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PREVALENCE OF SELECTED METABOLIC DISEASES IN DAIRY HERDS IN EASTERN POLAND

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ABSTRACT

The aim of the paper is to investigate the prevalence of metabolic diseases in selected dairy farms. The metabolic status of the Polish Holstein-Frisian dairy cows (PHF) was assessed using the fat-to-protein ratio (F/P ratio). The chemical quality of raw milk produced between 2014 and 2017 in ten herds located in eastern Poland (counties: Łosicki, Radzyński, Sokołowski and Ostrów Mazowiecka) was studied in the research. Based on 4838 daily observations, milk performance of 491 cows was assessed. The following indicators were determined: milk F/P ratio, milk daily yield and the content of protein, fat and dry matter. Several factors influenced basic milk composition and milk F/P ratio were tested. There were 4 lactation number groups (1 – first; 2 – second; 3 – third and fourth; 4 – fifth to ninth lactation), 10 herds (numbers 1–10), 4 stage of lactation groups (1–3, 4–6 , 7–10, 11–18 months), 4 classes of daily milk yield ($\leq$15 kg, 15.1–25 kg, 25.1–35 kg, >35 kg), 4 calving seasons (summer, JUN–AUG, autumn, SEP–NOV, winter, DEC–FEB, spring, MAR–MAY) and 4 F/P ratio groups ($\leq$1, indicating rumen acidosis,SARA; 1.1–1.4, optimal; 1.41–1.7, indicating subclinical ketosis, SCK; >1.7, indicating clinical ketosis, KET). The average milk fat-to–protein ratio was 1.26, but it varied considerably within individual groups. The results also showed that 3313, i.e. 68.5%, of milk samples had the F/P ratio ranging from 1.1 to 1.4, indicating adequate nutrition with well-balanced daily rations. However, 8.2% of the observations indicated the occurrence of acidosis (SARA) in the cow population, 19.9% of the observations suggested the occurrence of subclinical ketosis (SCK) and 3.3% of milk samples were from cows affected with clinical ketosis (KET).

Key words: cows, ketosis, acidosis, Fat/Protein ratio

INTRODUCTION

Ketosis is the most important metabolic disease of high-yielding dairy cows. For the diagnosis of the disease the assessment of β-hydroxybutyrate acid (BHBA) is most commonly used. Its level alongside the concentration of acetone and acetylacetic acid in the body fluids is the most characteristic of ketosis symptoms [Työppönen and Kauppinen 1980]. It is assumed that the critical point for the occurrence of ketosis is the BHBA level in blood of 14.4 mg · dL^{-1} (>1.4 mmol · L^{-1}). For clinical ketosis, a critical level of BHBA above 29.0 mg · dL^{-1} (ca. 3.0 mmol · L^{-1}) in blood is used.

The current consensus is to consider a cutoff point of BHBA at least of 1.2 mmol · L^{-1} for subclinical ketosis [McArt et al. 2012]. The SCK is defined as concentrations of BHBA $\geq$1.2 to 1.4 mmol · L^{-1} in blood and it is considered as a gateway condition for clinical ketosis [Suthar et al. 2013].

Buttchereit et al. [2010] reported that milk F/P ratio reflects the energy balance status of a cow in early lactation. In breeding practice, the primary indicator of the occurrence of subclinical ketosis is high fat content in milk, higher than the standard. Another important consequence of ketosis is also an increase in the proportion of saturated acids in milk fat. Subclinical ketosis also leads to a decrease in milk yield. It can be lower up to 300 kg during one lactation [Rajala-Schultz et al. 1999].

According to Gravert [1991], the ideal range for milk F/P ratio is 1–1.25, while according to Duffield [2013], 1.33 is the upper margin. According to Haas and Hofírek [2004], F/P ratio that is higher than 1.4 shows energy deficit and, if ketone bodies are present, subclinical ketosis. Richardt [Richardt 2004] determined a 1.5 value of F/P ratio as the risk level for subclinical ketosis, while Eicher

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[2004] considered beside the F/P ratio, the daily milk production as well, in order to find the indication of metabolic disorders (acidosis, ketosis).

