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THE ANALYSIS OF PROGRESS IN THE QUALITY TRAITS OF MILK AND THEIR INTERDEPENDENCE WITH MILK YIELD IN SELECTED HERDS OF CATTLE UNDER PERFORMANCE CONTROL

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ABSTRACT

The study conducted an analysis of production traits such as somatic cell count and urea content in milk, as well as the following sources of variability: year of study, month of the year, and herd over a period of 21 years in the herds under analysis. Additionally, the study took into account the most important aspects of dairy cattle breeding, including behavior, nutrition, welfare, milking systems, and the functional types of cattle along with their respective breeds. It was demonstrated that all sources of variability (year of study, month of the year, herd) had a statistically significant impact on the assessed traits (somatic cell count and urea content). It should be noted that the somatic cell count varied. which may indicate a significant environmental impact on this parameter. Throughout most of the study period, the somatic cell count remained within the established norms. The transition from a traditional feeding system to a TMR feeding system in the herds led to an improvement in the qualitative composition of the milk. In this regard, it is recommended to implement modern technological systems in dairy cattle herds in the form of a TMR feeding system. The results obtained over the 21-year period in selected dairy herds indicate well-conducted breeding work and improvements in environmental conditions. which have led to increased production in these herds and enhanced milk quality.

Key words: milk production, farm, cattle, phenotypic progress

INTRODUCTION

Dairy cattle farming in Poland is a very important sector of the economy. It serves as a source of livelihood for numerous farms and their support systems. Milk obtained from cows allows for the production of many dairy products that are highly valuable in the human diet. The human body derives a range of micro and macroelements from milk that are essential for its proper functioning. Milk is also used in the cosmetics and pharmaceutical industries [Barłowska et al. 2011].

Over the past twenty years. milk yield in cattle has clearly increased. This growth is linked to greater knowledge among breeders, resulting in better feed selection and appropriate choice of breeding stock to improve the genetic conditions of cows. In recent years, there has also been an increased awareness regarding animal welfare; in the past, dairy cattle were kept in tethered barns. In such barns, breeders strive to create the best possible living conditions for the cattle. Furthermore, there is a growing awareness among the breeding community about cow health and health-promoting practices.

With the increase in milk yield, other parameters of milk, such as the percentage levels of protein and fat, the protein-to-fat ratio, somatic cell count, and other quality-related traits, also improve. The most widespread dairy cattle breed in the world is the Holstein-Friesian breed developed in the USA, which is found in 128 countries; in Poland, it constitutes 90% of the cattle population [Guliński 2017].

Somatic cells (SC) are cells that naturally occur in bovine milk. They mainly include leukocytes, but also macrophages, fibroblasts, lymphocytes, neutrophils, and other immune cells. In normal bovine milk, their count is about 100.000 per milliliter, but in cases of diseases or inflammatory conditions, this number can increase [Sharma et al. 2011].

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The somatic cell count (SCC) in milk is an important indicator of milk quality. A high somatic cell count may indicate infection or inflammation in the cow. Conversely, low SCC values are desirable. The most common causes of increased SCC are bacterial infections caused by mastitis bacteria. Infection can occur as a result of injury, contamination, or through the contamination of milking equipment [Katakiewicz 2016]. During a bacterial infection, the somatic cell count in milk increases because these cells are primarily immune cells that fight pathogens [Sharma et al. 2011].

To prevent an increase in somatic cell count, breeders must maintain hygiene during milking and use milking equipment that is easy to clean and disinfect. In the event of suspected infection, prompt treatment is essential to prevent more serious health issues in the cow and loss of milk quality [Guliński et al. 2016].

