POLISH JOURNAL OF FOOD AND NUTRITION SCIENCES
Pol. J. Food Nutr. Sci. 2006, Vol. 15/56, SI 1, pp. 17–21

# TECHNOLOGICAL USEFULNESS OF MILK OF COWS OF SIX BREEDS MAINTAINED IN POLAND RELATIVE TO A LACTATION PHASE

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Key words: milk, technological usefulness of milk, cow breed, lactation phase

The investigations included 333 milk samples obtained from cows of 6 breeds maintained in Poland, *i.e.* Polish Holstein-Friesian black-white (150) and red-white (40) variety, Simental (29), Whitebacks (28), Jersey (37) and Polish Red (49). Milk was collected in the spring-summer season, when the dietary units included green forage. At the milk sampling a lactation phase was regarded, that is up to 120 days, from 120 to 200 and over 200. In each milk sample there were determined chemical composition, fat molecule diameter, thermostability and rennet induced milk coagulability. The parameters were analysed taking into consideration a cow breed and a lactation phase. It was found that milk of Whitebacks, Simental and Jersey exhibited a better protein-fat ratio and a high level of fat molecules of big-sized diameters. Milk of these cows and Polish Red withstood a sustained thermal treatment at 140°C and showed significantly shorter coagulation time due to a higher protein content. Therefore, milk from cows of these breeds proves more useful for processing, mainly cheese production. The effect of a lactation phase on milk chemical composition, its thermostability and coagulation time was indicated.

## INTRODUCTION

Milk and its products constitute the main components of a human diet. In the year 2004, a statistic Pole consumed about 260 L of milk along with its products and milk used for butter production [Seremak-Bulge, 2005]. However, consumers' demands as for the sensory attributes of dairy products are still growing. The Polish market offers a wide range of dairy products that yields a strong competition between the dairies and allows a consumer to take a right choice. A product quality is mainly relative to raw material. Recently the milk producers have been forced to improve milk sanitary quality and in consequence, over 90% of milk is purchased within the extra class. Nowadays the vital objective of the breeders and milk producers is to improve its technological parameters.

Technological quality of milk depends on its chemical composition, casein content in particular. The concentration of this protein is a determinant of cheese yield out of volume unit. The interrelations between each casein fraction and whey proteins affect milk thermostability [Jaworski, 1997]. It is one of the primary criteria for the evaluation of raw milk for thermal treatment at high temperatures. This problem has had great weight because production of milk of prolonged mean life is still increasing. The concentration of milk casein along with calcium and magnesium contents and rates also determine the coagulation time rate and curd firmness [Jaworski, 1997].

The content of protein, including casein, is mostly determined by genetic factors – mainly a cow breed as well as numerous extra-genetic factors, like nutrition [Barłowska *et al.*, 2005a].

Milk fat, in that its dispersion levels, are also of great importance for the assessment of milk usefulness in processing. Milk with majority of small-sized fat molecules (1–6 $\mu$m) is recommended for liquid milk production, while that with prevalence of big-sized globules (over 6 $\mu$m) for cheese and butter production [Barłowska *et al.*, 2005 b; Grega *et al.*, 2003; Wiking *et al.*, 2004].

Most of the studies on the evaluation of milk technological usability were performed in Poland on black-white cows with varied share of Holstein-Friesian cattle gene [Litwińczuk, 1991]. However, there are only few works referring this problem to the other breeds of cattle whose contribution in Poland is rather modest, yet considerable in milk production in some regions. These are regions of the Bieszczady, Pogórze and in the South-Eastern part of Poland. As for Whitebacks, there have not been published any results of the investigations on broadly formulated milk chemical composition and evaluation of technological usefulness of their milk. The literature provides the results concerning milk fat content in cows of this breed solely in the

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thirties, whereas the content of fat and protein – in the fifties of the last century [Litwińczuk *et al.*, 2004]. Later, no breeding work was undertaken within this pedigree and in consequence, its population decreased at a very fast rate, thus in the seventies this breed was considered extinguished. The efforts taken up in Poland in the second half of the nineties to restitute this breed have led to the restoration of this population. Being numerous enough it was acknowledged a Polish native cattle by the Ministry of Agriculture in 2003 and had the breeding registers opened [Litwińczuk *et al.*, 2003]. In January 2004, this breed was recorded in the FAO world list of breeds with genetic resources conserved.