In recent years cattle breeders have become more and more interested in the milk F/P ratio, especially in the early stages of lactation. The main reason is the possibility of its use as an important energy balance criterion in assessing cow feeding. It is assumed that normal protein content in the milk of PHF cows ranges from 3.2 to 3.6%. Normal fat content in the milk of this breed ranges between 3.5% and 4.5%, but in the case of high-performance cows it is about 4% [Guliński et al. 2018]. The milk F/P ratio of a healthy cow fed with a well-balanced daily ration should ranged from 1.1 to 1.3. The F/P ratio above 1.4 means the possibility of subclinical ketosis. When the F/P ratio exceeds 1.7, it means the clinical form of ketosis, especially with low protein content in milk and relatively high fat content. If the F/P ratio is too low (<1), it may be indicative of subclinical acidosis, which is most commonly found when excessive feeding or abnormal physical structure of the ration is administered. In herds affected by acidosis there is a decrease in the milk yield, deterioration of health and, in effect, increased cow culling.

Protein content is an essential element affecting the buying-in price of milk. Milk protein price has doubled in the payment systems worldwide due to its higher suitability of this component for milk processing. In recent years, a number of dairies have introduced a payment system based on protein content in the milk following diet changes observed in the world when consumers prefer lower fat food. Currently in most countries of the world cow breeders put the main emphasis on improving cow's milk by increasing protein concentration and its efficiency and by ameliorating the fat to protein ratio [Miglior et al. 2005].

In breeding practice, cows whose milk F/P ratio is lower are assessed as being more easily impregnated. Research of Löf et al. [2014] showed that the fat to protein ratio could be a good indicator for diagnosing cows at risk of poor fertility in order to determine where preventive measures could be taken.

As concluded by Negussie et al. [2013] milk F/P ratio is easily available from routine milk-recording schemes. It can be used as a low-cost monitoring tool of poor health and fertility in the most critical phases of lactation and as an important indicator trait to improve robustness in dairy cows through selection. In the study by Heringstad et al. [Heringstad et al. 2005], posterior means of heritability of liability in first, second, and third lactations were for ketosis respectively 0.14, 0.16, and 0.15.

The aim of the paper is to analyze the prevalence of ketosis and acidosis in selected herds of dairy cattle located in eastern Poland.

MATERIAL AND METHODS

The chemical quality of raw milk produced between 2014–2017 in ten herds located in eastern Poland (counties: Łosicki, Radzyński, Sokołowski and Ostrów Mazowiecka) was studied in the research. The data were test-day milk yields from Polish Holstein – Frisian (PHF) dairy cows registered in the Polish national recording system (SYMLEK). With 4838 daily observations, the studies involved the evaluation of milk performance parameters of 491 PHF dairy cows. The following characteristics of milk performance were determined: milk daily yield, the content of protein, fat, dry matter and the fat to protein ratio in milk.

Several factors influenced basic milk composition and F/P ratio were tested. There were 4 lactation number groups (1 – first; 2 – second; 3 – third and fourth; 4 – fifth to ninth lactation), 10 herds numbers (1–10), 4 stage of lactation groups (1–3, 4–6 , 7–10, 11–18 months), 4 classes of daily milk yield ($\leq$15 kg, 15.1–25 kg, 25.1–35 kg, >35 kg), 4 calving seasons (summer, JUN–AUG, autumn, SEP–NOV, winter, DEC–FEB, spring, MAR–MAY) and 4 F/P ratio groups ($\leq$1, indicating rumen acidosis; 1.1–1.4, optimal; 1.41–1.7, indicating subclinical ketosis; >1.7, indicating clinical ketosis).

The linear model containing fixed effects of lactation number groups, herd number, lactation month, calving season, daily milk yield class and F/P ratio groups effect was used. The results were statistically processed applying the multifactor analysis of variance. The following linear model was used:

$$Y_{ijklmno} = \mu + a_i + b_j + c_k + d_l + \\ + f_m + g_n + e_{ijklmno}$$

where:

$Y_{ijklmno}$ – the value of the trait
μ – general mean
a_i – effect of the lactation period ($i = 1,2,3,4$)
b_j – effect of the herd number ($j = 1,2..10$)
c_k – effect of calving season ($k = 1,2,3,4$)
d_l – effect the lactation number groups ($l = 1,2,3,4$)
f_m – effect of the daily milk yield ($m = 1,2,3,4$)
g_n – effect of the milk F/P ratio ($n = 1,2,3,4$)
$e_{ijklmno}$ – random error.

