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COMPARISON OF THE NUTRITIONAL VALUE AND TECHNOLOGICAL SUITABILITY OF MILK OF HOLSTEIN-FRIESIAN COWS FROM POLAND AND IMPORTED FROM SWEDEN AND GERMANY

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Abstract. The aim of this study was to determine the effect of the origin of Holstein-Friesian cows on the yield, concentration of protein fraction components and selected technological parameters of cow's milk. The fifty Holstein-Friesian cows from Poland, Sweden and Germany were involved in the experiment. The analysis of milk, protein and fat yield showed advantage of cows from Poland over those imported from Sweden and Germany. On the other hand, the most advantageous protein/fat ratio was found in the milk of Swedish cows. The analysis of the selected technological parameters of milk including the country of origin of cows revealed that the milk from Polish cows was characterized by a higher content of casein, dry matter and solids-not-fat than imported cows. The highest concentration of β-lactoglobulin and bovine albumin serum was observed in the milk of Swedish cows, whereas the milk from Polish cows was characterized by the highest level of α-lactoalbumin, lactoferrin and lactoperoxidase. The results of this study show that only the introduction of animals with high genetic potential can bring financial benefits expected from the sale of raw milk. Origin of animals plays an important role in determining of whey protein fraction and technological usefulness of milk.

Key words: cow milk, protein fraction, technological usefulness, Holstein-Friesian breed

INTRODUCTION

Diversity of breeding progress observed in many countries is the result of coincidence of different factors e.g. the genetic material of animals, breeding programs

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and environmental conditions. The import of breeding cattle with high genetic potential from the European Union to Poland accelerate the breeding progress [Kuczaj 2009]. Holstein-Friesian is the predominant dairy breed in Poland. There is also a strong genetic impact of populations of HF cows from Canada, Germany, France and the Netherlands on native population. In the Netherlands, for many years negative selection for milk yield, and great emphasis to quality of milk fat has been carried out. Whereas in Germany and in Poland selection index was focused on protein yield [Van Raden 2004]. However, transport stress often leads to problems with the acclimatization of animals in the new environmental conditions. In the imported cattle, worse performance, which is associated with hindered adaptability were observed Czerniawska-Piątkowska et al. [2009].

Protein is the basic structure of all living cells. Functional properties of proteins have decided that, in many countries, milk protein was the most important ingredient. The level of protein in cow's milk ranges from 31 to 36 g $\cdot$ kg^{-1}. The concentration of protein in milk is dependent on genetic factors (breed, intra-individual characteristics), environmental and physiological effects. The protein fraction of cow's milk is composed of six major proteins, which include: α-lactalbumin, β-lactoglobulin, a fraction α_{S1}-, α_{S2}-, β- and κ-casein. These proteins, in large part determine the quality of the technological and nutritional properties of milk [Heck et al. 2009].

Importing cattle from other countries is common practice of breeding. However, we cannot forget about the genetic potential of our native animals, which in many cases have a significantly better parameters of production or better technological usefulness of milk. So, the aim of this study was to determine an effect of the origin of Holstein-Friesian cows on the yield, concentration of protein fraction components and selected technological parameters of milk, and show which cows (about which the origin: Polish, Sweden or Germany) have a better parameters.

MATERIAL AND METHODS

Animals, treatment, and sampling

The study was performed in the West Pomeranian Province. The research material consisted of 50 Holstein-Friesian primaparous (at 105 $\pm$30 day of lactation and averaging 23.71 $\pm$2.26 kg day^{-1} of milk yield). The animals came from Poland (n = 13) and had been imported from Sweden (n = 22) and Germany (n = 15). The cows were kept in a tided system and fed total mixed ration (TMR) diet. The cows had continuous access to water and the TMR diet was provided for *ad libitum* intake. Cows were fed TMR twice a day, at 08.00 and 18.00 h. The TMR diets were formulated using the system of the French National Institute for

Agricultural Research (INRA). The chemical composition of the TMR diet, which was monitored by the feeding company, is presented in Table 1.

