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COW FEEDING SYSTEM VERSUS MILK UTILITY FOR YOGHURT MANUFACTURE

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Background. A cow feeding system had a significant effect on the basic parameters characterising milk technological usability. Milk from the Polish Black-and-White variety of the Holstein-Friesland cows kept in the Total Mixed Ration (TMR) feeding system or on the traditional feeding regime was compared in terms of its utility for yoghurt manufacture.
Material and methods. Milk samples, collected six times a year at about 2-month intervals, were assayed for density, acidity, and contents of fat, protein, and lactose. Dry matter and solid-not-fat (SNF) contents were determined, as was the protein/fat ratio. Thermal stability of the milk was assessed with alcohol tests. The yoghurts manufactured (test yoghurts) were assayed for acidity, acetaldehyde content, and hardness. The yoghurts were also subjected to sensory evaluation.
Results. The cow feeding regime was found to have distinctly affected the composition and physico-chemical parameters of milk. Milk samples collected from cows fed in the traditional system contained more fat and dry matter than the milk yielded by the TMR-fed cattle. The latter produced milk that usually showed higher crude protein and casein contents, as well as higher SNF contents; in addition, the density of that milk was higher.
Conclusions. The feeding regime did not affect, in any clear-cut way, the sensory characteristics of the test yoghurts. However, those yoghurts manufactured from the TMR-fed cow milk contained more acetaldehyde and, in most cases, showed higher hardness, compared to the yoghurts made from milk produced by the cows kept on the traditional feeding regime.

Key words: cattle feeding, milk, yoghurt

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INTRODUCTION

Genetic advances in dairy cattle husbandry have enhanced the genetic potential of cows and induced changes in their feeds and feeding systems [Krzyżewski and Grądziel 1992, Mroczek 2006]. The Total Mixed Ration (TMR) system, used in Poland since 1996, has revolutionised dairy cattle feeding. In TMR, all the feed ration components are mixed in proportions dependent on cattle needs [Lach 2007]. The highest possible yield of milk, as determined by a cow's genetic potential, and the basic milk constituents and milk quality reaching an appropriate level required by the industry, are largely dependent on a rational feeding regime that meets nutritional requirements of the cattle. Feeding is regarded as a factor which relatively quickly produces changes in milk composition and yield, although relationships between feed and milk composition are very complex [Minakowski 1993, Lach and Podkówka 2000]. Nutritional errors and inappropriate use of cows reduce their potential in both quantitative and qualitative terms. Feeding is one of measures with which to adjust milk composition to the varying demands of the market, defined primarily by expectations on the part of the consumer and the milk industry [Litwińczuk and Szulc 2005].

This study was aimed at determining effects of cattle feeding regime on physico-chemical characteristics of milk and its applicability to yoghurt manufacture.

MATERIAL AND METHODS

The study was carried out on milk collected from two farms (A and B) in Western Pomerania that raise the Polish Black-and-White variety of the Holstein-Friesland cows; the cows were kept either on the traditional or the TMR feeding regime. Milk samples were collected 6 times a year at about 2-month intervals (November, January, March, May, June, and September).

Farm A kept 12 cows; their average milk yield was about 7000 kg. In spring-summer, the cows were fed mainly pasture forage supplemented by concentrated feeds. In autumn-winter, the major fodder consisted of grass hay silage, sugar-beet pulp silage, and corn oilcake supplemented by cattle feed concentrate. Farm B kept 700 cows; their average milk yield was about 9300 kg. The cattle were kept in the TMR feeding system, the feeds used being adjusted to the daily milk yield and physiological status of the cows. The feeds included silages made of corn, sugar-beet pulp, and alfalfa, as well as grass hay silage, malt rootlets, and a mineral-vitamin mix. The milk batches examined were sampled after the morning milking; samples were delivered to the laboratory within 2 h from milking. The milk was subjected to sensory evaluation and physico-chemical assays. All the milk batches were normal in appearance, without visible impurities, almost white to cream (at a higher fat content) coloured, and had a characteristic smell. It was only the milk sampled in September at Farm A that was distinct in having an irregular, cow byre-resembling flavour. Following evaluation, the milk samples – serving as the raw material for test yoghurts – were pasteurised at 85°C for 10 min. Test yoghurts were made in the laboratory thermostat, following a procedure described in the thermostat instruction manual, except that no powdered milk was added to increase the dry matter content of the milk. The yoghurts were made by adding (5%) a starter obtained from freeze-dried yoghurt bacteria culture containing *Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* (Abiasa, Canada). The milk-starter mix portions, 50 cm^3 each, were poured into 80 cm^3 plastic containers, covered with aluminium foil, and incubated at 42°C until a coagulum was obtained (about 3 h). On each occasion, two test yoghurt batches were made, one from the Farm A (traditional feeding) milk and the other from the milk obtained from Farm B (TMR feeding system). The yoghurts were kept at 5°C (±1°) and sampled after 1, 3, 7, 14, and 21 days of storage, 6 containers from each batch being picked out each time.

