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COMPARISON OF PHYSICAL AND CHEMICAL PROPERTIES AND TECHNOLOGICAL VALUE OF MILK FROM HF COWS IMPORTED FROM FRANCE WITH LOCAL POPULATION OF BW COWS*

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The investigation included evaluation of milk obtained from 97 hf cows imported from France and 119 bw cows of local population with different share of hf breed. Milk from cows of the two populations was characterized by the proper freshness (pH value, potential acidity) meeting the criteria for purchase (PN-A-86002:1999), and a high hygienic quality (TNM, SCC) allowed them to be qualified to the extra class. Physicochemical evaluation of the milk studied showed that it was characterized by chemical composition typical of each of the breeds. Higher and statistically significant ($p \leq 0.05$) fat content was stated in milk of hf cows. The level of residual constituents was also higher in milk of hf cows but it was statistically insignificant. Analysis of functional properties of milk of the cows imported from France and the local bw cows showed satisfactory technological value as the raw material in cheesemaking technology (proper RCT). As regards the heat stability and ethanol stability of milk from hf and bw cows, it showed a limited use in UHT milk and milk concentrates. The differences between discriminants for technological usability of milk samples from two breeds were statistically insignificant.

INTRODUCTION

The quality of raw milk and its technological value is a very important problem conditioning the way of its utilization as a raw material in dairy industry. The importance of this problem is underlined by the fact that the principles of evaluation of raw material are controlled in all countries by the appropriate legal acts.

Introducing to our breeding the hf cattle forces changes in the way of its utilization and brings about the changes in the quality of the milk obtained. The earlier production results obtained from bw × hf and pure hf hybrids indicated a decreasing content of fat [Dorynek *et al.*, 1983; Feleńczak & Szarek, 1987; Janicki, 1981; Kaczmarek *et al.*, 1982], protein [Pasierbski *et al.*, 1984], and dry matter in the milk [Hybel & Szarek, 1984]. However, these results must be verified.

The objective of this experiment was to evaluate the physicochemical properties and technological value of milk from hf cows imported from France as compared with the local population of bw cattle.

MATERIAL AND METHODS

The investigation was carried out in the years 1998–2000 in one of the dairies of the Province of Warmia and Mazury. It included the milk obtained from 97 hf cows imported from France and 119 bw cows of local population with different share of hf breed. The animals were kept indoors. Once a month, just after milking, milk samples were taken (one from each group), cooled at 4°C±1 and preserved by an addition of 1 mL 2% solution of sodium azide per 1 L of milk.

The samples were tested for a hygienic purity based on the determination of the total number of microbes (TNM) using Bactoscan 8000S apparatus and somatic cell count (SCC) using Fossomatic 5000 apparatus. Freshness of raw milk was determined according to Polish Standard PN/68–A–86122 [Polska Norma, 1968] that is active acidity, potential acidity and electrolytic conductivity. Basic milk composition, *i.e*. density, dry matter content, and particular constituents: fat, protein and lactose were determined with Milkoscan 4000 apparatus, and the ash content according to PN/68–A–86122 [Polska Norma, 1968].

Technological value of raw milk was determined on the basis of discriminants of colloidal milk stability, *i.e*. the heat stability (HS) as the measurement of coagulation time of milk protein in T=140°C according to the method of White and Davies [Kruk *et al.*, 1979], and ethanol stability (ES) as an alcohol number [Kruk *et al.*, 1979], and the time of rennet coagulation (RCT) by the method of Alais and Jolles [1964].

The numeral material was characterized by arithmetical mean ($\bar{x}$) and variability coefficient (v). Figures were elaborated using Microsoft Excel programme. The data of both groups were analyzed statistically using analysis of variance and significance test of Duncan.

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RESULTS AND DISCUSSION

The characteristics of physicochemical, hygienic and qualitative features of milk from hf cows imported from France and local population of bw cattle was presented in Table 1.