Table 1. Ingredient and chemical composition of TMR

Tabela 1. Komponenty oraz skład chemiczny TMR-u

Ingredient Komponent	% of DM % s.m.
Concentrate – Pasza treściwa	28.5
Maize silage – Kiszonka z kukurydzy	34.6
Alfalfa silage – Kiszonka z lucerny	9.2
Grass silage – Kiszonka z traw	8.4
Wheat straw – Słoma pszenna	2.1
Beet pulp – Wysłodki buraczane	4.3
Brewers – Młóto	6.2
Rapeseed meal – Poekstrakcyjna śruta rzepakowa	4.6
Mineral-vitamin premix[1] – Premiks	0.7
$NaHCO_3$ – Węglan sodu	0.8
Limestone – Kreda pastewna	0.6
Chemical composition Skład chemiczny	
DM % – S.m. %	48.7
Ash % of DM – Popiół % s.m.	5.51
Crude protein % of DM – Białko surowe % s.m.	16.30
Acid detergent fibre % of DM – ADF	32.15
Neutral detergent fibre % of DM – NDF	22.56
Calcium % of DM – Wapń	0.60
Phosphorus % of DM – Fosfor	0.39
UFL per kg of DM – JPM	1.02

[1] Contained: 11.3% Na; 6.4 mg of Co/kg; 1,100 mg of Cu/kg; 85 mg of I/kg; 3,000 mg of Mn/kg; 26 mg of Se/kg; 5,100 mg of Zn/kg; 1,200,000 IU of vitamin A/kg; 144,000 IU of vitamin D/kg; and 3,900 IU of vitamin E/kg.

[1] Skład: 11,3% Na; 6,4 mg of Co/kg; 1 100 mg Cu/kg; 85 mg I/kg; 3 000 mg Mn/kg; 26 mg Se/kg; 5 100 mg Zn/kg; 1 200 000 IU witaminy A/kg; 144 000 IU witaminy D/kg; i 3 900 IU witaminy E/kg.

The cows were milked twice daily at 05.30 and 17.30 h and milk yield was recorded at each milking. Representative milk samples were collected from each cow during milking by means of a milk auto sampler directly from the milking pipe. Milk was placed in sterile bottles, preserved with Mlekostat CC. After milking, samples were immediately submitted to the Cattle Breeding Division (Milk Testing Laboratory of Warsaw University of Life Sciences) for chemical examination.

Chemical analyses of milk

Parameters of the milk, i.e. fat, protein, casein, urea, density, dry matter, solid not fat, lactose, potential acidity, free fatty acid and freezing point were determined by automated infrared analysis with a Milkoscan FT–120 instrument (Foss Electric).

Evaluation of hygienic status of the milk was based on somatic cell count on Somacount–150 (Bentley).

Whey proteins were examined on HPLC – Agilent 1100 series. Analytical standards of β-Lactoglobulin (β-LG), α-Lactoalbumin (α-LA), bovine albumin serum (BSA), Lactoferrin (Lf) and Lysozyme (Lz) from bovine testes were supplied by Sigma Aldrich. Acetonitrile (ACN) and trifluoroacetic (TFA) were obtained from Sigma Aldrich; membrane filters 0.45 µm were manufactured by Pall Laboratory. HPLC studies were carried out using Agilent instrument, consisting of the following elements: quaternary pump, detector UV-VIS, autosampler and Chemstation software. In the investigations on the development of the method for separation and identification of whey proteins' components: chromatographic columns Supelcosil^{TM} LC-318 Supelco and Supelguard, with particle size 5µm, pore size 300 Å. Chromatographic separation was performed using the following eluents: A – 0.1% TFA in the solution: acetonitrile:water (5 : 95), B – 0.1% TFA in the ACN:H2O (95 : 5). Conditions for linear gradient elution were: 0–32% B for 10 min, 32–52% B for 25min, 52–80% B for 3min; flow rate of mobile phase 1.2 ml/min; ambient temperature of separation. Whey proteins compounds were identified using UV detector at 220 nm wavelength [Kuczyńska 2011].

Moreover, the milk yield analysis was performed using the A_4 method. It was based on the data from milk recording including yield of milk, fat and protein (in kg) as well as their percentage in milk. To compare the obtained results, 4% fat corrected milk (FCM) yield was also calculated.

Statistical analysis

The obtained data were analyzed statistically using one-way analysis of variance (least-squares method) by means of the SPSS 12.0 package. The significance level was determined after performing preliminary statistical analyses. The following model for the analyzed milk samples was used:

$$Y_{ijk} = \mu + A_i + e_{ij},$$

where:
Y_{ijk} – dependent variable;
μ – general mean;

A_i– country effect ($i = 1, 2, 3$); 1 – Poland, 2 – Sweden, 3 – Germany;
e_{ij} – random error.

