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EFFECT OF DISEASE INCIDENCE ON THE MILK PERFORMANCE OF HIGH-YIELDING COWS IN SUCCESSIVE LACTATIONS*

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Key words: health status of cows, mastitis, endometritis, lameness, ketosis, ovarian cysts, milk yield, fat, protein.

Abstract

The study was conducted in the years 2006–2008. The experimental materials comprised 368 Holstein-Friesian cows purchased from Germany as in-calf heifers. The objective of this study was to determine the health status of cows in a commercial herd kept in the Olsztyn region, based on the type and incidence of diseases that occurred during three consecutive lactations, and to analyze the effect of these diseases on milk yield and composition in the first, second and third lactation cycle. The cows were divided into five groups: HEA – clinically healthy cows (showing no disease symptoms), MAS – cows with mastitis, LAM – cows with foot/leg defects and lameness, REP – cows with reproductive problems (retention of the placenta, endometritis, ovarian cysts), MET – cows with metabolic diseases (ketosis, abomasal displacement). It was found that the most common diseases during three consecutive lactations in the investigated herd were endometritis (37.63%) which occurred soon after calving (on day 18 post-partum), mastitis (35.48%), formation of ovarian cysts (10.10%), ketosis (8.39%) and leg/foot defects (6.44%). Retention of the placenta and abomasal displacement were diagnosed much less frequently (1.62% and 0.34% respectively). The percentage of healthy cows decreased in successive lactations (19.81% in the first lactation, 12.28% in the second lactation, 6.22% in the third lactation). During each lactation, more than one third of cows suffered from mastitis. The proportion of cows showing the symptoms of ketosis increased with age, from 5.12% in the first lactation to 12.23% in the third lactation. The highest yields of milk and milk components over a 305-day lactation cycle were noted in cows with reproductive diseases (ROZ). Foot/led defects and lameness (LAM), mastitis (MAS) and metabolic diseases (MET) had the most significant effect on a decrease in milk production.

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WPŁYW RODZAJU SCHORZEŃ U KRÓW WYSOKO WYDAJNYCH NA ICH UŻYTKOWOŚĆ MLECZNĄ W KOLEJNYCH LAKTACJACH

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S ł o w a k l u c z o w e: zdrowotność krów, *mastitis*, *endometritis*, kulawizny, ketoza, cysty jajnikowe, wydajność mleka, tluszcz, białko.

A b s t r a k t

Badania przeprowadzono w latach 2006–2008. Materiał badawczy stanowiło 368 krów rasy holsztyńsko-fryzyjskiej zakupionych jako jałówki cielne z Niemiec. Celem badań była ocena stanu zdrowotnego krów na podstawie rodzaju i częstotliwości występowania chorób w 3 kolejnych laktacjach, a także określenie ich wpływu na wydajność i skład mleka w I, II i III laktacji zwierząt użytkowanych w hodowli wielkostadnej w regionie olsztyńskim. Wszystkie krowy w stadzie podzielono na 5 grup zdrowotnych: ZDR – krowy zdrowe (bez objawów chorobowych); MAS – krowy z zapaleniem wymienia (*mastitis*); KUL – krowy z chorobami racic (kulawizny); ROZ – krowy z chorobami układu rozrodczego (zatrzymanie łożyska, zapalenie błony śluzowej macicy [*endometritis*], cysty jajnikowe); MET – krowy z chorobami metabolicznymi (ketoza, przemieszczenie trawieńca). W stadzie wysoko wydajnych krów odnotowano, że w trzech analizowanych laktacjach najczęściej stwierdzanymi chorobami były: zapalenia błony śluzowej macicy (37,63%), pojawiające się najwcześniej po wycieleniu (w 18 dniu), zapalenia wymienia (35,48%), a następnie cysty jajnikowe (10,10%), ketoza (8,39%) i kulawizny (6,44%); znacznie rzadziej diagnozowano zatrzymanie łożyska (1,62%) i przemieszczenie trawieńca (0,34%). Udział krów zdrowych zmniejszał się w kolejnych laktacjach, wynosząc w I laktacji 19,81%, w II – 12,28% i w III – tylko 6,22%. W każdej laktacji ponad 1/3 krów w stadzie zapadała na *mastitis*. Wraz z wiekiem wzrastał także udział krów z objawami ketozy z 5,12% (w I laktacji) do 12,23% (w III laktacji). Najwyższą wydajność mleka i jego składników w laktacji 305-dniowej odnotowano u krów z chorobami układu rozrodczego (ROZ). Największy wpływ na obniżenie produkcji mleka i jego składników miały choroby związane z układem ruchu (KUL), *mastitis* (MAS) oraz choroby metaboliczne (MET).