The milk samples studied were found to be characterized by a high hygienic quality. The total number of microorganisms in the milk was at a low level, varying from 12 840/mL to 23 080/mL. The number of somatic cells being an index of health of udder also produced low values. The lowest values of the number of somatic cells in milk samples of bw and hf cows were found in 1999 and amounted to 151 300/mL and 167 900/mL, respectively. In 1998 and 2000 the values of SCN were slightly higher and amounted to 185 900–189 400/mL in the milk from bw cows and 204 100–206 700/mL in the milk of imported cows. Considering criteria of the Polish Milk Standards PN-A-86002:1999, the samples studied met the requirements of the extra class, *i.e*. contained up to 100 000 microorganisms and to 400 000 somatic cells in 1 mL. The lower number of somatic cells in the milk from the local bw cows was found by Czaplicka *et al.* [2001]. A low content of microorganisms and somatic cells shows good condition of mammary glands of the animal tested.

The milk samples of both populations were characterized by satisfactory freshness (pH value 6.63–6.69 and potential acidity 6.27–6.44 °SH) and met requirements for purchased raw milk in accordance with Polish Milk Standards (PN-A--86002:1999). Confirmation of the freshness and cytological quality of the milk samples tested was based on measurements of electrolytic conductivity. They were between 5.57 and 5.74 $mS \cdot cm^{-1}$, taking typical values from normal commodity milk. Somewhat higher values of electrolytic conductivity of milk from hf cows of a normal chemical composition were obtained by Czerniewicz *et al.* [1999].

The physical and chemical evaluation of milk of both populations showed that it had a characteristic chemical composition for the given breed. The density of milk samples of both breeds amounted to 1.0298–1.0299 g/mL and did not departed from the values anticipated by Polish Milk Standards PN-A-86002:1999 (not smaller than 1.028 g/mL).

The findings obtained in the period of 1998–1999 have shown essentially higher concentration of fat in milk samples obtained from Holstein-Freezian breed as compared to milk from the bw cows. In 1998, the fat content in raw material from the hf animals was at the level of 4.20%, whereas in milk samples of bw cows it reached 4.00%. In 1999 and 2000, these values were 4.23% and 4.00% as well as 4.29% and 4.15%, respectively. The fat content of milk from the two groups of cows was in accordance with data from the literature, although higher values were obtained from those found by Czaplicka *et al.* [2000].

In 1998, protein content of milk from hf cows accounted for 3.24%. The level of this constituent in a raw material of bw cows was 3.20%. The difference in the milk protein concentration for hf and bw breed cows was statistically insignificant. In the next years, the differences between protein level in both studied cow populations were still lower and were: in 1999 – 0.02% and in 2000 – 0.01%, respectively. In 1999, the concentration of milk protein was distinctly higher in comparison with the results of 1998. This increase was 0.11%, in the case of bw cows and 0.09% in the case of hf cows. On the other hand in 2000, the protein content of milk was hold practically at the same level and averaged 3.31% in the milk from bw cows and 3.32% in the milk of hf cows. These values are in accordance with the literature data which indicate that in Poland, the protein content in milk from the cows being at control milking, accounts from 3.06% [Dymnicki *et al.*, 1995] to 3.24% [Czaplicka *et al.*, 1998].

All the milk samples studied from both cow groups were characterized by a high content of lactose. The differences between the concentration of this constituent in the milk from hf (4.77 – 4.82%) and bw (4.72 – 4.80%) cows were

TABLE 1. Characteristics of physicochemical, hygienic and qualitative features of milk from hf cows imported from France and local population of bw cattle in the period of 1999–2000.