RESULTS

In Table 2 are presented the yield and quality of milk examined cows according to the country of origin. The cows from Poland were characterized by a higher milk yield (8769 kg), FCM (9291 kg), fat (385.46 kg) and protein (286.77 kg) as well as a higher content of fat (44.0 g $\cdot$ kg^{-1}) compared with the animals imported from Sweden and Germany (in 305-day lactation). Significant differences in the fat (P $\leq$ 0.01), protein (P $\leq$ 0.05) and FCM (P $\leq$ 0.01) yield were found between the analyzed groups of cows. The mean value of the protein/fat ratio (PFR) in the studied cow population ranged between 0.76 and 0.86 (Table 2). The highest (the most advantageous) PFR (0.86) was found in the milk from cows imported from Sweden. An analysis of the urea content in milk performed in the present study showed its highest level in the milk from cows imported from Germany (182 mg $\cdot$ L^{-1}), however, it was within the physiological range (150-300 mg $\cdot$ L^{-1}). From the data presented in Table 2, it follows that the cytological quality of milk expressed in terms of somatic cell count met the requirements of the Extra class. These data show that the hygienic conditions on the experimental farm were adequate.

An analysis of parameters associated with its technological usefulness showed the advantage of the Polish-Holstein Friesian breed. The variability of the chemical composition of milk causes significant variations in its density, which ranges from 1.015 to 1.045 g $\cdot$ cm^{-3}. In the studied herd, milk density ranged from 1.030 (g $\cdot$ cm^{-3}) in Polish Holstein-Friesians and cattle imported from Sweden to 1.032 (g $\cdot$ cm^{-3}) in the German Holstein-Friesian breed (Table 3). The differences were significant (P $\leq$ 0.05). The milk from these cows was characterized by a higher proportion of dry matter and a higher casein content (29.3 g $\cdot$ 100g^{-1}) compared with imported cows. Citric acid content in the milk from the analyzed animals amounted to 0.12–0.13 (g $\cdot$ 100g^{-1}) and was in accordance with the current standard. An increase in the free fatty acids (FFA) content in milk causes the formation of undesired odors and aftertaste in the dairy products. A significant factor affecting the content of the constituent under discussion is the way of milk acquisition, which influences the physiological processes occurring inside the mammary gland. Fresh milk should have potential acidity of 6.0–7.5°SH. Potential acidity below 6°SH can indicate *mastitis* and an increase in acidity over 8°SH may result from advanced milk fermentation of lactose to lactic acid, ketonemia or improper feeding. Potential acidity evaluated in the present study was the highest in the milk from Polish cows (7.58°SH), and the lowest in the milk from German cows (6.56°SH). Significant differences ($P \leq 0.01$) in the index under discussion were found in the milk from German and Polish as well as ($P \leq 0.05$) Polish and Swedish cows. Animal feeding significantly affects the value of the index under discussion.

Table 2. Milk performance (305 day lactation) of cows according to their country of origin

Tabela 2. Wydajność krów (laktacja 305 dniowa) według kraju pochodzenia

Item Składnik	Country Kraj					
	Sweden Szwecja		Germany Niemcy		Poland Polska	
	LSM	SEM	LSM	SEM	LSM	SEM
Milk, kg Mleko, kg	7909	879	8160	1452	8769	1295
Fat, kg Wydajność tłuszczu, kg	305.55^{A}	32.86	328.93^{Bc}	42.27	385.46^{ABc}	69.85
Protein, kg Wydajność białka, kg	260.36^{a}	25.05	261.33^{b}	41.56	286.77^{ab}	35.74
Fat, $g \cdot kg^{-1}$ Tłuszcz, $g \cdot kg^{-1}$	38.8^{A}	3.7	41.0^{b}	5.9	44.0^{Ab}	4.6
Protein, $g \cdot kg^{-1}$ Białko, $g \cdot kg^{-1}$	33.0	1.3	32.3	2.5	32.8	1.4
protein/fat ratio stosunek białko/tłuszcz	0.86^{A}	0.07	0.80^{b}	0.08	0.76^{Ab}	0.14
Fat Corrected Milk, kg Wydajność mleka skorygowana na zawartość tłuszczu	7747^{A}	770	8198^{B}	1087	9291^{AB}	1499
Lactose, $g \cdot kg^{-1}$ Laktoza, $g \cdot kg^{-1}$	49.2	2.0	48.0	2.0	48.9	1.5
Urea, $mg \cdot L^{-1}$ Mocznik, $mg \cdot L^{-1}$	177	56.88	182	73.50	175	47.23
SCS, $10^{3}cm^{-3}$ Liczba Komórek Somatycznych, $10^{3}cm^{-3}$	5.16	0.39	4.82	0.35	4.83	0.36

SEM – standard error of the mean; LSM – least square of mean; $^{A, B, C}$ $P \leq 0.01$; $^{a, b, c}$ $P \leq 0.05$.
SEM – standardowy błąd średniej; LSM – średnia najmniejszych kwadratów; $^{A, B, C}$ $P \leq 0,01$; $^{a, b, c}$ $P \leq 0,05$.