Introduction

The health status of cattle is affected by livestock production intensification (MALINOWSKI et al. 2003, WROŃSKI et al. 2007). The breeding programs aimed at improving overall cow performance lead to general herd health deterioration, which is manifested in a higher disease incidence and a decrease in fertility. The most common health problems include metabolic diseases, reproductive diseases and motor system disorders (TWARDOŃ et al. 2001, JANOWSKI 2004, WÓJCIK 2005). As a result, the yields of milk and milk components decrease. According to FLEISCHER et al. (2001), since the correla-

tion between milk yield and disease incidence rates has not been proved, it should be assumed that high-producing cows are not more susceptible to diseases, provided that their maintenance and production needs are met. SHAVER (1997) pointed to the importance of adequate nutrition and well-being of cows during the perinatal period, when cows are particularly prone to abomasal displacement. The findings of other authors suggest that a significant increase in milk yield may be associated with such health problems as metabolic diseases, reproductive diseases and mastistis, as well as with higher feed costs and a deterioration in the nutritional value of milk (COPPOCK 1973, EMPEL et al. 1986, CORREA et al. 1993, KONDRACKI 2001). The above negative processes result in higher costs of medical treatment, a shorter herd life, reduced revenues from milk sales and, in consequence, lower milk production profitability (BRZOZOWSKI et al. 2003, DORYNEK et al. 2005).

The objective of this study was to determine the health status of cows in a commercial herd kept in the Olsztyn region, based on the type and incidence of selected diseases that occurred during three consecutive lactations, and to analyze the effect of these diseases on milk yield and composition.

Materials and Methods

The study was conducted in the years 2006–2008. The experimental materials comprised 368 Holstein-Friesian cows purchased from Germany as in-calf heifers. The cows were kept in four free-stall barns, on deep litter, under the indoor feeding system. The mono diet fed to cows was based on succulent roughage: hay silage, corn-cob-mix and corn garin silage as well as soybean meal, rapeseed meal, ground rye, pelleted concentrated feed "Focus" (Cargill, Poland) and a "Super Premium" vitamin premix. The diet was supplemented with diamond yeast metabolites, limestone, salt lick and sodium bicarbonate. Total mixed rations (TMR) were administered from a movable feed cart into feeders inside the barns. The cows were divided into five technological groups, based on their performance and physiological condition. Average daily milk yield in each group was as follows: group 1 – over 40 kg, group 2–31 to 40 kg, group 3–15 to 30 kg, group 4 – below 15 kg. Group 5 comprised dry cows.

Cows were milked twice daily in two herringbone milking parlors (2 x 7, Fullwood Limited Ellesmere Shropshire, England). Due to daily collection, milk was cooled to 6°C. Technological processes were managed and controlled with the use of Afifarm v.2. 05F software. The herd was regularly inspected by a veterinary surgeon. The following milk performance parameters were analyzed: the yields of milk, fat, protein and dry matter, and the percentage content of milk components over 305 days of the first, second and third

lactation, as dependent on disease incidence. Actual milk yield was converted into the yield of value-corrected milk (VCM) (kg), according to the following formula:

$$\text{VCM (kg)} = -0.05\ x\ \text{(milk kg)} + 8.66\ x\ \text{(fat kg)} + 25.98\ x\ \text{(protein kg)}$$

(ARBEL et al. 2001).