The following assays were performed, as specified by the Polish Standard PN-68/A--86122, in raw milk samples: fat content (Gerber method); protein content (Walker method); density (lactodensimeter); potential acidity (°SH); actual acidity (pH); and lactose content (Bertrand method) [Gaweł and Molska 1990]. Single and double alcohol tests [Gaweł and Molska 1990] were performed as well. The dry matter and solid-not-fat (SNF) contents were calculated using the Fleischmann formula (as specified by the Polish Standard PN-68/A-86122), and the protein/fat ratio was computed.

The following assays were performed on the test yoghurts: potential acidity (°SH; as specified by the Polish Standard PN-75/A-86130); acetaldehyde content (diffusion technique with 3-methyl-2-benzothianolinonhydrazone) [Less and Jago 1969]; and hardness (Texture Profile Analysis, TPA, with a Stable Micro Systems TAXTplus texture analyser). Hardness was determined using the penetrometric test involving a 20 mm diameter aluminium cylinder. The penetration depth was 25 mm; the velocity of approach to the sample surface, as well as that of shaft submergence and emergence was 5 $mm \cdot s^{-1}$; the pressure of 1G was applied.

Panel sensory evaluation of the yoghurts (1-5 scale, with half-scores) was performed. The highest score (5), corresponding to very good quality, was assigned for the coagulum being firm, homogenous, and lacking whey; for the flavour being distinct, refreshing, slightly acidic, typical of yoghurt; and for the texture being homogenous, firm, and jelly-like on the cross-section.

The numerical data presented as arithmetic means of 3 replicates (5 in the case of hardness) were subjected to one-way analysis of variance (milk composition and properties) and to Student's *t* test (physico-chemical analyses of the yoghurts).

RESULTS AND DISCUSSION

As shown by the results (Table 1), the feeding regime (traditional on Farm A versus TMR system on Farm B) affected the physico-chemical properties of the milk. The Farm A milk showed higher dry matter and fat contents throughout the period of study (1 year); on the other hand, the Farm B milk showed almost consistently (except for June) a higher SNF content and, in most cases, higher contents of protein and casein. The lactose contents in the two groups of milk were similar in November, January, and March (autumn-spring), whereas differences in the lactose content were visible in May, June, and September (spring-summer), the Farm B milk usually containing more lactose. A particularly low lactose content was observed in the Farm A milk in September, the milk yielding also a highly irregular smell and taste.

Among the basic milk constituents, the fat content is most susceptible to alteration by cattle feeding regime modification. The milk fat content depends primarily on the fodder characteristics such as the physical structure and energy content per unit dry

Table 1. Composition and physico-chemical properties of milk produced on Farm A and Farm B