The aim of the present paper was to evaluate the technological usefulness of milk obtained from cows of six main breeds relative to a lactation stage used for milk production in Poland.

## MATERIAL AND METHODS

The investigations included 333 milk samples collected from the cows of the following 6 breeds: Polish Holstein-Friesian of black-white variety (150) and red-white (40), Simental (29), Whitebacks (28), Jersey (37) and Polish Red (49). The cows of the Polish HF breed red-white variety, Simental, Polish Red and Whitebacks grazed the pasture, the green forage being the basic bulky feed. The cows from the Polish FH breed black-white variety, however, were maintained on the farms of the intensive milk production. Their diet was dominated with maize silage and hay-silage, whereas forage was supplied to supplement bulky feeds.

In each milk sample the contents of fat, protein and lactose were determined with Milko-Scan equipment. Dry mass content was computed adding up these three components and 0.65% value (mean ash content). Casein content was established after Walker's method according to the Polish Standard [PN-68/A-86122]. Moreover, fat molecules' diameter was determined according to the Polish Standard [PN-75/A-86059], milk thermostability in oil bath TEWES-BIS at a temperature of 140°C [Jurczak, 1999] and rennet induced milk coagulability using Schern method [Jurczak, 1999]. All the analyses were performed only in those milk samples where somatic cells count did not exceed $400\times10^3$/mL (Somacount 150) and active acidity ranged from 6.5 to 6.8.

The results were analysed taking into consideration a lactation phase, *i.e.* up to 120 day, from 121 to 200 day and over 200 day.

The results obtained were analysed statistically with StatSoft Inc. STATISTICA ver.6 software based on two-way analysis of variance with interaction. The significance of differences was determined with Fisher's test (LSD).

## RESULTS AND DISCUSSION

The results in Table 1 present the chemical composition of milk from cows of different breeds and indicate that the highest milk fat had the cows Jersey (4.95%). A relatively high concentration of fat in milk was also established at two native breeds, *i.e.* Whitebacks (4.75%) and Polish Red (4.72%). The lowest fat content was detected in milk of Simental cows (4.22%).

One of the main parameters determining the technological usefulness of milk is a protein concentration and this component ratio to fat. The highest total protein content, in that casein, was detected in milk of Jersey cows, namely 4.15 and 3.14% respectively, while the lowest in red-white cows (3.37 and 2.38%). The protein-fat ratio proved the highest in the following two breeds: Simental and Jersey – reaching 0.85, whereas the lowest in milk from red-white cows – 0.71. Reklewski [1997] claims that in milk of the other breeds this ratio may oscillate from 0.64 to 0.85. Barłowska *et al.* [2005b] and Grega *et al.* [2000] reported a better protein-fat ratio, *i.e.* 0.89–0.93, in analysing the population of Simental cows.

Working on the changes of the milk composition of cows over lactation, it was stated that in most cases (regardless the breed) the progression of lactation caused an increased concentration of fat, protein, casein and dry matter (Table 2). Lactose content, however, was observed to reduce then. A protein-fat ratio also showed an upward tendency. These relations were confirmed in the previous studies made by the present authors [Barłowska *et al.*, 2005a]. Górska & Mróz [2005], analysing the changes of the milk chemical composition during lactation of black-white cows, showed gradual growth of protein content (3.10 to 3.29) at varied fat contents. As a result, a change of these two components (protein and fat) throughout lactation improved their proportion.

In analysing the physical quality of fat, on the grounds of fat molecule size (Tables 3 and 4), it was indicated that milk from Polish Red cows exhibited the highest share of molecules of small-sized diameter (79.47%). The lowest percentage of those particles was detected in milk of cows of the old Polish Whitebacks (63.34%). Milk with a high amount of big-sized molecules is more recommended for cheese and

TABLE 1. Chemical composition of milk from cows of various breeds (mean values).