Based on their health status, the cows were divided into five groups: HEA – clinically healthy cows (showing no disease symptoms), MAS – cows with mastitis and other udder diseases, LAM – cows with foot/leg defects (lameness, foul-in-the-foot), REP – cows with reproductive problems (retention of the placenta, endometritis, ovarian cysts), MET – cows with metabolic diseases (ketosis, abomasal displacement). The analysis did not include cows in which more than one disease was diagnosed.

The results were processed statistically using Statistica ver. 7.1 software. Least square means (LSM) and standard errors (Se) were determined by a one-factor analysis of variance, and the significance of differences between means was estimated by Duncan's test.

Results and Discussion

Disease incidence in groups of cows over three consecutive lactations is presented in Table 1. The percentage of healthy cows decreased gradually during successive lactation cycles. In each lactation, over 30% of cows were affected by reproductive problems (REP), including endometritis, formation of ovarian cysts and retained placenta (32.47%, 31.10% and 36.20% in the first, second and third lactation respectively). In a study conducted by FLEISCHER et al. (2001), the most common diseases observed in lactating cows were metritis (23.0%) and mastitis (21.6%), followed by the occurrence of ovarian cysts (11.7%) and abomasal displacement (1.1%). HINRICHS et al. (2006) also reported that reproductive disorders were diagnosed most frequently in lactating cows.

The second most common disease was mastitis (MAS). Disease incidence rates increased with cow's age (from 22.73% in primiparous cows to 27.23% in the oldest cows). According to MALINOWSKI et al. (2003), mastitis remains the most frequent disease in dairy cattle herds, and the treatment of this condition generates the highest costs. These authors examined 972 cows in western Poland, and observed the clinical symptoms of mastitis in 15.1% of the population. They concluded that effective mastitis control requires both regular herd monitoring and the implementation of new prevention and treatment programs.

Table 1

Disease incidence in groups of cows over three consecutive lactations

Group of cows	Lactation						Average	
	I		II		III			
	n	%	*n*	%	N*	%	*n*	%
HEA	61	19.81	40	12.28	19	6.22	40	12.77
MAS	70	22.73	81	24.73	52	27.23	68	24.90
LAM	47	15.26	7	2.54	–	–	27	8.90
REP	100	32.47	95	31.10	69	36.30	88	33.29
MET	30	9.73	35	12.47	37	18.85	34	13.68
TOTAL	308	100	256	83.12	191	62.01	882	81.71

* number of cases

Cows with foot and leg defects had the lowest share among the analyzed groups (Table 1). They accounted for 15.26% of the studied population in the first lactation and for 2.54% in the second lactation, while no cases of lameness were noted in the third lactation. This could result from the fact that as many as 43 cows (11.68%) were culled for health disorders in the second lactation, and a total of 177 cows (48.10%) were culled in the second and third lactation. TWARDOŃ et al. (2001) demonstrated that on dairy farms over 15% of cows suffer from lameness. According to these authors, the most prevalent reasons for lameness include too high milk production levels, feeding excessive amounts of high-protein concentrate and insufficient amounts of high-energy feed to cows, genetic factors and inadequate foot care. EMPEL et al. (1986), and POGORZELSKA and LEWAROWSKI (2005) reported that hoof health is affected by housing conditions, as foot and leg abnormalities are much more common in the tie-stall system than in the free-stall system.

Endometritis was diagnosed most frequently in the investigated herd (Table 2), i.e. in more than 36% of cows in every lactation. CORREA et al. (1993) found that metritis causes massive economic losses on dairy farms, being the main reason for culling due to decreased milk production and impaired reproduction.

A high incidence of mastitis was noted in the present study (32.62%, 37.37% and 36.78% of cows in the first, second and third lactation respectively). Other frequently occurring health disorders in the analyzed herd were the formation of ovarian cysts (10.40%), lameness (6.44%) and retention of the placenta (1.62%). The most prevalent metabolic diseases (Table 2) were ketosis (8.39%) and abomasal displacement (0.34%).