Properties	November		January		March		May		June		September	
	Farm A	Farm B	Farm A	Farm B	Farm A	Farm B	Farm A	Farm B	Farm A	Farm B	Farm A	Farm B
Dry matter, %	12.4^{A}	11.73^{A}	12.72^{A}	11.9^{A}	12.47^{A}	11.68^{A}	14.27^{A}	11.86^{A}	12.66^{A}	11.61^{A}	13.11^{A}	11.96^{A}
Solids-not-Fat, SNF	8.12^{A}	8.30^{A}	8.25^{A}	8.53^{A}	8.17^{A}	8.41^{A}	8.22^{A}	8.53^{A}	8.66^{A}	8.44^{A}	8.11^{A}	8.46^{A}
Crude protein, %	3.06^{A}	3.36^{A}	3.01^{A}	2.94^{A}	2.90	2.86	3.23^{A}	3.46^{A}	2.88^{A}	3.30^{A}	2.96^{A}	3.14^{A}
Casein, %	2.34^{A}	2.57^{A}	2.31^{A}	2.25^{A}	2.22	2.19	2.47^{A}	2.65^{A}	2.21^{A}	2.53^{A}	2.26^{A}	2.41^{A}
Fat, %	4.28^{A}	3.43^{A}	4.47^{A}	3.37^{A}	4.3^{A}	3.27^{A}	6.05^{A}	3.33^{A}	4.00^{A}	3.17^{A}	5.00^{A}	3.50^{A}
Lactose, %	4.49	4.45	4.47	4.42	4.51	4.56	5.38^{A}	5.18^{A}	4.27^{A}	4.75^{A}	3.75^{A}	4.45^{A}
Density, g/cm^{3}	1.028	1.0294	1.0284	1.0304	1.0282	1.030	1.0270	1.0304	1.0304	1.0302	1.0274	1.0300
Acidity, °SH	6.00	6.00	7.75^{A}	7.20^{A}	6.93^{A}	6.60^{A}	6.53^{A}	7.20^{A}	7.40^{A}	6.90^{A}	7.80^{A}	7.20^{A}
pH	6.73	6.77	6.68	6.77	6.74	6.74	6.76	6.78	6.68	6.70	6.44	6.37
Single alcohol test	–	–	–	–	–	–	–	–	–	–	–	–
Double alcohol test	–	–	–	–	–	–	–	–	–	–	–	–
Protein/fat ratio	0.71^{A}	0.98^{A}	0.67^{A}	0.87^{A}	0.67^{A}	0.87^{A}	0.53^{A}	1.04^{A}	0.72^{A}	1.04^{A}	0.59^{A}	0.90^{A}

alcohol test (-) – milk is not coagulate.
^{A}Statistically significant differences for mean values of analysed features in the month ($p \leq 0.05$).

weight [Litwińczuk and Litwińczuk 2001]. The traditional feeding regime applied involved a higher contribution of volumetric fodder, hence the higher fat content in the Farm A milk. Feeding system effects on the milk protein content were much weaker. In addition to the food ration protein level and/or application of protein-rich feeds, the milk protein content depends highly on energy-rich feeds being administered to cattle at the same time. Thus, energy-deficient feeds are the main cause of low protein content in milk in summer [Krzyżewski and Grądziel 1993, Litwińczuk and Litwińczuk 2001]. The protein contents were high in the Farm B milk in 4 out of the 6 tests performed, which may be indicative of a better composition and energy balance of the TMR feed. On the other hand, the milk lactose content is usually insensitive to feeding modifications [Minakowski 1993]. The low lactose content in the Farm A milk may be indicative of mastitis.

Similar data on milk yield and fat content were reported by Barłowska [2007] for the Simmental cows. She found the TMR-fed cows to have produced more milk and the milk to show higher dry matter, crude protein, and lactose contents. In contrast, the milk produced by traditionally fed cows contained more fat and energy. Reklewska et al. [2003], too, showed the Black-and-White cows kept in an extensive system and using a natural pasture to produce much less milk than those cows not let out to graze and kept instead in the TMR system; however, the milk produced by the former showed higher contents of fat and numerous biologically important components. On the other hand, the TMR system-kept Holstein cows studied by White et al. [2001] showed a higher daily milk production compared to the pasture-raised cows; the milk of the former showed also higher fat and lactose contents. The Jersey cows showed a higher daily milk yield when fed pasture forage, but the milk produced by the TMR-fed cows had a more favourable composition (more fat, protein, and lactose).

The milk density conformed to the Polish Standard PN-A-86002:1999, i.e., it did not drop below 1.028 $g \cdot cm^{-3}$, except for the milk produced in May and September on Farm A (1.027 $g \cdot cm^{-3}$). The generally lower density of the milk produced by the traditionally fed cows resulted from the higher fat content of that milk.

The potential (titrated) acidity of the milk assayed failed to conform to the Polish Standard PN-A-86002:1999 in two batches of the Farm A milk only (January and September). The actual acidity (pH) of both Farm A and B milk was too high with respect to the Polish Standard mentioned in September.

Throughout the period of study (1 year), the milk batches evaluated showed appropriate thermal stability, as determined with alcohol tests (single and double).