The data contained in Table 4 represent the content of the above-mentioned whey proteins in cow milk according to the country of origin. Cow milk obtained from the Polish Holstein-Friesian breed was characterized by a higher content of lactoferrin (Lf) and lactoperoxidase (Lp), whereas the cows imported from Sweden produced milk with a higher β-LG and BSA content. On the other hand, milk from German cows was characterized by the highest lysozyme (Lz) content.

DISCUSSION

Importing cattle from other countries is common practice of breeding. However, we cannot forget about the genetic potential of our native animals, which in many cases have a significantly better parameters of production or better technological usefulness of milk. The cows from Poland were characterized by a higher milk yield, FCM, fat and protein as well as a higher content of fat compared with the animals imported from Sweden and Germany (Table 2). Kamieniecki et al. [2008] analyzing two groups of cattle imported from the Netherlands (140 cows) and Sweden (102 cows) and reported, that the cows imported from the Netherlands had significantly higher milk, FCM, fat and protein yield as well as a higher fat and protein content in milk compared with cows from Sweden. In the study Czerniawska-Piątkowska et al. [2009] 81 native cows also had a higher milk yield (8463 kg) in the first 305-day lactation in comparison to the 84 cows imported from Germany (8400 kg). Significant differences in the milk chemical composition between breeds were recorded Januś and Borkowska [2011]. They observed a lower fat, protein and lactose concentration in the milk from Polish Holstein-Friesian cows of Black-and-White strain compared with the Montbeliarde breed. In the present study, the highest lactose content was found in the milk from Swedish cows (49.2 g $\cdot$ kg^{-1}). Czerniewicz et al. [1999] observed a lower lactose content in the milk from Holstein-Friesian cows imported from Germany and France (46.0 g $\cdot$ kg^{-1}) compared with the results of the present study (Table 2). A lower lactose content in milk (32.0–41.0 g $\cdot$ kg^{-1}) was also found Kamieniecki et al. [2008] in Holstein-Friesian cattle from the Netherlands. According to Piironen and Syvaeoja [1992], the lactose level in milk can be one of the indices proving its usefulness for cheese production. A high lactose content in the present study was confirmed by Czerniewicz and Kiełczowska [2008], which prove, that the milk was obtained from healthy mastitis-free cows.

An analysis of the urea content in milk performed in the present study showed its highest level in the milk from cows imported from Germany, however, it was within the physiological range. Similar values (150–269 mg $\cdot$ L^{-1}) were obtained by Kuczyńska et al. [2011] who analyzed various cow nutrition models at conventional farms. According to Skrzypek et al. [2005], both a decreased and an increased urea level in milk indicates the deficiency of energy available for rumen microorganisms and energy deficiency in a diet.

Many parameters affect the technological usefulness of milk as a raw material. The most significant are: acidity, density, solids-not-fat including total protein and casein as well as protein/fat ratio. An analysis of parameters associated with its technological usefulness showed the advantage of the Polish-Holstein Friesian breed. Additionally, Barłowska et al. [2011] reported that the technological quality of milk depends to a large extent on the speed of curd formation and its quality as well as on the thermal stability and size of fat globules. However, it is the casein content in milk that is the main technological parameter determining cheese yield per volume unit of raw material. Barłowska [2007], performing studies on seven cow breeds, found the highest milk density in Polish Red cattle (1.0301 g · ml^{-1}) and the lowest one in Polish Holstein-Friesian cows of Red-and-White strain (1.0282 g · ml^{-1}). The cited author observed the highest casein content in the milk from Jersey cows (30.6 g · kg^{-1}). A lower content of this constituent (25.9 g · kg^{-1}) was found in the milk from Polish Holstein-Friesian cows of Black-and-White strain compared with the results of the present study (29.3 g · kg^{-1}; Table 3). Król et al. [2011] showed a higher content of total protein (36.2 g · kg^{-1}) and casein (27.4 g · kg^{-1}) in the milk from Simmental cows compared with Polish Holstein-Friesian cows of Black-and-White strain (34.8 and 26.3 g · kg^{-1}, respectively).