In a study performed by FLEISCHER et al. (2001), the percentage of cows with metabolic diseases (acidosis, ruminal alkalosis and ketosis) increased in successive lactations. According to the above authors, this could be related

Table 2

Types of diseases diagnosed in cows during three consecutive lactations

Type of disease	Lactation						Average	
	I		II		III			
	N*	%	*n*	%	N	%	*n*	%
Endometritis	271	37.22	321	38.77	179	36.14	257	37.63
Mastitis	237	32.62	308	37.37	182	36.78	242.3	35.48
Formation of ovarian cysts	80	10.97	69	8.32	58	11.70	69	10.10
Ketosis	37	5.12	76	9.23	59	12.23	57.3	8.39
Lameness	88	12.03	44	5.29	–	–	44	6.44
Retention of the placenta	15	2.04	7	0.85	11	2.24	11	1.62
Abomasal displacement	–	–	2	0.17	5	0.91	2.3	0.34
Total	728	100	827	100	494	100	682.9	100

* – number of cases

to the diet whose influence on the health status of cows is particularly important at high milk production levels, reaching 7 to 10 000 kg per lactation. This relationship was also observed by BOHDANOWICZ-ZULA et al. (2004) who found that an increase in milk yield is often accompanied by the occurrence of metabolic diseases, especially at the first stage of lactation, due to the imbalance between milk production levels and nutrient supply and intake.

According to MALINOWSKI and KACZMAROWSKI (2003), the reasons for retention of the placenta in cows are complex and have not been fully elucidated yet. Retained placenta is a risk factor for both acute and chronic post-partum endometritis and the formation of ovarian cysts. The negative impact of retained placenta on the reproductive performance of dairy cows, leading to increased culling rates, has also been documented.

The time of disease occurrence after calving is shown in Table 3. Endometritis was diagnosed soonest after calving (18 days post-partum on average). In the oldest cows the symptoms appeared as early as on day 16 post-partum in the third lactation. Motor system disorders, including lameness, were recorded much later, on day 150 post-partum on average. Their occurrence is closely correlated with the age of cows, since younger animals generally have healthier legs and feet. During the first and third lactation, lame cows were detected within 194 and 82 days post-partum respectively. Mastitis was diagnosed on day 81 after calving in the third lactation, while in primiparous cows the symptoms of this disease were observed two months later. A decrease in cow performance was noted after recovery, ending the period of maximum milk production.

Table 3

Time of disease occurrence (days post-partum)

Type of disease	Lactation			
	I	II	III	Average
Endometritis	20	19	16	18
Mastitis	139	104	81	108
Formation of ovarian cysts	116	107	62	95
Lameness	194	173	82	150
Ketosis	40	30	35	35

GIL et al. (2007) studied the relationship between milk performance and fertility indicators in dairy cows and found that an increase in milk yield was accompanied by extended inter-pregnancy interval. Ovarian cysts and chronic endometritis were detected in 19% and 21% of the analyzed population respectively. STEVENSON and CALL (1988) demonstrated that the formation of ovarian cysts (diagnosed in 47% of cows) is observed most frequently between day 31 and 60 post-partum. Ovarian cysts are detected more often in older cows. Cows aged from 7 to 10 years are more prone to developing ovarian cysts than those aged 2 to 7 years. These regularities were not confirmed in the present study. NOGALSKI and GÓRAK (2007) stress the fact that blood analyses performed at the first stage of lactation may be a helpful reproductive management tool enabling to evaluate the metabolic profile of cows and to predict the optimum time for insemination. According to the above authors, conception rates can be increased in high-producing cows by prolonging the rest period after calving.

Milk yield and composition over three 305-day lactations, as dependent on the health status of cows, are presented in Table 4. In the first and second lactation, clinically healthy cows (HEA) were characterized by productivity exceeding 9000 kg milk. An even higher milk yield, i.e. 9487 kg in the second lactation and 9254 kg in the third lactation, was recorded in group 4 cows (REP).