| Breed | Content (%) | | | | | | |
|---|---|---|---|---|---|---|---|
| | n | Fat | Total protein | Casein | Protein/Fat ratio | Lactose | Dry matter |
| Polish Holstein-Friesian of black-white variety | 150 | $4.66^{b}$ | $3.40^{a}$ | $2.57^{B}$ | 0.76 | $4.83^{b}$ | $13.51^{a}$ |
| Polish Holstein-Friesian of red-white variety | 40 | $4.67^{b}$ | $3.37^{a}$ | $2.38^{A}$ | 0.71 | $4.84^{b}$ | $13.54^{a}$ |
| Simental | 29 | $4.22^{a}$ | $3.52^{a}$ | $2.65^{B}$ | 0.85 | $4.88^{b}$ | $13.27^{a}$ |
| Whitebacks | 28 | $4.75^{b}$ | $3.57^{ab}$ | $2.58^{B}$ | 0.77 | $4.87^{b}$ | $13.83^{a}$ |
| Jersey | 37 | $4.95^{b}$ | $4.15^{c}$ | $3.14^{C}$ | 0.85 | $4.79^{b}$ | $14.54^{b}$ |
| Polish Red | 49 | $4.72^{b}$ | $3.67^{b}$ | $2.74^{B}$ | 0.77 | $4.60^{a}$ | $13.63^{a}$ |

a, b, A, B, C – differences between the breeds; a, b – differences significant at $p\leq0.05$; A, B, C – differences significant at $p\leq0.01$

TABLE 2. Chemical composition of milk from cows of various breeds relative to a lactation phase (mean values).

| Breed | Lactation phase (days) | n | Content (%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Fat | Total protein | Casein | Protein/ Fat ratio | Lactose | Dry matter |
| Polish Holstein-Friesian of black-white variety | to 120 | 51 | $4.28^{A}$ | $3.16^{A}$ | $2.45^{A}$ | 0.79 | $4.89^{b}$ | $12.97^{A}$ |
| | 121–200 | 41 | $4.54^{A}$ | $3.43^{B}$ | $2.48^{A}$ | 0.79 | $4.86^{ab}$ | $13.48^{AB}$ |
| | over 200 | 58 | $5.08^{B}$ | $3.59^{C}$ | $2.75^{B}$ | 0.74 | $4.77^{a}$ | $14.01^{B}$ |
| Polish Holstein-Friesian of red-white variety | to 120 | 12 | 4.62 | $3.07^{A}$ | $2.21^{a}$ | $0.66^{a}$ | 4.83 | $13.19^{a}$ |
| | 121–200 | 16 | 4.69 | $3.36^{B}$ | $2.38^{ab}$ | $0.71^{ab}$ | 4.85 | $13.56^{ab}$ |
| | over 200 | 12 | 4.69 | $3.67^{C}$ | $2.56^{b}$ | $0.77^{b}$ | 4.81 | $13.82^{b}$ |
| Simental | to 120 | 11 | 4.12 | $3.33^{a}$ | 2.49 | 0.81 | 4.97 | 13.08 |
| | 121–200 | 10 | 4.33 | $3.64^{b}$ | 2.72 | 0.86 | 4.83 | 13.45 |
| | over 200 | 8 | 4.22 | $3.64^{b}$ | 2.80 | 0.88 | 4.81 | 13.32 |
| Whitebacks | to 120 | 12 | 4.90 | $3.51^{ab}$ | 2.57 | $0.74^{a}$ | 4.86 | 13.92 |
| | 121–200 | 9 | 5.00 | $3.46^{a}$ | 2.45 | $0.70^{a}$ | 4.74 | 13.84 |
| | over 200 | 7 | 4.63 | $3.77^{b}$ | 2.65 | $0.84^{b}$ | 4.93 | 13.98 |
| Jersey | to 120 | 8 | $4.41^{A}$ | $3.83^{A}$ | $3.04^{ab}$ | 0.89 | 4.86 | $13.76^{a}$ |
| | 121–200 | 15 | $4.83^{AB}$ | $4.17^{B}$ | $3.04^{a}$ | 0.87 | 4.77 | $14.42^{a}$ |
| | over 200 | 14 | $5.39^{B}$ | $4.32^{B}$ | $3.30^{b}$ | 0.82 | 4.76 | $15.12^{b}$ |
| Polish Red | to 120 | 23 | 4.59 | $3.43^{A}$ | $2.54^{A}$ | $0.75^{A}$ | 4.59 | $13.27^{a}$ |
| | 121–200 | 11 | 4.63 | $3.73^{B}$ | $2.80^{AB}$ | $0.81^{B}$ | 4.53 | $13.70^{b}$ |
| | over 200 | 15 | 4.81 | $3.98^{C}$ | $3.03^{B}$ | $0.82^{B}$ | 4.64 | $13.86^{b}$ |

a, b, A, B, C – differences between the breeds; a, b – differences significant at $p \leq 0.05$; A, B, C – differences significant at $p \leq 0.01$