Significance of differences between means was estimated with the Duncan test at the level of P = 0.01. To carry out calculations GLM and FREQ procedures (with use of chi-square test (χ^2) at P $\leq$ 0.01) of the SAS statistical package were used [SAS Institute Inc. 2008].

RESULTS AND DISCUSSION

Assessment of the milk capacity in the cow population

Table 1 presents data on the milk performance of the cow population. The daily production of 491 cows was determined using 4838 periodic observations. The average daily yield of milk varied considerably, and in 10 herds of the cattle it amounted to 22.1 kg and ranged from 15.9 kg (herd No. 2) to 30.4 kg (herd No. 6). Data on fat and protein content and the milk F/P ratio confirmed the well-known fact of high variation in the level of these parameters in PHF dairy cows. The highest fat content was in milk produced by herd 9 (4.53%), with the highest protein content in herd 1 (3.51%). The lowest level of fat was in the milk of cows in herd 8 (4.02%), and the lowest protein content was in herd 5 (3.20%).

The variation of the chemical composition of cows' milk is the result of a number of factors which consistently differentiate the level of individual components at the production level. The production conditions include the season of the year, the cow's age, the lactation stage and the pregnancy, the cow's condition during milk production, the disease (mainly metabolic and udder) and feeding [Litwińczuk et al. 2006, Antkowiak et al. 2007, Miciński and Pogorzelska 2011, Barłowska et al. 2014, Guliński et al. 2018]. In view of the high variation in milk chemical composition, some authors point out that the impact on the above factors should be taken into account when determining it. Guliński and Kłopotowska [2019] suggest including somatic cell count, nutrition level and the milk yield in studying PHF-typical milk chemical composition.

Effect of selected factors on the milk F/P ratio

Table 2 presents the distribution of the milk F/P ratio, according to the effects of factors listed in Materials and Methods. Based on 4838 observations the average value of the ratio amounted to 1.26, but it ranged from 0.01 to 3.06. A high statistically significant (P = 0.01) effect of the lactation period, the herd and the production level on the formation of the milk fat to protein ratio were noted in the research. The highest values of the ratio were found in milk produced during the first months of lactation, but also in the milk of cow herd 2 and in the milk of cows with the production level of 15–25 kg, with 1.32, 1.32 and 1.29, respectively.

Currently, in Poland the average milk F/P of PHF cows is 1.23 [Guliński et al. 2018]. After a 15-year assessment of cow population in southern Podlasie Guliński et al. [2018] found only a slight increase of this ratio. Similarly, only a slight variability of the F/P ratio was observed both throughout lactation and over the productive lifetime [Guliński et al. 2018]. The lowest average ratio reaching 1.15 was recorded by Barłowska et al. [2006] for Simmental and Jersey cows, and the highest (1.29) for Red-and-White cows. In other Simmental populations studied by Grega et al. [2000] and Barłowska et al. [Barłowska et al. 2005] this ratio was even lower and ranged from 1.07 to 1.19. In contrast, Litwińczuk et al. [2006], studying Black-and-White PHF milk, as well as the authors of many other studies [Bogucki and Sawa 2002, Barłowska et al. 2005, Górska et al. 2006] carried out on cows with varying amount of PHF blood recorded the similar average F/P ratio of 1.20.

In their studies of 1693 Holstein-Friesian cows in Germany, Buttchereit et al. [2012] recorded the average milk F/P ratio within the first 180 of lactation of 1.13. They estimated the heritability of the ratio at 0.30.