Production progress is influenced by genetic and environmental factors. When breeding animals and altering the genetic makeup of selected low-yield breeds to improve their genetic traits by introducing animals with outstanding breeding values, it is also necessary to enhance the environmental conditions for the animals. Basic environmental conditions include animal nutrition, particularly the provision of essential nutrients to improve their productivity (yield). Based on information from the Polish Federation of Cattle Breeders and Dairy Producers (PFHBiPM), the milk yield of dairy cows in our country has significantly increased. This is partly due to the transformation of our native cattle (mainly lowland black-and-white and lowland red-and-white breeds) into Polish Holstein-Friesian cattle. This has been primarily achieved through the artificial insemination of our cows with the semen of Holstein-Friesian bulls. This is one of the factors contributing to the increase in productivity of dairy cattle. Equally important in enhancing productivity has been the introduction of changes in animal nutrition. Traditional feeding has shifted from mainly roughage feeds, such as green fodder and silage, to the implementation of modern feeding systems like TMR and PMR. Additionally, a crucial factor influencing the increased productivity of dairy cattle is the focus on ensuring proper animal welfare, including changes in the housing system for the animals in barns. In many cases, these are very modern barns that provide the proper microclimate. Other modern technologies for animal husbandry have also been introduced, such as milking systems. Particular attention has been paid to the zoohygienic conditions of milk collection and to the health and hygiene of the udder. All of these aforementioned factors have undoubtedly contributed to the increase in productivity and improvement in milk quality. It should be emphasized that the involvement of breeders engaged in the breeding and husbandry of cattle is essential in all these efforts. Additionally, support from the government in terms of funding certain research and providing advisory services directly related to production and available to breeders is also needed.

The issues of breeding and production progress have been analyzed by many authors engaged in cattle breeding and usage [Guliński 2016, Szulc et al. 2016], as well as numerous foreign authors. Contemporary evaluation methods are at a high level. utilizing very precise statistical methods such as BLUP and ANIMAL MODEL. In addition, molecular genetics is incorporated into the assessment of value and pedigree, which accurately characterizes the genomes of animals, especially bulls.

The aim of the study was to analyze production progress over a period of 21 years of performance evaluation (from 2000 to 2020) related to milk quality in selected herds undergoing milk performance assessment. The analysis focused on the following traits: somatic cell count and urea content in milk.

MATERIAL AND METHODS

The research material was collected from five farms located in the Podlaskie Voivodeship, which were subject to milk performance control conducted by the Polish Federation of Cattle Breeders and Dairy Producers. The study focused on the following traits:

- urea content in milk,
- somatic cell count (SCC).

The analysis included five herds of Polish Holstein-Friesian observed over a period of 21 year, from 2000 to 2020.

Farm 1: maintained 60 dairy cows in a free-stall system. During the study period, the herd size remained at a similar level. The breeding work of the farm owner involved systematically inseminating cows with purebred Holstein-Friesian bulls and retaining only purebred Holstein-Friesian cows for further breeding. As a result, by 2020, all dairy cows kept on this farm were of the Holstein-Friesian breed. The cattle on this farm have been fed a mixed feed ration prepared according to the TMR system from the beginning.

Farm 2: in 2000 the herd consisted of 52 cows, and over the analyzed years, this number increased to 71 cows. Initially, the cattle were kept in a tie-stall system and fed traditionally. In 2010, with the increase in herd size. the barn was modernized to a free-stall system. Since then, the feeding method for the cows has been based on the TMR system. The cattle kept on the farm were of the Polish Holstein-Friesian breed.

Farm 3: kept 19 dairy cows in 2000. The breeder's systematic efforts to increase production and milk yield by breeding cows exclusively with purebred Holstein-Friesian bulls and introducing only heifers and PHF into the herd led to an expansion to 85 cows by 2020. At the same time, after the construction of a free-stall barn in 2007, the feeding system was changed from traditional to TMR.

Farm 4: maintained 83 Polish Holstein-Friesian cows. Throughout the entire study period, the cattle were kept in a free-stall barn. Milking took place in a side-by-side milking parlor, and feeding was based on the TMR system, with PMR used periodically.

Farm 5: over the analyzed years, it maintained an average of around 80 dairy cows in two tie-stall barns. Until 2008. the cattle were fed traditionally, then switched to the TMR system. Milking was carried out using a wireless milking machine.

The data were collected based on breeding records available in selected farms located in the Podlaskie Voivodeship. The breed raised in the evaluated herds was the Polish Holstein-Friesian breed.

The collected research results were subjected to statistical analysis. Arithmetic means and standard deviations were calculated, taking into account the effects of the study year. calendar month. and herd (farm). Correlations were also estimated between sources of variability and the analyzed traits. as well as between the analyzed traits themselves. Regression coefficients were calculated based on the study year and month for the traits under investigation.

Multifactorial analyses of variance with interaction were performed for individual traits, taking into account the effects of the study year, calendar month, and farm (herd). The calculations were carried out using the SAS statistical software [SAS 2000].