TABLE 3. Technological usefulness indices of milk from cows of different breeds (mean values).

| Breed | n | Fat molecule share (%) | | | Thermostability (min) | Coagulation time (min) |
|---|---|---|---|---|---|---|
| | | Small (<6 $\mu$m) | Medium (6–10 $\mu$m) | Big (> 10 $\mu$m) | | |
| Polish Holstein-Friesian of black-white variety | 150 | $74.83^{C}$ | $22.29^{B}$ | $2.96^{B}$ | $2{:}31^{A}$ | $6{:}34^{B}$ |
| Polish Holstein-Friesian of red-white variety | 40 | $72.01^{B}$ | $26.41^{C}$ | $0.98^{A}$ | $1{:}50^{A}$ | $8{:}25^{C}$ |
| Simental | 29 | $71.51^{C}$ | $23.11^{B}$ | $5.37^{C}$ | $4{:}04^{B}$ | $4{:}32^{A}$ |
| Whitebacks | 28 | $63.34^{A}$ | $27.05^{C}$ | $9.49^{D}$ | $3{:}32^{A}$ | $4{:}54^{A}$ |
| Jersey | 37 | $76.72^{C}$ | $18.34^{A}$ | $4.93^{C}$ | $4{:}43^{B}$ | $5{:}21^{A}$ |
| Polish Red | 49 | 79.47D | $16.75^{A}$ | $3.77^{B}$ | $3{:}43^{B}$ | $4{:}40^{A}$ |

A, B, C, D – differences between the breeds; A, B, C, D – differences significant at $p \leq 0.01$

butter making [Wiking *et al.*, 2004]. The results obtained demonstrate that such milk is produced by mainly Whitebacks (9.49%), Simental (5.37%) and Jersey (4.93%) cows. A very low share of such molecules was recorded in milk of cows Polish Holstein-Friesian (HF) of red-white variety (0.98%). Grega *et al.* [2003] also found that molecule percentage of the biggest sized diameter was the lowest in milk of cows HF and black-white and the highest in Simental and Polish Red. The present authors' [Barłowska *et al.*, 2005b] studies conducted on three breeds demonstrated that milk of Red-White (no HF gene share) and Simental cows had more big-sized fat molecules compared to milk of black--white cows (with HF gene share).

Milk thermostability constitutes a very important index for the evaluation of milk usefulness for thermal treatment at high temperatures. Our own investigations confirmed that the sustained thermal treatment at 140°C (over 3 min 30 s) was withstood by milk of Simental, Whitebacks, Jersey and Polish Red cows. Lower resistance to the thermal treatment was shown by milk of black- and red-white cows, namely around 2 min (Table 3). In course of lactation, the milk usability for thermal treatment reduced (Table 4).

Coagulability induced by rennet is a valuable indicator for the assessment of milk usefulness at the cheese making process. Mistry *et al.* [2002] associate the rate of rennet curd development with protein and casein amount in milk and micelle size, that as confirmed in the present studies. Milk from Simental, Jersey, Whitebacks and Polish Red cows was characterised by a higher protein content (Table 1) and its coagulation time was significantly shorter ($p \leq 0.01$) compared to the milk of cows of the Polish Holstein-Frisian breed (black- and red-white variety). In contrast, Grega *et al.* [2003] proved a converse relation because the milk coagulation time in minutes was: 6:24 for black-white cows; 7:12 for red-white; 8:97 for Polish Red and 9:52 for Simental. Thus, it appears that in the case of two breeds, that is black- and red-white, our own results are in accordance with the literature presented, whereas in the other two they were nearly twice as low. Budsławski [1973] claims that milk whose coagulation time is 4–10 min is recognized appropriate and suitable for cheese making. It should be stressed, though, that too long coagulation time implies that it originated from a diseased mammary gland. The milk samples in our own studies were controlled in this respect.