Distribution of the milk F/P ratio

Effect of selected factors on the distribution of the milk F/P ratio is presented in Table 3. According to the data in 68.5% of milk samples the fat to protein ratio ranged from 1 to 1.4, indicating that they came from cows fed with fully balanced food rations. In 19.9% of milk samples the F/P ratio ranged from 1.41 to 1.7, suggesting that they were from cows with subclinical ketosis. In 3.3% of total milk samples the fat to protein ratio was above 1.7, indicating clinical ketosis. Additionally, 8.2% of milk samples with the F/P ratio below 1 suggested that they came from animals affected with acidosis.

A detailed analysis of the effects of various factors revealed that the highest percentage of milk samples indicating subclinical ketosis was during the first three months of lactation (29.2% of the total), in the milk of herd 2 (31.9%) and the primiparous group (21.0%) and in the group with a daily yield of 15–25 kg (22.2%). The results showed that regarding the prevalence of clinical ketosis the greatest risk in the conditions of eastern Poland is associated with the first lactation trimester. During this period the F/P ratio of 7.7% of milk samples exceeded 1.7. It was also found that increasing milk yields of the cow population to a higher degree was accompanied by a higher risk of lactic acidosis than ketosis. In the group of cows with the average daily yield of milk of over 35 kg, 25.6% suffered from acidosis and 12.2% from ketosis (subclinical and clinical).

Generally, data on the prevalence of SCK vary considerably, depending on their source. The problem is mostly observed in poorly-fed animals with high milk production potential. In Poland among cows that were assessed for β-hydroxybutyrate acid the level exceeding 1.4 mmol · L^{-1} was found in at least 10% of the animals. However, according to Słoniewski after Guliński [2017], 20% of cows in the first lactation, 16% in the second and 23% in the third and subsequent lactation were affected in a similar way. In the USA and Canada, the prevalence

Table 1. General characteristics of the cow population

Tabela 1. Ogólna charakterystyka badanej populacji krów

Description Wyszczególnienie	Herd number Numer stada										Total / average Razem/ średnio
	1	2	3	4	5	6	7	8	9	10	
Number of cows, n – Liczba krów, n	29	22	49	37	24	72	170	30	28	30	491
Number of observations, n – Liczba obserwacji, n	345	256	484	367	248	887	1550	220	243	238	4838
Daily milk yield, kg – Wydajność dobowa mleka, kg											
Average – Średnia	22.5	15.9	22.3	17.5	21.3	30.4	18.5	23.9	18.8	29.6	22.1
Standard deviation – Odchylenie standardowe	6.1	6.0	8.1	5.3	8.5	6.2	6.2	6.2	6.0	6.0	8.6
Min.	6.0	5.1	3.6	6.0	4.1	6.0	3.0	9.9	1.6	16	1.6
Max.	46.0	40.4	46.0	34.4	50.0	60.0	44.0	49.3	40.8	47.6	60.0
Fat concentration, % – Zawartość tłuszczu, %											
Average – Średnia	4.36	4.53	4.26	4.12	4.43	3.97	4.56	4.02	4.53	4.20	4.33
Standard deviation – Odchylenie standardowe	0.95	0.83	0.75	0.97	0.97	0.90	0.79	0.64	0.80	0.75	0.87
Min.	1.79	1.86	2.40	2.20	1.55	1.59	2.04	2.45	1.63	2.71	1.58
Max.	9.17	8.14	6.58	8.97	7.5	9.87	9.0	7.42	7.55	6.79	9.87
Protein concentration, % – Zawartość białka, %											
Average – Średnia	3.51	3.43	3.50	3.20	3.50	3.47	3.46	3.28	3.44	3.29	3.43
Standard deviation – Odchylenie standardowe	0.46	0.43	0.44	0.48	0.50	0.49	0.45	0.38	0.58	0.42	0.47
Min.	2.53	2.45	2.59	2.26	2.18	2.20	2.27	2.38	2.21	2.25	2.18
Max.	5.14	4.88	4.91	5.27	5.21	6.01	5.62	4.43	5.96	4.73	6.01
Milk Fat/Protein ratio (F/P ratio) – Wskaźnik tłuszczowo-białkowy mleka											
Average – Średnia	1.24	1.32	1.21	1.28	1.26	1.14	1.32	1.23	1.33	1.25	1.26
Standard deviation – Odchylenie standardowe	0.22	0.20	0.18	0.24	0.20	0.21	0.21	0.16	0.23	0.18	0.22
Min.	0.51	0.46	0.01	0.29	0.53	0.35	0.30	0.72	0.72	0.83	0.01
Max.	2.77	1.95	2.12	2.75	2.34	3.05	2.92	1.74	2.41	2.01	3.05

of subclinical ketoses in bovine herds ranged from 30 to 50% [Duffield 2013].