RESULTS

Table 1 presents the means and standard deviations for the characteristics: urea content and the number of somatic cells, depending on the year of study. The number of somatic cells experienced dynamic changes throughout the study period. Differences were noticeable both between years, where year-to-year differences reached up to 150.000. In 2012, the number of somatic cells was 231.7 thousand, and already a year later, this value increased to 383.3 thousand. The largest changes occurred in farm no. 1, where SCC (somatic cell count) fluctuated from 560,000 in 2008 to 157,000 in 2010. The smallest changes were observed in animals from farms 4 and 5, though there were both increases and decreases there as well.

The urea content over the studied years remained at a similar level, with only slight variations ranging from 212.8 to 247.6 mg · ml^{-1}. The standard deviation ranged between 30.32 and 66.77 (Table 1).

Table 3 presents the urea content and the number of somatic cells in different herds and months of the year. All farms started the year at a similar level regarding the number of somatic cells. averaging around 318.000 per ml. In May almost all farms except for farm 5 recorded an increase in somatic cells to over 360.000 per ml. During the summer months, farms 1, 2 and 3 experienced an increase in somatic cells in the milk. The highest results in terms of somatic cell count were shown by herd number 1 reaching 482.6 thousand per ml in July. At the beginning of autumn (October), the somatic cell count remained at a lower level, below 300 thousand per ml. Farm number 4 experienced its peak in somatic cell count in May, exceeding 370 thousand per ml. Farm number 5 maintained a steady somatic cell count below 310.000 throughout the year, with a slight increase to just above 310 thousand per ml in June and again in September (Table 3).

The highest urea level was recorded in farm no. 2, reaching 307.33 mg · ml^{-1} in 2013 (Table 2). When analyzing the value of this parameter depending on the month of the calendar year, it was found that in February, urea reached its highest value, specifically 270.3 mg · ml^{-1}. From February to June, it remained at a level of around 260–270 mg · l^{-1}. From July to October, the urea level fluctuated below 260 mg · l^{-1}, only to rise again in the remaining months. In farm no. 4, the value of the studied parameter remained between 231 mg · ml^{-1} and 248 mg · ml^{-1} throughout the year. Only in July did it drop below 230 mg · ml^{-1}. The highest urea value in this herd was recorded in October, slightly below 250 mg · ml^{-1}. The other farms showed dynamic changes in the content of this quality parameter, indicating the level of feeding in the respective farms (Table 3).

Table 4 presents correlations and significance levels with respect to traits (milk yield, fat content percentage, protein content percentage, somatic cell count, urea level, fat-to-protein ratio, FCM and ECM indices) as well as sources of variability (study year, month of the year, herd). The highest correlation value can be observed between the FCM and ECM indices, amounting to 0.9984, and between milk yield and the FCM and ECM indices, amounting to 0.9884 and 0.9899, respectively.

Table 5 presents a regression analysis between traits (milk yield, fat percentage, protein percentage, somatic cell count, urea content, fat-to-protein ratio, FCM. and ECM indices) and sources of variability (year, month). The highest regression value can be observed between somatic cell count and month of the year (1.8689), while the lowest was between month and the FCM index (–0.0314).

DISCUSSION

Fiedorowicz [1998, 2006] highlighted the issue of changes in milk yield and their impact on quality following the implementation of modern technologies using TMR in his studies. The research showed a significant improvement in both milk yield and quality after changing the cow management technology. The issue of im-

Table 1. The number of somatic cells and urea depending on the year of study

Calendar year	Urea, mg · ml^{-1}		Somatic cell count, thousands per mL	
	$\bar{X}$	SD	$\bar{X}$	SD
2000	232.7	51.73	358.8	147.94
2001	226.6	66.77	341.0	147.99
2002	237.4	56.72	270.5	95.22
2003	237.9	37.54	337.2	110.27
2004	212.8	38..61	286.1	125.96
2005	222.2	46.93	351.4	128.00
2006	239.9	47.96	338.9	126.79
2007	235.8	45.84	321.8	29.45
2008	247.6	53.81	366.3	304.19
2009	242.2	52.98	388.6	148.31
2010	234.9	51.53	277.7	111.21
2011	229.4	37.92	331.6	109.37
2012	221.5	54.50	231.7	110.48
2013	214.3	61.08	383.3	180.15
2014	219.2	36.50	354.8	120.56
2015	218.9	45.83	317.2	89.83
2016	244.2	57.31	312.4	122.37
2017	229.7	30.32	389.2	158.32
2018	231.2	46.84	363.7	102.76
2019	233.7	43.24	351.0	127.81
2020	244.8	45.78	358.1	131.27