Throughout the period of study, the protein/fat ratio was clearly higher in the Farm B milk (0.87-1.04) than in the Farm A milk (0.59-0.72). According to Krzyżewski et al. [1997], a high-energy, low-fibre cattle feed ration, while supplying exogenous amino acids, will reduce the milk fat content and increase the protein content, thus leading to an improved protein/fat ratio. This is at present one of the major objectives in dairy cattle husbandry in those countries most advanced in milk production.

The milk produced by the cows fed traditional fodder (Farm A) showed dry matter and fat contents to be similar in November, January, and March, wider variations in those constituents being observed in May, June, and September. On the other hand, dry matter and fat contents in the milk produced by the Farm B cows (TMR system feeding) were similar throughout the period of study.

No clear effect of milking season on crude protein and casein contents in the milk batches assayed was found. The lowest and very similar crude protein and casein contents in the Farm B milk were recorded in January and March (Table 1).

As already stated, the milk produced on Farms A and B was used to make yoghurt. The tests performed did not reveal any substantial differences in sensory characteristics of the test yoghurts, except for the Farm A yoghurt evaluated in September, when an irregular flavour (cow byre-like) was perceived (Table 2). As already mentioned, the milk from which the yoghurt was made showed that irregular flavour as well. The highest scores were awarded to yoghurt texture, the taste scoring the lowest. The appearance scored slightly lower due to a small whey release. Mould spots on the yoghurt surface were observed three times, after 21 days of storage: in January and September in the Farm A yoghurts and in May in the Farm B yoghurt. The worsened taste, reflected in lower scoring, resulted primarily from bitter flavour, intensifying during storage and perceived alternately in the Farm A and Farm B yoghurts. The slightly bitter flavour of the test yoghurts did not depend on the milk used for yoghurt manufacture; instead, the cause should be sought in the bacterial starter used. Additional tests (data not published) showed that all the yoghurts made with the same bacterial culture starter from pasteurised and UHT milk from different parts of Poland had a slightly bitter flavour appearing between day 3 and day 7 of storage and intensifying with time. This bitter flavour could have been due to the presence of bitter peptides, which may be indicative of undesirable proteolytic activity of the bacterial strains used [Dzwolak et al. 2006].

The test yoghurt texture scored very high. It should be mentioned that, except in January, the coagulum was firmer in the Farm B than in the Farm A yoghurts.

Table 2. Scores awarded during sensory evaluation of yoghurts made from milk obtained from cows kept on traditional or TMR feeding regimes and stored cold (1-5 scale)

	Farm A, November					Farm B, November					Farm A, January					Farm B, January				
	1	3	7	14	21	1	3	7	14	21	1	3	7	14	21	1	3	7	14	21
Appearance	4.25	4.60	4.30	4.50	4.25	4.40	4.20	4.5	4.58	4.13	4.50	4.79	4.83	4.58	1.00 ◊	4.00	4.33	4.63	4.30	4.35
Smell	4.13	5.00	4.90	4.50	4.13	4.38	5.00	4.75	4.67	4.80	4.30	5.00	4.92	5.00	4.08	4.92	5.00	5.00	4.83	4.92
Taste	5.00	4.00	4.00 ■	3.58 ▲	3.00 ○	5.00	4.00 ■	3.50 ▲	3.40	2.50 ♦	4.00	4.00 ■	3.40 ○	3.10 ○	2.60 ○	4.00	4.00 ■	3.53 ▲	3.10 ○	2.00 ♦
Texture	5.00	5.00	5.00	4.8	4.80	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	4.20	4.50	4.90	5.00	5.00
	Farm A, March					Farm B, March					Farm A, May					Farm B, May				
	1	3	7	14	21	1	3	7	14	21	1	3	7	14	21	1	3	7	14	21
Appearance	4.50	4.67	4.58	4.42	4.50	4.10	4.33	4.50	4.67	4.50	4.67	4.92	4.96	4.79	4.85	4.50	5.00	4.92	4.92	1.00 ◊
Smell	4.42	4.67	4.67	5.00	4.67	4.17	4.75	4.92	5.00	4.75	4.75	4.50	5.00	5.00	4.83	5.00	4.92	5.00	4.92	4.00
Taste	4.00	4.00	4.00 ■	3.00 ○	2.90 ○	4.00	3.90 ▲	3.90 ▲	3.00 ○	2.70 ♦	5.00	4.20	4.00 ■	3.50 ▲	3.50 ▲	4.20	4.00 ■	3.55 ▲	3.10 ○	2.90 ○
Texture	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Farm A, June					Farm B, June					Farm A, September					Farm B, September				
	1	3	7	14	21	1	3	7	14	21	1	3	7	14	21	1	3	7	14	21
Appearance	4.17	4.21	4.88	4.30	1.00 ◊	3.71	3.92	4.33	4.00	4.25	4.75	4.83	5.00	4.67	1.00	3.79	3.75	4.25	4.50	4.60
Smell	4.50	4.90	5.00	4.60	3.10	4.54	4.83	4.92	5.00	4.83	2.00	3.00	2.00	3.67	2.60	4.08	4.92	5.00	4.83	4.50
Taste	4.50	4.00	3.50 ▲	3.50 ▲	1.00 □	5.00	4.00 ■	3.00 ○	3.00 ○	2.80 ♦	3.00 ●	3.20 ●	3.00 ●■	2.50 ●▲	2.10 ●♦	4.00	4.00 ■	3.90 ▲	3.50 ○	3.50 ○
Texture	5.00	5.00	5.00	5.00	4.00	5.00	5.00	5.00	5.00	5.00	4.50	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00