Property		1998				1999				2000			
		bw		hf		bw		hf		bw		hf	
		$\bar{x}$	v	$\bar{x}$	v	$\bar{x}$	v	$\bar{x}$	v	$\bar{x}$	v	$\bar{x}$	v
Total Bacteria Count	[*1000/mL]	20.18	40.23	22.31	38.23	14.83	38.65	17.49	41.36	13.89	33.45	16.68	35.94
Somatic Cell Count	[*1000/mL]	189.36	68.22	206.73	59.36	151.25	58.39	167.86	69.14	185.36	54.23	204.11	59.76
Active acidity	[pH]	6.66	2.30	6.64	1.90	6.66	0.70	6.63	0.92	6.68	0.80	6.67	0.90
Potential acidity	[°SH]	6.27	8.90	6.39	7.24	6.41	6.32	6.44	5.60	6.40	8.90	6.36	7.24
Electrolytic conductivity	[$mS \cdot cm^{-1}$]	5.57	4.51	5.60	2.80	5.58	4.91	5.61	3.55	5.59	3.10	5.74	5.12
Fat content	[%]	4.00[a]	4.56	4.20[a]	2.27	4.00[b]	5.26	4.23[b]	6.24	4.15	7.24	4.29	6.24
Protein content	[%]	3.20	2.43	3.24	3.15	3.31	4.15	3.33	4.12	3.31	2.15	3.32	1.36
Lactose content	[%]	4.72	4.29	4.77	3.86	4.80	4.96	4.82	4.51	4.79	7.15	4.80	6.14
Ash content	[%]	0.71	2.71	0.73	2.54	0.70	6.12	0.73	5.49	0.75	3.58	0.80	4.12
Dry matter content	[%]	12.63	3.15	12.94	3.49	12.89	3.36	13.11	3.92	13.02	3.24	13.10	2.36
Density	[g/mL]	1.0300	0.81	1.0300	0.63	1.0299	0.55	1.0298	0.31	1.0289	0.30	1.0299	0.50
Rennet coagulation	[min]	2.41	21.00	2.29	17.94	2.43	19.23	2.28	17.11	2.50	16.13	2.56	18.92
Ethanol stability	[mL]	5.53	5.93	5.33	8.92	5.58	6.13	5.38	5.36	5.63	10.28	5.53	12.04
Heat stability	[min]	4.69	22.10	5.16	31.03	5.19	28.44	4.95	16.15	4.75	25.13	4.92	28.13

Values signed by small letters in the years are statistically significantly different at $p \leq 0.05$

statistically insignificant. A high level of that constituent confirms that the milk tested came from healthy cows – free of mastitis.

Analysis of the results of milk composition from cows of both populations showed a typical ash content and the difference between its level for milk of bw and hf breed was statistically insignificant. A higher average content of basic constituents in the milk of hf cows was accompanied by a higher concentration of dry matter of that milk as compared with the milk of bw cows. In 1998, in the milk sampled from the hf French cows there was 12.94% of dry matter. This value was by 0.17% lower than in 2000. In 1998, milk of the local animals averaged 12.63% of dry matter, in 1999 – 12.89%, and in 2000 – 13.02%.

The level of dry matter was typical for commodity production of each of the two breeds. The differences of basic constituents of milk for hf and bw breed were statistically insignificant at the level of $p \leq 0.05$.

Freshness, hygienic quality and chemical composition of milk determine technological properties of milk that are important in the production of the definite dairy articles. The colloidal stability of milk is a significant element of the evaluation of its technological use, particularly in the production of UHT milk and milk concentrates for which criteria of the acceptance are established usually at the level of HS ≥ 8 min and ES ≥ 6 mL [Kruk & Czerniewicz, 1996]. The analysis of discriminants of the colloidal stability showed its relatively low values, both in the case of milk samples from hf cows and bw cows. During three years of the study, a higher, although statistically insignificant at the level of $p \leq 0.05$, resistance to heat coagulation was observed for milk of hf cows ($\bar{x}$=5.01 min) than for milk obtained from bw cows for which the mean value HS amounted to 4.88 min. Ethanol stability, on the other hand, was characterized by a smaller differentiation for the two breeds in particular years of the study. It was also found that the milk obtained from bw cows showed a higher resistance to ethanol coagulation.