$\bar{X}$ – arithmetic mean, SD – standard deviation

Table 2. The number of somatic cells and urea depending on the herd and the year of research

	SCC, thousands per mL					Urea, mg · ml^{-1}				
Herd year	1	2	3	4	5	1	2	3	4	5
2000	321.00	440.75	393.42	288.25	350.42	253.75	232.92	231.75	261.75	183.25
2001	436.08	335.50	429.00	246.83	257.75	209.50	277.83	256.08	232.5	156.92
2002	264.17	281.00	157.50	344.67	305.25	237.92	265.08	203.00	267.42	213.42
2003	383.58	326.42	284.67	356.92	334.33	232.58	257.50	226.17	247.67	225.75
2004	314.08	435.75	144.50	292.83	243.17	207.83	223.58	182.25	231.83	214.92
2005	346.42	364.83	335.33	362.42	348.00	221.08	254.42	176.00	234.42	224.92
2006	302.83	408.50	396.33	313.50	273.33	227.83	294.67	220.33	244.67	212.17
2007	384.00	247.17	406.58	302.08	268.92	228.42	235.5	258.00	236.92	220.00
2008	560.08	417.50	215.58	341.42	296.75	222.58	280.17	243.17	236.5	255.75
2009	429.00	409.25	488.67	310.42	305.5	256.08	264.25	224.25	247.33	218.92
2010	157.50	267.58	388.42	322.08	253.08	203.0	246.33	252.42	244.17	228.50
2011	284.67	367.08	394.08	288.25	323.92	226.17	233.5	225.67	232.42	229.17
2012	144.50	248.08	177.50	355.42	232.75	182.25	266.67	193.75	243.42	221.58
2013	386.08	420.50	365.50	379.58	365.00	161.92	307.33	161.92	220.25	219.83
2014	356.58	366.83	482.50	314.33	253.50	186.25	243.50	217.08	230.0	219.25
2015	293.33	285.08	380.33	306.33	320.75	200.0	271.17	184.08	219.42	219.75
2016	356.33	305.58	324.00	270.50	305.33	241.33	264.25	241.33	250.00	305.33
2017	488.67	430.58	488.67	274.92	262.92	224.25	262.0	224.25	220.75	217.42
2018	388.42	403.58	388.42	314.83	323.33	252.42	216.92	252.42	209.42	224.83
2019	394.08	354.67	394.08	299.33	312.92	225.67	266.08	225.67	229.75	221.33
2020	348.67	291.92	505.00	335.50	309.50	246.33	286.67	237.67	242.00	211.50

Table 3. Number of somatic cells and urea depending on the month of the year and herd of cows (herd number)

Month		Herd – No.									
		1	2	3	4	5	1	2	3	4	5
		Urea, mg · ml^{-1}					Somatic cell count, thousands per mL				
I	X̄	202.2	252.3	213.4	233.2	204.5	327.4	322.0	315.8	317.9	306.8
	SD	±33.21	±39.05	±51.76	±25.38	±35.23	±130.79	±116.10	±142.53	±88.95	±144.03
II	X̄	1218.7	270.3	225.5	239.9	213.3	289.2	319.4	278.4	312.8	274.4
	SD	±47.32	±56.70	±56.55	±26.65	±48.77	±154.19	±103.21	±170.43	±72.42	±58.96
III	X̄	219.5	261.2	207.3	234.4	218.8	291.5	336.5	334.1	294.5	304.5
	SD	±57.07	±35.12	±61.10	±21.94	±31.38	±121.15	±119.21	±190.76	±87.73	±129.03
IV	X̄	228.7	268.8	226.4	234.2	225.0	326.9	348.2	309.1	340.5	278.1
	SD	±50.32	±59.52	±36.33	±22.60	±37.28	±144.70	±132.46	±165.69	±75.02	±71.93
V	X̄	225.4	262.5	227.4	241.9	213.6	367.9	376.8	376.1	372.9	296.3
	SD	±52.68	±41.73	±59.71	±30.57	±37.91	±176.68	±139.73	±156.48	±131.63	±78.32
VI	X̄	213.8	266.4	180.4	240.9	213.1	346.3	388.2	371.3	336.9	314.5
	SD	±51.86	±55.37	±52.77	±30.72	±19.34	±122.93	±125.40	±180.44	±103.72	±110.46
VII	X̄	212.3	252.1	210.5	226.1	218.4	482.6	359.2	428.0	304.1	304.3
	SD	±30.85	±46.54	±37.18	±38.46	±37.30	±473.58	±119.28	±185.84	±74.14	±72.08
VIII	X̄	239.6	259.9	232.9	242.3	220.3	390.0	419.0	456.7	299.3	298.1
	SD	±42.51	±67.72	±74.88	±41.52	±26.14	±156.75	±171.21	±194.28	±87.77	±59.44
IX	X̄	241.0	241.5	240.5	238.0	211.4	402.6	338.6	449.0	294.7	311.6
	SD	±67.67	±47.08	±78.20	±32.11	±35.98	±197.80	±101.14	±224.98	±78.25	±64.63
X	X̄	224.4	263.7	218.5	248.6	221.8	299.3	352.6	304.3	293.2	309.6
	SD	±35.77	±66.94	±52.32	±39.04	±37.29	±95.70	±128.31	±118.47	±56.30	±83.35
XI	X̄	220.2	248.7	212.7.	231.4	211.8	322.8	338.1	363.3	299.1	301.8
	SD	±42.69	±56.67	±58.84	±29.27	±56.47	±166.52	±117.78	±184.09	±73.27	±64.25
XII	X̄	209.8	267.1	219.7	236.2	235.9	347.9	334.6	322.6	317.2	269.4
	SD	±40.49	±71.67	±54.37	±29.26	±64.15	±137.34	±99.97	±151.97	±113.77	±94.83