■ – slightly bitterish, ▲ – bitterish, ○ – distinctly bitter, ♦ – very bitter, ◊ – mould, □ – irregular stale-bitter, ● – irregular cow byre-like.

The physical properties of yoghurt depend mostly on the milk protein content. The coagulum firmness is controlled by the ratio between casein and the remaining milk proteins. Protein hydratation and swelling, as well as partial crystallisation of fat, i.e., processes contributing to yoghurt viscosity, structural homogeneity, and syneresis restriction, are the major factors controlling yoghurt structure and texture [Żbikowska and Żbikowski 1995, Tamime and Robinson 1999].

Throughout the period of study, acidity of the test yoghurts complied to the Polish Standard PN-A-86061:2002, i.e., exceeded 0.6% (when converted to lactic acid), which is equivalent to 26.67°SH. In all the six tests performed, the acidity increase during storage proceeded in a similar manner (Fig. 1). The highest increase was observed during the first 7 days of storage: from 4 to 6.93 and from 5.53 to 6.57°SH in the Farm A and Farm B yoghurts, respectively. During the ensuing 14 days of storage, the yoghurt acidity changed only slightly. Statistically significant differences in yoghurt acidity were identified in March, May, and September (Table 3). Yoghurt acidity increase during cold storage was also reported by Kowalska et al. [2000] and by Cais-Sokolińska and Pikul [2001].

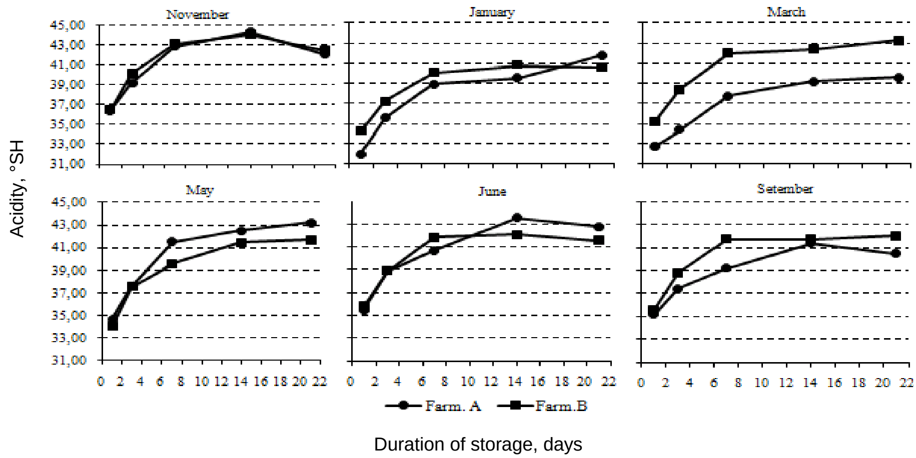

Fig. 1. Changes in acidity of yoghurts made from milk obtained from cows kept on traditional or TMR feeding regimes during cold storage

Table 3. Results of paired comparisons (Student's *t* test) of changes in acidity, acetaldehyde content, and hardness of yoghurts made from milk obtained from Farm A and Farm B during cold storage