Table 3. Parameters of milk technological usefulness according to the country of origin
Tabela 3. Parametry technologiczne mleka krów według kraju pochodzenia

Iteam Składnik	Country Kraj					
	Sweden Szwecja		Germany Niemcy		Poland Polska	
	LSM	SEM	LSM	SEM	LSM	SEM
Density, g · cm^{-3} Gęstość, g · cm^{-3}	1.032^{ab}	0.001	1.030^{a}	0.002	1.032^{b}	0.002
Dry matter, g · kg^{-1} Sucha masa, g · kg^{-1}	131.1	9.8	132.2	11.0	132.5	6.9
Solids-not-fat, g · 100 g of milk^{-1} Sucha masa beztłuszczowa [g · 100 g of milk^{-1}	9.01	0.38	8.86	0.40	9.11	0.25
Potential acidity, °SH Kwasowość czynna, °SH	6.84^{a}	0.98	6.56^{B}	0.87	7.58^{aB}	0.75
Citric acid, g · 100 g of milk^{-1} Kwas cytrynowy, g · 100 g of milk^{-1}	0.12	0.02	0.12	0.02	0.13	0.02
Free Fatty Aacids, g · 100g of fat^{-1} Wolne kwasy tłuszczowe, g · 100g of fat^{-1}	0.18	0.06	0.16^{a}	0.05	0.21^{a}	0.04
Freezing point, °C Punkt zamarzania, °C	0.560	0.025	0.547^{a}	0.024	0.567^{a}	0.015
Casein, g · kg^{-1} Kazeina, g · kg^{-1}	28.5	2.5	28.0	2.8	29.3	2.4

SEM – standard error of the mean; LSM – least square of mean; $^{A, B, C}$ P ≤ 0.01; $^{a, b, c}$ P ≤ 0.05.
SEM – standardowy błąd średniej; LSM – średnia najmniejszych kwadratów; $^{A, B, C}$ P ≤ 0,01; $^{a, b, c}$ P ≤ 0,05.

The stimulation of the lipolytic processes, according to Staniewski [2009], may be associated with a faulty construction of milking devices and their improper operation. Mechanical milking damages fat globule membranes to a larger extent than hand milking. The highest FFA content was found in the milk from German cows and the lowest in the milk from Polish cows (Table 3).

Górska and Mróz [2004] emphasize that abnormal natural milk acidity may occur even in healthy cows. Puchajda et al. [2000] who compared physico-chemical parameters of milk from the local Black-and-White cows and imported German Holstein-Friesians, found that the milk from the native cows was characterized by somewhat higher acidity, which was confirmed in the present study (Table 3). Deficiency of energy in the diets for cows during lactation causes a decrease in acidity expressed on the SH° scale and higher titratable acidity is associated with a higher content of casein proteins in milk [Strzałkowska et al. 2002].

An analysis of the results obtained by other authors and concerning whey proteins content in the milk from cows of various breeds shows high variability of the evaluated constituents. Król et al. [2011] showed that cow breed significantly affects whey proteins content. The milk from Polish Holstein-Friesian cows of Black-and-White strain contained a lower amount of main albumins, that is, β-LG (2.87 g $\cdot$ dm^{-3}) and α-LA (0.95 g $\cdot$ dm^{-3}) compared with the Simmental (3.28 g $\cdot$ dm^{-3} and 1.12 g $\cdot$ dm^{-3}, respectively) and Jersey (3.06 g $\cdot$ dm^{-3} and 0.99 g $\cdot$ dm^{-3}, respectively) breed. The content of BSA amounted from 0.43 g $\cdot$ dm^{-3} in the Polish Holstein-Friesian Black-and-White strain to 0.47 g $\cdot$ dm^{-3} in the Polish Holstein-Friesian Red-and-White strain. The cited values are similar to those obtained in the present study (Table 4). Other authors, who analyzed milk from Swedish and Danish cows, did not show any breed effect on the level of the whey proteins under discussion Wedholm et al. [2006], which was confirmed in the present study (Table 4).