Brunner et al. [2019] studied the prevalence of SCK and production-related clinical diseases in early lactating cows in various countries across the world, other than those in North America and Western Europe. Twelve countries of South and Central America (Argentina, Brazil, Chile, Colombia, Mexico), Africa (South Africa), Asia (Thailand, China), Eastern Europe (Russia, Ukraine), Australia, and New Zealand were assessed. Data from a total of 8,902 cows from 541 commercial dairy farms were obtained. A minimum of five cows per farm were blood sampled and examined once after parturition up to day 21 of lactation. Across all investigated countries, the SCK prevalence was 24.1%, ranging from 8.3% up to 40.1%. Despite differences in production systems across countries and variation between individual farms within a region, the authors pointed out that data on SCK prevalence aligned with observations in Western European and North American dairy herds [Brunner et al. 2019]. Data from 1693 Holstein-Friesian primiparous cows in Germany recorded within the first 180 days of lactation by Buttchereit et al. [2012] indicated that disease frequencies (percentage of cows with at least one case) was 9.7% for metabolic disorders.

Fiorentin et al. [2018] evaluated a total of 299 Holstein cows during early lactation (from calving to 30th day of lactation) in 15 herds located in the western region of Santa Catarina state in Brasil. Blood samples were collected for the measurement of BHBA. In that research, the cut-off point for SCK was when serum BHBA concentration was over 1.2 mmol · L^{-1}. The results showed a 9% occurrence of subclinical ketosis. Although no significant differences were observed in subclinical ketosis prevalence among cows with different production levels. The rate of this disorder was almost double in cows yielding more than 30 L per day than in cows producing 15–30 L per day, with 14.9% and 6.9%, respectively.

Asl et al. [2011] found that the prevalence of SCK was greatest in high-yielding dairy cows and in those with two or more lactations. Vlček et al. [2016] studied 208 Holstein cows from 3 dairy farms in west Slovakia calved between 2012 and 2015. The research included 908 test-day records of the yield from cows with 5 to 150 days in milk (DIM). The sample of cows produced 35.25 ±11.55 kg of milk daily. The average F/P ratio was 1.19 ± 0.25, and 19.71% of all observation were at risk of acidosis with 8.92% at risk of ketosis. The occurrence of ketosis risk decreased from 5 to 150 DIM. In the first month of lactation the proportion of ketosis risk was 22%, and in the fifth month it was 2.78%. The occurrence of acidosis risk increased and the occurrence of ketosis

Table 2. Effect of selected factors on the milk Fat/Protein ratio

Tabela 2. Wpływ analizowanych czynników na wielkość wskaźnika tłuszczowo-białkowego mleka