proving milk yield and quality has also been analyzed in the works of Guliński [2017] and Guliński et al. [2002], as well as Guliński and Salamończyk [2007]. The issue of the quantity and quality of milk and the impact of environmental factors, primarily the varied feeding system, has been analyzed in the works of Litwińczuk [2000], Litwińczuk and Szulc [2005] and Litwińczuk et al. [2018]. Salamończyk and Guliński [2007] examined the influence of selected genetic and environmental factors on milk production volume.

The intensification of milk production is often associated with changes in productivity and, to a lesser extent, in milk composition. Intensive production requires a significant improvement in cattle breeding conditions, particularly in nutrition. This affects both the quantity of final production and the chemical composition of milk [Reklewski 2008].

The impact of intensive feeding of high-yielding cows on urea levels was analyzed in the work of Szarkowski et al. [2009], It was found that the intensification of feeding has a significant effect on the increase of urea levels in milk. This may also influence the composition of other parameters that determine milk quality.

The composition of bovine milk can vary significantly depending on factors such as nutrition, the animal's health status. lactation stage, age of the cow, and breed of the animal. bovine milk is composed of 87% water, with various proteins (such as casein, albumin, and globulin) making up 3.2% to 3.5% of the milk's mass, fat content ranging from 3.4% to 4%, and carbohydrates from 4.6% to 5%, with lactose being the main carbohydrate in bovine milk. The milk also contains B vitamins, as well as vitamins A, D, E, K, and pantothenic acid. In addition, the composition of milk includes minerals such as calcium, potassium, phosphorus, sodium, magnesium, and chloride. Gregory et al. [1998] demonstrated a relationship between the health condition of the animal and the composition and quality of milk. In the five studied farms, differences in the quantity, composition, and quality of milk produced by cows were also observed, indicating that there were differences in the nutrition and management of the animals in these farms.

An important component of milk is urea. Urea in bovine milk is one of the indicators of its quality as well as the quality of cow nutrition. Typically, low urea concentration in milk indicates good cow nutrition and health status, while high urea concentration may indicate health

Table 4. Correlation indicators and significance of indicators between traits and somatic cell count and urea content, as well as sources of variability