The measurement of rennet coagulation time as well as sensory analysis of the clots obtained, showed satisfactory use of the studied milk samples in cheesemaking technology [Ziajka, 1997]. In the period of 1998–2000, statistically insignificant differentiation of that index was found between the milk samples studied. However, the material obtained from hf cows was characterized by somewhat shorter (statistically insignificant) rennet coagulation time which averaged RCT = 2.39 min in comparison to the milk of bw cows (RCT = 2.45 min). The structure of the clots obtained was characterized by the proper rheological features.

SUMMARY AND CONCLUSIONS

The obtained results of the study on physicochemical characteristics and technological use of milk from hf cows imported from France and local bw cows with different hf genes allow to draw the following conclusions:

1. Milk from cows of the two populations was characterized by the proper freshness (pH value, potential acidity) meeting the criteria for purchase (PN-A-86002:1999), and a high hygienic quality (total number of microbes and number of somatic cells) allowed them to be qualified to the extra class.

2. Physicochemical evaluation of the milk studied showed that it was characterized by chemical composition typical of each of the breeds (fat, protein, lactose and dry matter content).

3. Higher and statistically significant ($p \leq 0.05$) fat content was stated in milk of hf cows. The level of residual constituents was also higher in milk of hf cows but it was statistically insignificant.

4. Analysis of functional properties of milk of the cows imported from France and the local bw cows showed satisfactory technological value as the raw material in cheesemaking technology (proper rennet coagulation time). As regards the thermal stability and ethanol stability of milk from hf and bw cows, it showed a limited use in UHT milk and milk concentrates. The differences between discriminants for technological usability of milk samples from two breeds were statistically insignificant.

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PORÓWNANIE CECH FIZYKOCHEMICZNYCH I JAKOŚCI TECHNOLOGICZNEJ MLEKA KRÓW HF IMPORTOWANYCH Z FRANCJI Z MIEJSCOWĄ POPULACJĄ BYDŁA CZARNO-BIAŁEGO

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Badania przeprowadzono w latach 1998–2000 w jednej z obór znajdujących się na terenie województwa warmińsko-mazurskiego. Objęto nimi mleko uzyskane od 97 importowanych francuskich holsztyno-fryzów i 119 krów miejscowej rasy czarno-białej z różnym udziałem krwi hf.

Przeprowadzona analiza uzyskanych wyników wykazała, że mleko pochodzące od krów obu badanych populacji charakteryzowało się odpowiednią świeżością (pH, °SH), spełniającą kryterium przyjęcia mleka do skupu według PN-A-86002:1999, a wysoka jakość higieniczna (ogólna liczba drobnoustrojów i liczba komórek somatycznych – tab. 1) pozwoliła je zakwalifikować do klasy ekstra.

Ocena fizykochemiczna badanego mleka wykazała, że posiadało ono charakterystyczny dla każdej z ras skład chemiczny (zawartość tłuszczu, białka, laktozy i suchej masy). Wyższą i istotną na poziomie $p \leq 0,05$ zawartość tłuszczu stwierdzono w mleku krów hf. Poziom pozostałych składników był również wyższy w mleku krów hf ale statystycznie nieistotny (tab. 1).

Analiza właściwości funkcjonalnych mleka krów importowanych z Francji i miejscowej rasy cb wykazała zadowalającą jego przydatność jako surowca w technologii serowarskiej (odpowiedni czas koagulacji podpuszczkowej). Natomiast wartości stabilności cieplnej i etanolowej mleka (tab. 1), pochodzącego zarówno od krów rasy hf jak i cb, wskazują na ograniczoną jego przydatność do produkcji spożywczego mleka UHT i koncentratów mlecznych. Różnice między wyróżnikami przydatności technologicznej próbek mleka krów obu ras były statystycznie nieistotne.