Factor Czynnik	Number of observations, n Liczba obserwacji, n	Milk Fat/Protein ratio Wskaźnik tłuszczowo-białkowy mleka			
		$\bar{x}$	SD	min	max
Stage of lactation – months – Okres laktacji – miesiące					
1–3	1351	1.32^{A}	0.26	0.46	3.06
4–6	1348	1.23^{B}	0.20	0.29	2.76
7–10	1522	1.24^{B}	0.19	0.01	2.92
11–18	617	1.21^{C}	0.18	0.35	1.91
Herd number – Numer stada					
1	346	$1.24^{E,D}$	0.22	0.51	2.77
2	257	1.32^{A}	0.20	0.46	1.95
3	485	1.21^{F}	0.18	0.01	2.12
4	367	1.28^{B}	0.24	0.29	2.75
5	249	1.26^{C}	0.20	0.53	2.34
6	883	1.14^{G}	0.21	0.35	3.06
7	1550	1.32^{A}	0.21	0.30	2.92
8	221	1.23^{E}	0.16	0.72	1.74
9	243	1.33^{A}	0.23	0.72	2.41
10	237	$1.25^{D,C}$	0.16	0.83	2.01
Calving season – Sezon wycielenia					
Summer, JUN–AUG – letni, czerwiec–sierpeiń	1351	1.33^{A}	0.26	0.46	3.05
Autumn, SEP–NOV – jesienny, wrzesień–listopad	1348	1.24^{B}	0.20	0.29	2.75
Winter, DEC–FEB – zimowy, grudzień–luty	1522	1.24^{B}	0.19	0.01	2.92
Spring, MAR–MAY – wiosenny, marzec–maj	617	1.21^{C}	0.18	0.35	1.91
Lactation number – Numer laktacji					
1	1656	1.27	0.21	0.35	2.76
2	1294	1.26	0.21	0.54	2.27
3–4	1439	1.26	0.24	0.01	3.06
5–9	449	1.26	0.24	0.46	2.90
Daily milk yield, kg – Wydajność dobowa mleka, kg					
≤15	1020	1.28^{A}	0.19	0.53	2.44
15.1–25	2280	1.29^{A}	0.21	0.01	2.92
25.1–35	1140	1.25^{B}	0.24	0.30	3.06
>35	398	1.15^{C}	0.24	0.53	2.44
Milk Fat/Protein ratio – Wskaźnik tłuszczowo-białkowy mleka					
≤1	399	0.87^{A}	0.13	0.01	1.00
1.1–1.4	3313	1.21^{B}	0.10	1.01	1.39
1.41–1.7	966	1.49^{C}	0.08	1.40	1.69
>1.7	160	1.88^{D}	0.26	1.70	3.06
Total/average – Razem/średnio	4838	1.26	0.22	0.01	3.06

A, B – The mean values within the factors marked with different letters differ significantly at P = 0.01.
A, B – Średnie w obrębie czynników oznaczone różnymi literami różnią się istotnie przy P = 0,01.

risk decreased from early to mid-lactation. Following Eicher's recommendations [Eicher 2004], subclinical disorder (ketosis/acidosis) was determined using the F/P ratio and the daily milk production. Additionally, the F/P ratio ≥1.5 in cows that yielded between 33 to 50 kg per day was used as an indicator of subclinical ketosis, while F/P ratio <1.0 in cows that yielded between 20 to 43 kg per day was used as an indicator of subclinical acidosis.

Gantner et al. [2016] studied first-parity cows of Holstein breed in Croatia and found that ketosis prevalence was highest in the first 15 days of lactation, with 33% of affected cows, while in cows with more lactations the prevalence peak was on the 25th day. Regarding acidosis prevalence, high values were determined at the beginning of lactation with a decreasing trend until mid-lactation, then the prevalence increased up to 22%. A

Table 3. Effect of selected factors on the distribution of the Fat/Protein ratio in milk

Tabela 3. Udział prób mleka z różną wielkością wskaźnika tłuszczowo-białkowego z uwzględnieniem analizowanych czynników