Pair compared	Parameter	November	January	March	May	June	September
				Acidity			
Yoghurt Farm A vs. yoghurt Farm B	a	1.4560	1.6621	11.4755	3.1534	0.4793	3.0443
	b	0.2191	0.1718	3.2915E–4	0.0344	0.6568	0.0382
		–	–	+	+	–	+
				Acetaldehyde			
Yoghurt Farm A vs. yoghurt Farm B	a	4.8000	2.6937	6.0577	2.3131	3.2282	7.8937
	b	8.6484E-3	0.0544	3.7487E-3	0.0818	0.0320	1.3929E-3
		+	–	+	–	+	+
				Hardness			
Yoghurt Farm A vs. yoghurt Farm B	a	17.2500	3.2605	0.9128	2.4570	3.3151	9.3497
	b	6.6272E-5	0.0311	0.4130	0.0699	0.0295	7.2869E-4
		+	+	–	–	+	+

a – calculated *t* value, b – level of significance, "+" – difference significant, "–" – difference non--significant.

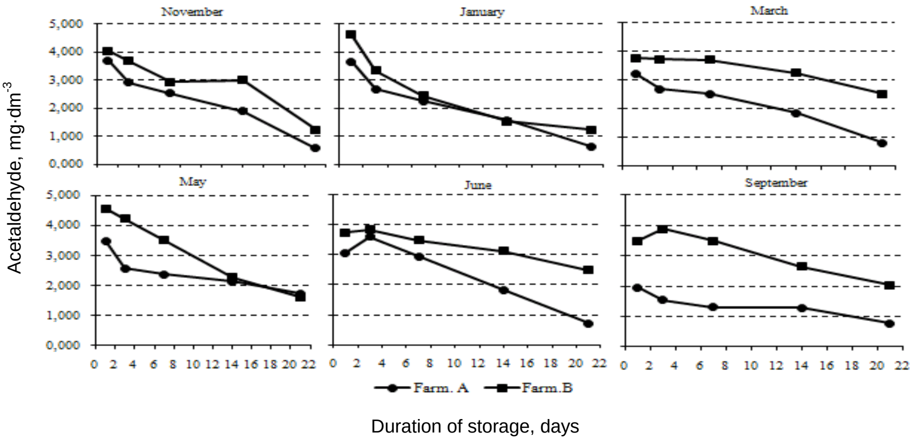

Fig. 2. Acetaldehyde contents in yoghurts made from milk obtained from cows kept on traditional or TMR feeding regimes during cold storage

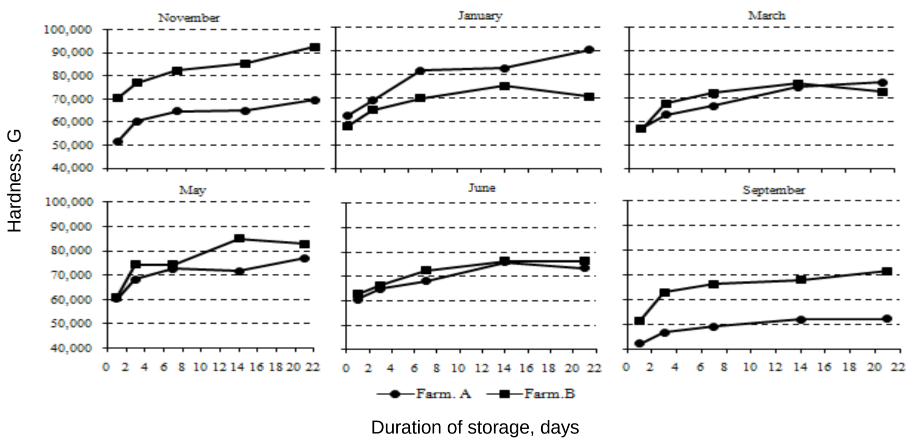

Fig. 3. Hardness of yoghurts made from milk obtained from cows kept on traditional or TMR feeding regimes during cold storage