TABLE 4. Technological usefulness indices of milk from cows of various breeds subject to lactation phase (mean values).

| Breed | Lactation phase (days) | n | Fat molecule share (%) | | | Thermostability (min) | Coagulation time (min) |
|---|---|---|---|---|---|---|---|
| | | | Small (<6 $\mu$m) | Medium (6–10 $\mu$m) | Big (>10 $\mu$m) | | |
| Polish Holstein-Friesian of | to 120 | 51 | $74.78^{B}$ | $21.64^{A}$ | $3.58^{a}$ | 2:44 | 6.50 |
| black-white variety | 121–200 | 41 | $71.82^{A}$ | $24.73^{B}$ | $3.42^{ab}$ | 2:39 | 6:02 |
| | over 200 | 58 | $76.83^{C}$ | $21.24^{A}$ | $2.13^{b}$ | 2:10 | 6:41 |
| Polish Holstein-Friesian of | to 120 | 12 | $72.22^{ab}$ | 24.74 | 0.53 | $2:32^{b}$ | 9:23 |
| red-white variety | 121–200 | 16 | $73.84^{b}$ | 25.18 | 0.98 | $1:28^{a}$ | 7:21 |
| | over 200 | 12 | $69.74^{a}$ | 28.96 | 1.29 | $1:38^{ab}$ | 8:11 |
| Simental | to 120 | 11 | 72.80 | 22.19 | $4.01^{A}$ | $6:33^{B}$ | 5:22 |
| | 121–200 | 10 | 71.30 | 23.30 | $4.40^{AB}$ | $3:02^{A}$ | 4:01 |
| | over 200 | 8 | 70.03 | 24.15 | $4.82^{B}$ | $2:25^{A}$ | 4:22 |
| Whitebacks | to 120 | 12 | $60.19^{a}$ | 28.64 | $10.89^{b}$ | 4:09 | 4:11 |
| | 121–200 | 9 | $68.14^{b}$ | 23.84 | $9.02^{ab}$ | 3:28 | 2:54 |
| | over 200 | 7 | $66.13^{b}$ | 25.37 | $8.07^{a}$ | 2:31 | 5:00 |
| Jersey | to 120 | 8 | 76.06 | 18.59 | 5.36 | 5:18 | 6:14 |
| | 121–200 | 15 | 76.80 | 17.64 | 5.56 | 4:29 | 3:54 |
| | over 200 | 14 | 76.98 | 18.92 | 4.10 | 4:07 | 6:16 |
| Polish Red | to 120 | 23 | 79.42 | 16.75 | 3.79 | 4:12 | 4:47 |
| | 121–200 | 11 | 82.83 | 14.45 | 2.71 | 4:00 | 4:30 |
| | over 200 | 15 | 78.76 | 17.43 | 3.81 | 3:03 | 4:41 |

a, b, A, B, C – differences between the breeds; a, b – differences significant at $p \leq 0.05$; A, B, C – differences significant at $p \leq 0.01$

The present studies revealed also that milk gained at the mid lactation time, *i.e.* between 121 and 200 day, underwent the coagulation process most readily. This dependence was shown in all the breeds analysed. It was likely to result from an increased milk protein content at this phase when calcium and magnesium persisted at a high level [Kowalski, 2002]. A high protein concentration along with appropriate content of calcium and magnesium ensure the proper course of curd formation and its firmness [Anonymous, 1999].

## CONLCUSION

Summing up, milk obtained from Simental, Whitebacks, Jersey and Polish Red cows proves more useful for processing, especially cheese making. It is ensured by a higher protein content, in that casein, more favourable protein-fat ratio, better thermostability and the shorter coagulation time. Therefore, it is recommended that milk should be used on a larger scale to produce specific dairy products considered as brand regional products.