Factor Czynnik	Milk Fat / Protein ratio – Wskaźnik tłuszczowo-białkowy mleka							
	≤1		1.1–1.4		1.41–1.7		>1.7	
	n	%	n	%	n	%	n	%
Stage of lactation, months – Okres laktacji, miesiące								
1–3	105	7.8	746	55.2	394	29.1	105	7.7
4–6	121	8.9	951	70.5	252	18.6	24	1.8
7–10	109	7.1	1138	74.7	252	16.5	23	1.5
11–18	63	10.2	478	77.4	68	11.0	8	1.3
Herd number – Numer stada								
1	38	10.9	237	68.5	64	18.5	7	2.0
2	14	5.4	152	59.1	62	31.9	9	3.5
3	45	9.3	382	78.7	51	10.5	7	1.4
4	27	7.3	238	64.9	80	21.8	22	5.9
5	14	5.6	180	72.3	49	19.6	6	2.4
6	173	19.5	649	73.5	45	5.1	16	1.8
7	57	3.6	975	62.9	446	28.7	72	4.6
8	11	4.9	168	76.0	40	18.1	2	0.9
9	9	3.7	147	60.4	73	30.0	14	2.1
10	11	4.6	185	78.1	36	15.2	5	2.1
Calving season – Sezon wycielenia								
Summer, JUN–AUG – letni, czerwiec–sierpeń	62	5.7	763	70.0	221	20.3	44	4.0
Autumn, SEP–NOV – jesienny, wrzesień–listopad	130	10.3	824	65.4	264	20.9	42	3.3
Winter, DEC–FEB – zimowy, grudzień–luty	88	9.2	644	67.2	196	20.3	31	3.2
Spring, MAR–MAY – wiosenny, marzec–maj	161	10.5	1022	66.8	293	19.1	53	3.5
Lactation number – Numer laktacji								
1	123	7.4	1135	68.5	348	21.0	50	3.0
2	97	7.5	901	69.6	261	20.1	35	2.7
3–4	147	10.2	960	66.7	280	19.4	52	3.6
5–9	32	7.1	317	70.6	77	17.1	23	5.1
Daily milk yield, kg – Wydajność dobowa mleka, kg								
≤15	70	6.8	706	69.2	219	21.4	25	2.4
15.1–25	122	5.3	1578	69.2	507	22.2	73	3.2
25.1–35	105	9.2	782	68.6	202	17.7	51	4.4
>35	102	25.6	247	62.0	38	9.5	11	2.7
Total /average – Razem /średnio	399	8.2	3313	68.5	966	19.9	160	3.3

Test value $\chi^2 = 481.5$; differences significant at $P \leq 0.01$.
Wartość testu $\chi^2 = 481{,}5$; różnice istotne przy $P \leq 0{,}01$.

significant negative effect of subclinical ketosis on daily milk yield for each parity was noted. A decrease in milk yield of 4.21, 2.73, 2.78, 2.83 and 3.72 kg per day in each parity (i.e., parities 1, 2, 3 and 4+) was found within 35 days after the detection of subclinical ketosis.

Table 4 presents the effect of the milk F/P ratio on selected milk production traits. There was a significant effect of the ratio on the daily milk yield and fat, protein and dry matter content. The highest content of fat and dry matter was in milk with the highest F/P ratio (>1.7), with its average level of 5.78% and 14.2%, respectively. The lowest level of fat was in milk with the lowest F/P ratio (≤1), with the average of 3.08%. A strong relationship was noted between the F/P ratio and the milk production traits. An increase in F/P ratio was accompanied by a decrease in the concentration of protein and an increase in the amount of fat and dry matter in milk. In milk with milk F/P ratio ≤1, 1.1–1.4, 1.4–1.7, >1.7 the levels of protein were 3.46, 3.49, 3.32, 3.07, the levels of fat: 3.08, 4.22, 4.97, 5.78 and dry matter: 13.7, 13.1, 13.6, 14.2, respectively.

CONCLUSIONS

According to 4838 observations the average milk F/P ratio was 1.26, but large variation within individual factors

Table 4. The effect of the F/P ratio on selected milk production traits

Tabela 4. Wpływ wskaźnika tłuszczowo-białkowego mleka na wybrane cechy użytkowości mlecznej

Milk F/P ratio Wskaźnik tłuszczowo-białkowy mleka	Number of observations, n Liczba obserwacji, n	Daily milk yield, kg Dobowa wydajność mleka, kg		Fat content, % Zawartość tłuszczu, %		Protein content, % Zawartość białka, %		Dry matter content, % Zawartość suchej masy, %	
		x̄	SD	x̄	SD	x̄	SD	x̄	SD
≤1	399	26.3^{A}	11.8	3.08^{A}	0.59	3.46^{A}	0.49	$13.7^{A,B}$	1.4
1.1–1.4	3313	$21.9^{B,C}$	8.4	4.22^{B}	0.69	3.49^{A}	0.44	13.1^{B}	1.6
1.41–17	966	20.7^{C}	7.3	4.97^{C}	0.72	3.32^{B}	0.46	$13.6^{A,B}$	1.9
>1.7	160	22.8^{B}	8.1	5.78^{D}	1.06	3.07^{C}	0.45	14.2^{A}	1.3
Total /average Razem/średnio	4838	22.1	8.6	4.33	0.86	3.44	0.46	13.3	1.5

