38 and 26–35, respectively, after calving. The data in Fig. 1 show that regardless of the health status of the cows during lactation and their milk yield in kg ECM, the daily peak in yield was noted in the second month after calving. However, comparison of the course of lactation of cows with different production capacity revealed fundamental differences. Where milk production was lowest, the differences in yield between cows of different health status were small. In this group, higher daily milk yield was usually observed in successive months in cows in which mastitis was not noted during lactation. Where milk production was average, higher daily yield in cows without mastitis was only observed at the beginning of lactation (months 1st and 2nd after calving) and the end (from 9th month). During the entire course of lactation of cows with the highest level of production, the highest daily yield was observed in cows in which mastitis was noted at least once between calving and the dry period. This may suggest that if treatment is applied

immediately after symptoms of inflammation are observed and the cows recover quickly, higher milk yield could be achieved.

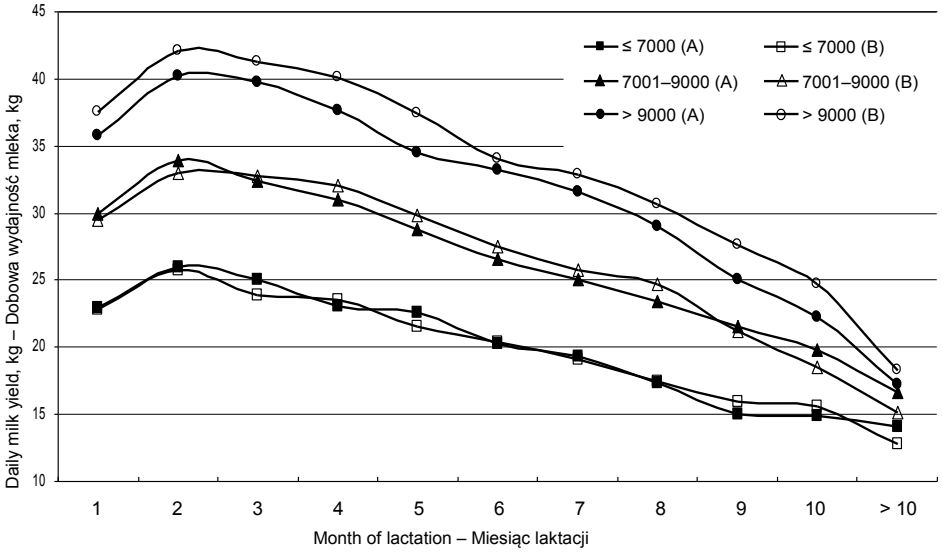


Fig 1. The course of lactation in cows with different milk production levels and health status (A – healthy, B – ill) during lactation

Rys. 1. Przebieg laktacji krów o różnym poziomie produkcji i statusie zdrowotnym (A – zdrowe, B – chore) w trakcie laktacji

Studies by other authors have also indicated different dependencies between occurrence of mastitis in cows and their milk production capacity. Deluyker et al. [1991] noted a decrease in milk yield in cows during the period when mastitis had been diagnosed and the animals were undergoing treatment. A study by Halasa et al. [2009] shows that increased somatic cell count, which is associated with subclinical cases of mastitis, was accompanied by a decrease (0.20–0.62 kg) in daily milk production. Sawa et al. [2007 a] found that the coefficient of correlation estimated based on test-day milkings between LNSCC and milk yield was –0.192$^{xx}$. Dürr et al. [2008] demonstrated that a 1-unit increase in LSCC resulted in a decrease in yield of 0.33–0.84 kg milk/day in primiparous cows and 0.74–2.45 kg in multiparous cows. The authors also found that milk loss depended on the stage after calving. Hagnestam-Nielsen et al. [2009] report that in 305-day lactations of cows with subclinical forms of mastitis, milk yield fell by 155 kg (2%) in primiparous cows and 445 kg (5%) in multiparous cows. Losses in daily milk production associated with increased somatic cell count depended on the stage after calving, and were highest during the late lactation period.

## CONCLUSIONS

To sum up, both lactation number and the level of milk production in the 305-day period after calving were both found to be factors influencing the occurrence of mastitis in cows. Lactations in which mastitis occurred at least once between calving and the dry period were noted more frequently in multiparous cows than in primiparous cows. In both groups, the percentage of lactations in which mastitis was noted increased with the level of production. The health status of the mammary glands had a substantial effect on the somatic cell count in the milk. Therefore, it is extremely important to prevent mastitis. Higher daily milk yield over the course of lactations with mastitis in cows with the highest production potential indicates that highly productive cows are most susceptible to mastitis. It can be presumed that cows in which mastitis occurred during lactation would have produced even more milk if the disease had not occurred.

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## WYSTĘPOWANIE MASTITIS U KRÓW RASY POLSKIEJ HOLSZTYŃSKO-FRYZYJSKIEJ ODMIANY CZARNO-BIAŁEJ W ZALEŻNOŚCI OD WIEKU I POZIOMU WYDAJNOŚCI ORAZ JEGO WPŁYW NA JAKOŚĆ CYTOLOGICZNĄ MLEKA I PRZEBIEG LAKTACJI

**Streszczenie.** Celem pracy była ocena wpływu wieku i wydajności krów w laktacji standardowej na częstotliwość występowania laktacji z notowanymi przypadkami mastitis. Określono także wpływ występowania mastitis na liczbę komórek somatycznych w mleku oraz przebieg laktacji. Badania przeprowadzono w stadzie krów rasy polskiej holsztyńsko-fryzyjskiej o wydajności > 8 tys. kg mleka. Objęto nimi 496 laktacji oraz 5405 wyników próbnych udojów. Stwierdzono, że do występowania mastitis u krów predysponowała zarówno kolejność laktacji, jak i poziom produkcji. U wieloródek, w porównaniu z pierwiastkami, częściej stwierdzano laktacje, w których przynajmniej raz w okresie od wycielenia do zasuszenia wystąpiło zapalenie wymienia. Status zdrowotny wymion wpływał istotnie na liczbę komórek somatycznych w mleku. Wystąpienie mastitis nie wpływało na przebieg laktacji krów o niskiej i przeciętnej wydajności. Wyższa wydajność dobowa w przebiegu całych laktacji z mastitis

u krów o najwyższym potencjale produkcyjnym wskazywała na największą podatność zwierząt wysokowydajnych na zapalenia gruczołów mlekowych.

**Słowa kluczowe:** liczba komórek somatycznych, laktacja, pierwiastki, wieloródki, zdrowotność wymion

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