GRÖHN et al. (1995) reported that reproductive disorders (metritis, ovarian cysts and retained placenta) had no effect on milk production levels, while RAJALA and GRÖHN (1998) demonstrated a negative impact of retained placenta on milk yield within a few weeks after the first calving. In a study conducted by STEVENSON and CALL (1988), cow productivity did not change during retention of the placenta, but this disorder caused a significant decrease in daily milk yield expressed in kg over the entire production cycle. STEVENSON and CALL (1988) pointed to an increase in milk production in cows with ovarian cysts over 305-day lactation, but during the extended inter-calving interval milk yield decreased by 2.5%. According to these authors, a high milk yield during

Table 4

Milk yield and composition in three 305-day lactations as dependent on the heath status of cows

Trait	Lactation	Group of cows									
		HEA		MAS		LAM		REP		MET	
		LSM	Se	LSM	Se	LSM	Se	LSM	Se	LSM	Se
Milk (kg)	I	7027^{A}	288	7355^{B}	302	8314^{C}	253	6997^{A}	273	6779^{A}	265
	II	9235^{A}	338	8804^{B}	403	8220^{C}	586	9487^{D}	412	8299^{C}	413
	III	9186^{A}	872	7610^{B}	406	8320^{C}	564	9254^{A}	551	7310^{D}	414
Significance of differences		$2.3>1^{xx}$		$2>3.1^{xx}$; $3>1^{x}$		$1.3>2^{xx}$		$2.3>1xx$; $2>3^{x}$		$2.3>1^{xx}$	
VCM (kg)	I	7665^{A}	279	8517^{B}	290	9414^{C}	294	8059^{D}	258	7555^{E}	248
	II	10112^{A}	293	9585^{B}	362	9389^{B}	608	10119^{A}	378	9177^{B}	376
	III	9898^{a}	589	9592^{b}	586	8423^{b}	725	10311^{c}	448	8456^{d}	441
Significance of differences		$2.3>1^{xx}$; $2>3^{x}$		$2.3>1^{xx}$		$1.2>3^{xx}$		$2.3>1^{xx}$		$2.3>1^{xx}$; $2>3^{x}$	
Fat (kg)	I	265^{A}	9.29	297^{B}	10.79	339^{B}	12.34	290^{A}	9.10	264^{A}	7.95
	II	343^{A}	11.32	353^{A}	11.28	348^{A}	25.00	353^{A}	10.14	321^{B}	13.77
	III	351^{A}	12.34	301^{B}	20.06	344^{B}	25.07	369^{A}	10.96	301^{A}	12.36
Significance of differences		$2.3>1^{xx}$		$2>1.3^{xx}$		n.s.d.		$2.3>1^{x}$		$2.3>1^{xx}$	
Fat (%)	I	3.77^{A}	0.12	4.04^{B}	0.13	4.08^{B}	0.09	4.14^{B}	0.09	3.90^{C}	0.13
	II	3.72^{A}	0.14	4.01^{B}	0.13	4.24^{C}	0.20	3.72^{A}	0.12	3.87^{D}	0.13
	III	3.82^{A}	0.45	3.96^{B}	0.11	4.14^{B}	0.19	3.99^{A}	0.13	4.12^{B}	0.12
Significance of differences		$3.1>2^{x}$		$1.2>3^{x}$		$2.3>1^{x}$		$1>3.2^{xx}$; $3>2^{x}$		$3.1>2^{xx}$	
Protein (kg)	I	235^{A}	9.01	256^{B}	9.67	274^{C}	7.90	240^{A}	7.54	230^{A}	8.04
	II	313^{A}	9.01	300^{A}	11.45	279^{B}	17.00	313^{A}	13.21	282^{B}	11.13
	III	303^{A}	25.86	261^{B}	17.02	285^{B}	21.20	317^{A}	14.96	250^{B}	11.50
Significance of differences		$2.3>1^{xx}$		$2>1.3^{xx}$		n.s.d.		$3.2>1^{xx}$		$2.3>1^{xx}$	
Protein (%)	I	3.35^{a}	0.04	3.48^{b}	0.05	3.29^{a}	0.04	3.43^{b}	0.05	3.40^{b}	0.07
	II	3.39^{a}	0.04	3.41^{a}	0.07	3.40^{a}	0.07	3.30^{b}	0.05	3.40^{a}	0.06
	III	3.30^{a}	0.07	3.43^{b}	0.07	3.43^{b}	0.05	3.43^{b}	0.08	3.42^{b}	0.04
Significance of differences		$2>1.3^{x}$		n.s.d.		$3>1^{x}$		$1.3>2^{x}$		n.s.d.	
Dry matter (kg)	I	854^{a}	25.42	926^{b}	34.24	1031^{c}	32.81	887^{a}	29.31	862^{a}	33.50
	II	1116^{a}	33.00	1083^{b}	41.66	1031^{b}	69.35	1127^{a}	42.77	1010^{b}	45.18
	III	1097^{a}	65.17	921^{b}	58.81	1029^{b}	77.06	1145^{c}	55.20	903^{a}	46.57
Significance of differences		$2.3>1^{xx}$; $2>3^{x}$		$2>1.3^{xx}$		n.s.d.		$3.2>1^{xx}$		$2>1.3^{xx}$	
Dry matter (%)	I	12.15^{a}	0.17	12.59^{b}	0.16	12.40^{b}	0.11	12.68^{c}	0.13	12.72^{c}	0.31
	II	12.09^{a}	0.17	12.30^{b}	0.18	12.54^{c}	0.25	11.88^{d}	0.14	12.17^{e}	0.19
	III	11.94^{a}	0.51	12.10^{b}	0.16	12.37^{c}	0.25	12.37^{c}	0.25	12.35^{c}	0.13
Significance of differences		$1>3^{xx}$; $1>2^{x}$		$1>2.3^{x}$		$2>1.3^{x}$		$1.3>2^{x}$		$1>3.2^{x}$	