	Milk yield, kg	% fat	% protein	SCC thousands per mL	Urea, mg · ml^{-1}	Fat/protein ratio	FCM, kg	ECM, kg
Year	0.337 < 0.000	0.212 < 0.000	0.322 < 0.000	0.059 0.035	0.007 0.808	–0.023 0.422	0.391 < 0.000	0.400 < 0.000
Month	–0.013 0.649	–0.033 0.250	0.075 0.008	0.044 0.117	0.027 0.344	–0.071 0.012	–0.019 0.496	–0.015 0.599
Herd	0.583 < 0.000	–0.329 < 0.000	–0.252 < 0.000	–0.137 < 0.000	–0.087 0.002	–0.127 < 0.000	0.556 < 0.001	0.547 < 0.000
Milk yield, kg	1.000	–0.385 <0.000	–0.036 0.197	–0.091 0.001	–0.008 0.767	–0.301 < 0.000	0.988 < 0.000	0.990 < 0.000
% fat		1.000	0.136 < 0.000	0.136 < 0.000	–0.015 0.606	0.761 < 0.000	–0.243 < 0.000	–0.263 < 0.000
% protein			1.000	0.062 0.027	0.199 < 0.000	–0.532 < 0.000	–0.016 0.576	0.032 0.255
SCC thousands per mL				1.000	0.066 0.018	0.079 0.005	–0.073 0.010	–0.073 0.010
Urea, mg · ml^{-1}					1.000	–0.138 < 0.000	–0.008 0.780	0.003 0.908
Fat/protein ratio						1.000	–0.194 < 0.000	–0.241 < 0.000
FCM, kg							1.000	0.998 < 0.000
ECM, kg								1.000

problems or inadequate nutrition. However, it is important to remember that urea concentration in bovine milk is just one of many indicators of milk quality and should not be assessed in isolation but rather in the context of other indicators, such as fat and protein content, bacterial counts, and the presence of prohibited substances. The urea content in milk underwent significant changes over the years in the studied farms, which may indicate variability and seasonality in cattle feeding practices on these farms. The highest urea levels were recorded in farm number 2. According to the literature [Borkowska et al. 2006, Guliński et al. 2008, Radkowska 2012], the urea content in bovine milk typically ranges from 0.1 to 0.4 g · l^{-1}. However, in certain cases, such as metabolic or nutritional stresses, metabolic diseases, inflammatory conditions of the mammary gland, or increased protein intake in the diet, the urea content in milk may increase.

Other important parameters that are studied to assess milk quality include fat content, protein content, lactose, somatic cells from the mammary gland, and microorganisms. Litwińczuk et al. [2018] conducted research on the mineral content and basic chemical composition of milk from cows of different breeds raised in organic and conventional farms, with both intensive and traditional feeding systems. In the study, milk samples were taken from 60 cows representing three breeds: Polish White, Polish Red, and Simmental. The results showed that there were no significant differences in urea content between cows raised in different feeding systems or depending on the breed of the cows. The average urea content in milk was approximately 0.1 g · l^{-1} [Litwińczuk et al. 2018].

The somatic cell count in milk is an indicator of udder health in cows and milk quality. A high somatic cell count in milk is usually a result of udder infection, meaning that milk from such an udder does not meet quality standards.

The somatic cell count in milk is expressed in thousands of somatic cells per milliliter of milk. The average somatic cell count in bovine milk is around 200.000 to 400.000 per milliliter, but this value can vary depending on factors such as lactation period, cow age, nutrition, and breeding conditions.

The most common cause of an increase in somatic cell count in milk is an infection caused by bacteria, fungi, or viruses. These infections can lead to udder diseases, such as mastitis, and in severe cases, may even result in reduced milk quality or its complete withdrawal from the market. A high somatic cell count in milk is unfavorable not only for milk quality but also from the perspective of cow health and productivity. Therefore, it is important to provide proper udder care and maintain appropriate sanitary-hygienic conditions, as well as to implement udder disease prevention measures, such as vaccinations or other preventive methods [Sawa 2004].

Table 5. Regression indicator between traits (somatic cell count. urea content) and sources of variability (year. month)

Trait	Year	Month
SCC, thousands per ml	0.005	1.869
Urea, mg · ml^{-1}	0.056	0.383

Harmon [1994] describes the impact of mastitis on physiological and behavioral indicators of cow welfare, such as body temperature, respiratory rate, rest periods, social interactions, and more. The author indicates that mastitis causes pain and discomfort in cows, which negatively affects their welfare. The article also provides information on factors influencing the risk of mastitis in cows, such as udder hygiene, breeding systems, and nutrition. The author emphasizes the need to prevent mastitis through the use of appropriate breeding practices and disease prevention. The article also presents various methods for diagnosing and treating mastitis in cows, as well as possible ways to improve the welfare of cows with mastitis. According to the author's findings, the occurrence of udder inflammation is more common during the summer months.