CONCLUSIONS

1. An analysis of milk, FCM, protein and fat yield in kg, revealed the advantage of cows from Poland over those imported from Sweden and Germany. On the other hand, the most preferable protein/fat ratio was found in the milk from Swedish cows (0.86). The differences in the values of the studied traits were significant ($P \leq 0.01$ and $P \leq 0.05$).
2. An analysis of the selected milk technological parameters, including the country of origin, showed that the milk from Polish cows was characterized by a higher content of casein, dry matter, solids-not-fat compared with the remaining groups of imported cows. In the case of milk potential acidity, small deviations (0.08°SH increase) from the Polish Norm were found,

Table 4. Concentration of whey proteins according to the country of origin

Tabela 4. Zawartość białek serwatkowych w mleku krów według kraju pochodzenia

Whey protein Białka Serwatkowe	Country Kraj					
	Sweden Szwecja		Germany Niemcy		Poland Polska	
	LSM	SEM	LSM	SEM	LSM	SEM
β-Lactoglobulin, g · L^{-1} β-Laktoglobulina, g · L^{-1}	4.44^{A}	1.14	3.94^{Ab}	0.90	4.15^{b}	0.85
α-Lactoalbumin, g · L^{-1} α-Laktoalbumina, g · L^{-1}	1.36	0.57	1.44	0.44	1.61	0.40
Lactoferrin, g · L^{-1} Laktoferyna[g · L^{-1}	0.22	0.09	0.25	0.09	0.27	0.10
Bovine Serum Albumin, g · L^{-1} Bydlęca albumina serum, g · L^{-1}	0.47	0.21	0.44	0.24	0.42	0.25
Lactoperoxidase, mg · L^{-1} Laktoperoksydaza, mg · L^{-1}	0.18^{ab}	0.09	0.24^{a}	0.12	0.23^{b}	0.17
Lysozyme, µg · L^{-1} Lizozym, µg · L^{-1}	28.77^{Ab}	8.86	39.28^{Ac}	8.78	33.19^{bc}	7.53

SEM – standard error of the mean; LSM – least square of mean; $^{A, B, C}$ $P \leq 0.01$; $^{a, b, c}$ $P \leq 0.05$.
SEM – standardowy błąd średniej; LSM – średnia najmniejszych kwadratów; $^{A, B, C}$ $P \leq 0{,}01$; $^{a, b, c}$ $P \leq 0{,}05$.

which may be associated with a higher content of casein proteins in the milk from Polish cows. The differences were significant ($P \leq 0.01$ and $P \leq 0.05$). The milk from German cows contained the lowest amount of casein.

3. The highest concentration of β-LG and BSA was shown in the milk from Swedish cows, whereas the milk from Polish cows was characterized by the highest level of lactoferrin (Lf) and lactoperoxidase (Lp).

The results of this study show that only the introduction of animals with high genetic potential can bring benefits expected from the quality of raw milk, which will allow to cover expenses related to the import of heifers from EU countries. In addition, the origin of animals plays an important role in determining of the chemical composition of milk, technological usefulness and level of whey proteins in milk of Holstein-Friesian breed.

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PORÓWNANIE WARTOŚĆ ODŻYWCZEJ I PRZYDATNOŚCI TECHNOLOGICZNEJ MLEKA KRÓW RASY HOLSZTYŃSKO-FRYZYJSKIEJ Z KRAJU I IMPORTOWANYCH ZE SZWECJI I NIEMIEC

Streszczenie. Celem pracy było określenie wpływu kraju pochodzenia krów rasy holsztyńsko-fryzyjskiej na wydajność, zawartość i skład frakcji białkowej oraz wybrane parametry technologiczne mleka krowiego. W doświadczeniu wykorzystano 50 krów pochodzących z Polski (13) oraz importowanych ze Szwecji (22) i Niemiec (15). Wyniki analizy wydajności mleka, białka oraz tłuszczu wskazały istotną przewagę krów pochodzących z Polski nad importowanymi. Najkorzystniejszym stosunkiem białka do tłuszczu charakteryzowały się natomiast krowy pochodzące ze Szwecji. Podczas analizy wybranych parametrów technologicznych mleka okazało się, że krowy z Polski wykazały przewagę nad importowanymi również w odniesieniu do zawartości kazeiny, suchej masy i masy beztłuszczowej mleka. Najwyższy poziom β-laktoglobuliny i albuminy serum stwierdzono w mleku krów pochodzących ze Szwecji, podczas gdy w mleku krów pochodzących z Polski zaobserwowano najwyższy poziom α-laktoalbuminy, laktoferryny i laktoperoksydazy. Badania wskazują że, jedynie wprowadzenie zwierząt o wysokim potencjale genetycznym może przynieść wymierne korzyści i przyczynić się do poprawy jakości mleka. Pochodzenie zwierząt istotnie determinuje skład frakcji białkowej oraz przydatność technologiczną mleka.

Słowa kluczowe: frakcja białka, mleko krowie, przydatność technologiczna, rasa holsztyńsko-fryzyjska

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