Significance of differences between groups: *A, B* at $p \leq 0.01$ and *a, b* at $p \leq 0.05$;
Significance of differences between lactations: xx – $p \leq 0.01$ and x – $p \leq 0.05$.
n.s.d. – non-significant difference

previous lactations and a high genetic potential of cows do not contribute to disease occurrence.

In the present study the lowest milk yield was reported for cows with metabolic disorders (MET) – 6779 kg milk in the first lactation, 8299 kg milk in the second lactation and 7310 kg milk in the third lactation. Substantially higher productivity was noted when actual milk yield was converted into the yield of value-corrected milk (VCM), which exceeded 10 000 kg milk in healthy cows in the second lactation (10 112 kg) and in cows with reproductive diseases in the second and third lactation (10 119 kg and 10 311 kg respectively).

Regardless of the group, milk fat yield was lower in the first lactation (264 to 339 kg) than in the next two lactations. The highest fat yield was reported for the oldest cows of group 4 (REP) (369 kg). The same trend was noted with respect to milk protein yield, which was the lowest in the first lactation (230 to 274 kg). As regards the percentage content of milk components, the highest values were observed in cows characterized by the lowest milk yield, whereas the lowest – in cows marked by the highest milk yield. MICIŃSKI et al. (2008) analyzed disease incidence in dairy cattle herds and found that the highest-producing cows were most susceptible to diseases.

Conclusions

It was found that the most common diseases during three consecutive lactations in the investigated herd were endometritis (37.63%) which occurred soon after calving (on day 18 post-partum), mastitis (35.48%), formation of ovarian cysts (10.10%), ketosis (8.39%) and leg/foot defects (6.44%). Retention of the placenta and abomasal displacement were diagnosed much less frequently (1.62% and 0.34% respectively). The percentage of healthy cows decreased in successive lactations (19.81% in the first lactation, 12.28% in the second lactation, 6.22% in the third lactation). During each lactation, more than one third of cows suffered from mastitis. The proportion of cows showing the symptoms of ketosis increased with age, from 5.12% in the first lactation to 12.23% in the third lactation. The highest yields of milk and milk components over a 305-day lactation cycle were noted in cows with reproductive diseases. Foot/led defects and lameness, mastitis and metabolic diseases had the most significant effect on a decrease in milk production.

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