## REFERENCES


1. Anonymous, The value of mineral components in animal nutrition. Pasze Polskie, 1999, 12, 74–77 (in Polish).
2. Barłowska J., Litwińczuk Z., Topyła B., Król J., The physico-chemical properties of milk from black- and red-white cows over the spring-summer period regarding a lactation phase. Rocz. Nauk. Pol. Tow. Zoot., 2005a, 1, 163–170 (in Polish).
3. Barłowska J., Litwińczuk Z., Topyła B., Physico-chemical parameters of milk from different cow breeds in spring-summer feeding period. Med. Wet., 2005 b, 61, 8, 937–939 (in Polish).
4. Budsławski J., Consumable milk. WPLiS, Warszawa 1973 (in Polish).
5. Górska A., Mróz B., Urea content in cow milk in lactation period. Zesz. Nauk. Przegl. Hod., 2005, 74, 79–85 (in Polish).
6. Grega T., Najgebauer D., Sady M., Wiechniak-Małek, Kraszewski J., Quality of butter and rennet curd from the milk of cows of different breeds. Rocz. Nauk. Zoot. 2003, 30, 151–159 (in Polish).
7. Grega T., Sady M., Kraszewski J., Technological usefulness of milk of Simental cows. Rocz. Nauk. Zoot., 2000, 27, 331–339 (in Polish).
8. Jaworski J., The physico-chemical properties of milk. 1997, *in*: The Dairying – Selected Problems (ed. S. Ziajka). Publ. ART. Olsztyn, vol. I, pp. 45–90 (In Polish)
9. Jurczak M.E. Milk, production, examination, processing. 1999I, II Edition revised and completed Publ. SGGW, Warszawa (in Polish).
10. Kowalski Z.M., The problems from dairy cow feeding. 2002, *in*: Milk Production, Practical Application of the EU and Poland Requirements from Farms. Association of Individual Milk Manufacturers, Warszawa, 2002, pp. 39–72 (in Polish).
11. Litwińczuk A., Evaluation of chemical composition of milk concerning milk protein and its fractions in Black-and-White cows and their crosses with a different proportion of Holstein-Fresian blood. Prace i Materiały Zootechniczne, 1991, 41, 33–40 (in Polish).
12. Litwińczuk Z., Chabuz W., Stanek P., Jankowski P., Introductory results of studies on genetic distinctiveness of White-Back cattle. Annales UMCS, 2003, sec. EE, 21, 41–46 (in Polish).
13. Litwińczuk Z., Stanek P., Chabuz W., Jankowski P., Whitebacks – the native cattle of the Polesie region. Teka

Kom. Ochr. Kszt. Środ. Przyr., 2004, 1, 130–138.
14. Mistry V., Brouk Bruk., Kasperson K., Martin E., Cheddar cheese from milk of Holstein and Brown Swiss cows. Milchwissenschaft, 2002, 57, 19–23.
15. Polish Standard PN-68/A-86122 – Milk. Research methods (in Polish).
16. Polish Standard PN-75/A-86059 (in Polish).
17. Reklewski Z., Genetic conditioning of cow milk efficiency in Poland. 1997, *in*: All-Polish seminar on "Potentials and hindrances in milk production in the light of Poland membership in EU", 26–27 May 1997, Krynica Morska, Poland (in Polish).
18. Seremak-Bulge J., The state of the Polish dairying six months after Poland accession to the EU. Przegl. Mlecz., 2005, 2, 10–15 (in Polish).
19. Wiking L., Stagsted J., Björck L., Nielsen J.H., Milk fat globule size is affected by fat production in dairy cows. Int. Dairy J., 2004, 14, 909–913.

## PRZYDATNOŚĆ TECHNOLOGICZNA MLEKA KRÓW SZEŚCIU RAS UTRZYMYWANYCH W POLSCE Z UWZGLĘDNIENIEM FAZY LAKTACJI

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Celem pracy była ocena przydatności technologicznej mleka pozyskiwanego od 6 głównych ras krów wykorzystywanych do produkcji mleka w Polsce, tj. polski holsztyno-fryz odmiany czarno- i czerwono-białej, simental, białogrzbiet, jersey i polska czerwona. Mleko pobierano w okresie wiosenno-letnim, kiedy w skład dawek pokarmowych wchodziła zielonka pastwiskowa. Przy pobieraniu prób mleka uwzględniano fazę laktacji, tj. do 120 dni, od 121 do 200 i powyżej 200. W każdej próbie mleka oznaczano: skład chemiczny, średnicę kuleczek tłuszczowych, termostabilność oraz zdolność krzepnięcia pod wpływem podpuszczki. Stwierdzono, że mleko białogrzbietów, simentalerów i jerseyów charakteryzowało się korzystniejszym stosunkiem białka do tłuszczu oraz wysokim udziałem kuleczek o dużej średnicy. Ponadto mleko tych krów i polskich czerwonych wytrzymywało dłuższy czas obróbki cieplnej w temperaturze 140°C oraz charakteryzowało się istotnie krótszym czasem krzepnięcia, co łączyło się z wyższą zawartością białka. Można stwierdzić zatem, że mleko krów tych ras jest bardziej przydatne do przetwórstwa, w szczególności do produkcji serów.