A, B – Means marked with different letters differ significantly at P = 0.01.
A, B – Średnie w obrębie czynników oznaczone różnymi literami różnią się istotnie przy P = 0,01.

was recorded. It was observed that in 3313 milk samples, i.e. 68.5%, the milk F/P ratio ranged from 1.1 to 1.4, indicating adequate nutrition and daily rations. However, 8.2% of the observations indicated the prevalence of acidosis in the cow population, 19.9% of the observations suggested the occurrence of subclinical ketosis and 3.3% of the milk samples were from cows affected with clinical ketosis. In addition, the analysis of the fat to protein ratio showed that cows in the first three months of lactation were particularly susceptible to metabolic problems. In this group the share of animals affected by acidosis or ketosis was close to 45%.

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CZĘSTOTLIWOŚĆ WYSTĘPOWANIA WYBRANYCH CHORÓB METABOLICZNYCH U KRÓW NA PRZYKŁADZIE STAD BYDŁA MLECZNEGO WSCHODNIEJ POLSKI

STRESZCZENIE

Celem pracy było przeanalizowanie częstotliwości występowania chorób metabolicznych w wybranych stadach bydła mlecznego. Z wykorzystaniem wskaźnika tłuszczowo-białkowego mleka krów rasy Polskiej Holsztyńsko-Fryzyjskiej (PHF) dokonano oceny ich statusu metabolicznego. W pracy przeanalizowano jakość chemiczną mleka surowego, które zostało wyprodukowane w latach 2014–2017 w dziesięciu stadach zlokalizowanych na terenie południowego Podlasia (powiaty: Łosicki, Radzyński, Sokołowski i Ostrów Mazowiecka). Analiza dotyczyła oceny wskaźników użytkowości mlecznej z 4838 obserwacji okresowych pochodzących od 491 krów. Oceniono następujące cechy użytkowości mlecznej: wydajność dobowa mleka, procentowa zawartość białka, tłuszczu, suchej masy i wskaźnik tłuszczowo-białkowy w mleku. W pracy analizowano wpływ szeregu czynników oddziaływujących na skład chemiczny mleka i wielkość wskaźnika tłuszczowo-białkowego w mleku. Były to: 4 grupy wiekowe obejmujące krowy, które ukończyły 1, 2, 3–4, 5–9 laktacje), poszczególne stada krów (1–10), 4 okresy laktacji (1–3, 4–6 , 7–10, 11–18 miesiące), 4 poziomy produkcyjne ($\leq$15 kg, 15,1–25 kg, 25,1–35 kg, >35 kg na dobę), 4 sezony wycielenia (czerwiec – sierpień, wrzesień – listopad, grudzień – luty, marzec – maj) oraz cztery poziomy wskaźnika tłuszczowo-białkowego w mleku ($\leq$1 wskazujący na kwasicę; 1,1–1,4 optymalny; 1,41–1,7 wskazujący na subkliniczną ketozę; >1,7 wskazujący na kliniczną ketozę). Przeciętna wielkość wskaźnika tłuszczowo-białkowego wyniosła 1,26. W pracy wykazano duże jego zróżnicowanie w obrębie poszczególnych czynników. Otrzymane wyniki wykazały także, że 3313 tj. 68,5% prób mleka charakteryzowało się wskaźnikiem tłuszczowo-białkowym zamykającym się w granicach 1,1–1,4 co wskazuje na poprawność żywienia i stosowanych dawek pokarmowych. 8,2% obserwacji wskazywało na występowanie kwasicy w badanej populacji krów, 19,9% obserwacji wskazywało na występowanie podklinicznej ketozy a 3,3% prób mleka pochodziła od krów dotkniętych kliniczną ketozą.

Słowa kluczowe: krowy, ketoza, kwasica, stosunek tłuszczowo-białkowy

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