In summary, the overall results obtained in this study are very promising. They reflect the significant commitment of breeders – farm owners – to the comprehensive improvement of both environmental factors and the genetic enhancement of cattle herds for dairy productivity. However, it should be noted that this study did not include a detailed analysis of the impact and changes in the breeding values of cows. The focus of the study was on analyzing production progress in selected herds. However, it should be understood that production progress would not be possible without improving the breeding value of the animals. High breeding value requires significant improvement of the environment, including nutrition, as well as improvements in the animal management system.

Milk productivity in cattle in our country has been the subject of research by many distinguished scholars. Their works are compiled in both original publications and in monographs and textbooks. It is worth noting at least some of the authors who have addressed the full range of issues related to cattle productivity, including Litwińczuk [2000], Litwińczuk and Szulc [2005], Reklewski [2005], Reklewski [2008], Szarek [2010], Szulc [2016], Guliński [2017] and, among many others. The above works contain a detailed analysis of the factors related to cattle breeding and utilization. All these authors highlight the complexity of issues associated with cattle breeding and husbandry. These studies also address the economic aspect of dairy productivity in cattle, as well as the strategic aspect related to food security in the country.

CONCLUSIONS

Based on the results obtained, the following summary and conclusions were formulated:

1. The analysis of variance conducted for the assessed quality traits showed that all sources of variability (year of study, month of the year, herd) and the interaction of year x herd had a statistically significant impact on the evaluated traits (somatic cell count, urea content). The interaction of month x herd was not statistically significant.
2. The somatic cell count underwent dynamic changes throughout the study period. Differences were noticeable between years, with year-to-year variations reaching up to 150.000. The situation was dynamic in all herds, but the most significant changes occurred in the first herd, where fluctuations ranged from 560.000 cells per ml in 2008 to 157.000 cells per ml in 2010. Herds 4 and 5 were the most stable in terms of this parameter, although slight fluctuations were also observed in these herds.
3. The urea content over the studied years remained at a similar level, with only slight variations ranging from 212.8 to 247.6 mg · ml^{-1}. The highest level of this parameter was observed in animals from farm 2, reaching as much as 307 mg · ml^{-1} in 2013. In farm 4, the urea level was consistently stable, falling within accepted quality standards. The other farms showed minor fluctuations in this parameter, likely related to the quality of animal feed.
4. The improvement in milk production achieved in herds 2 and 5 resulted from changes in the management technology for the cows. These herds transitioned from traditional feeding methods to a TMR feeding system. The production results obtained in these herds have significant practical implications. It is recommended to implement modern technological systems. such as the TMR feeding system, in dairy cattle herds.

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ANALIZA POSTĘPU W ZAKRESIE CECH JAKOŚCI MLEKA I ICH WZAJEMNEJ ZALEŻNOŚCI Z WYDAJNOŚCIĄ MLECZNĄ W WYBRANYCH STADACH BYDŁA OBJĘTYCH KONTROLĄ UŻYTKOWOŚCI

STRESZCZENIE

W pracy została przeprowadzona analiza cech produkcyjnych takich jak liczba komórek somatycznych i zawartość mocznika w mleku oraz następujących źródeł zmienności: rok badań, miesiąc w roku oraz stado na przestrzeni 21 lat w stadach objętych analizą. Ponadto w pracy uwzględniono najważniejsze aspekty chowu i hodowli bydła mlecznego, do których można zaliczyć: behawior, żywienie, dobrostan, systemy udoju mleka oraz typy użytkowe bydła i należące do nich rasy. Wykazano, że wszystkie źródła zmienności (rok badań, miesiąc w roku, stado) miały statystycznie istotny wpływ na oceniane cechy (liczba komórek somatycznych i zawartość mocznika). Należy stwierdzić, że liczba komórek somatycznych wahała się, co może świadczyć o znaczącym wpływie środowiska na ten parametr. W przeważającej części okresu badań liczba komórek somatycznych była w granicach określonych norm. Wprowadzenie w stadach zmiany systemu żywienia z tradycyjnego na system żywienia TMR spowodowało poprawę składu jakościowego mleka. W związku z tym zaleca się wdrażanie w stadach bydła mlecznego nowoczesnych systemów technologicznych w postaci systemu żywienia TMR. Wyniki uzyskane w okresie 21 lat w wybranych stadach krów mlecznych świadczą o prawidłowo prowadzonej pracy hodowlanej i poprawie warunków środowiskowych, dzięki którym nastąpił wzrost produkcji w tych stadach i poprawa jakości mleka.

Słowa kluczowe: produkcja mleka, gospodarstwo rolne, bydło, postęp fenotypowy

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