The content of acetaldehyde, a typical yoghurt flavour component, was another characteristic assayed in the test yoghurts. Except for 2 cases with slightly higher acetaldehyde contents found in the Farm A yoghurts (Fig. 2), the acetaldehyde content was higher in the yoghurts made from Farm B milk throughout the period of study (6 tests). The acetaldehyde content was observed to gradually decrease during storage in all the yoghurts assayed. A significantly higher acetaldehyde content was typical of the Farm B yoghurts in November, March, June, and September (Table 3). The acetaldehyde content decreased at a lower rate in the Farm B yoghurts than in the yoghurts made from the Farm A milk. After 21 days of storage, the acetaldehyde content in the Farm B yoghurts was lower by about 73 in January and 33% in March, relative to the original content, whereas the reduction in the Farm A yoghurts ranged from about 85% in November to 50% in May. Acetaldehyde may be formed as a result of metabolism of saccharides (lactose, glucose), nucleic acids or nitrogen compounds (e.g., threonine). A particularly high threonine aldolase activity is typical of *Lactobacillus delbrueckii* ssp. *bulgaricus*, a yoghurt starter component. Presumably, the higher acetaldehyde content in the yoghurt made from the Farm B milk resulted from the latter being a better medium for the yoghurt bacteria, compared to the Farm A milk. After a prolonged incubation, acetaldehyde content usually decreased as a result of alcohol dehydrogenase-mediated transformation to ethanol [Libudzisz 1998]. An acetaldehyde content reduction in yoghurt during storage was reported also by Gaafar [1992].

As shown by the study, the test yoghurt hardness, similarly to the acetaldehyde content, depended on the milk origin, i.e., the feeding regime (Fig. 3). Yoghurt hardness was observed to increase during 21 days of storage in all the 6 tests. Yoghurts made from the Farm B milk showed usually a higher hardness; it was only in January that a significantly higher hardness was recorded in the Farm A yoghurt. The significantly higher hardness of the yoghurts made from the Farm B milk was found in November, June, and September (Table 3).

Due to increased acidity, the coagulum usually becomes harder, most probably because of the protein-protein bonds becoming stronger [Walstra 1998]. This pattern was confirmed in this study, as the acidity of the yoghurts and their hardness were observed to gradually increase during storage. Salvador and Fiszman [2004] reported hardness of yoghurts made from both whole and skimmed milk to increase during cold storage. Yeganehzad et al. [2007], too, observed probiotic yoghurt hardness to increase during 21 days of storage at 4°C.

CONCLUSIONS

1. In terms of sensory characteristics, the milk produced by TMR-fed cows did not differ from the milk produced by the cows kept on the traditional feeding regime.
2. The TMR-fed cow milk showed lower dry weight and lower fat content, its solid-not-fatt and, in most cases, protein and casein contents being higher than those in the milk produced by the cows fed traditionally.
3. The protein/fat ratio was higher in the TMR cow milk than in that produced by the cows kept on the traditional feeding regime.
4. Yoghurts made from milk produced by the traditionally fed cows were similar in their sensory characteristics to yoghurts made from milk produced by the TMR-fed cows.
5. Yoghurts made from milk produced by the TMR-fed cows showed higher acetaldehyde content and hardness (except for January) than yoghurts made from milk produced by the traditionally fed cows.

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SPOSÓB ŻYWIENIA KRÓW A PRZYDATNOŚĆ MLEKA DO PRODUKCJI JOGURTU

Wprowadzenie. System żywienia krów ma istotny wpływ na wartość podstawowych wskaźników charakteryzujących przydatność technologiczną mleka. Oceniono przydatność do produkcji jogurtu mleka pochodzącego od krów rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej, żywionych systemem TMR i systemem tradycyjnym.
Materiał i metody. Mleko do badań pobierano sześciokrotnie w ciągu roku w odstępach ok. dwumiesięcznych. W mleku oznaczono gęstość, kwasowość oraz zawartość tłuszczu, białka i laktozy. Obliczono zawartość suchej masy i suchej masy beztłuszczowej oraz stosunek białkowo-tłuszczowy. Oceniono też stabilność termiczną mleka za pomocą testów etanolowych. W jogurtach doświadczalnych oznaczono kwasowość, zawartość aldehydu octowego i twardość. Wykonano też punktową ocenę organoleptyczną.
Wyniki. Stwierdzono wyraźny wpływ systemu żywienia krów na skład i cechy fizykochemiczne mleka. Mleko pochodzące od krów żywionych systemem tradycyjnym zawierało więcej tłuszczu i suchej masy, a pochodzące od krów żywionych systemem TMR – na ogół więcej białka całkowitego i kazeiny oraz suchej masy beztłuszczowej, a także większą gęstość.
Wnioski. Sposób żywienia krów nie miał wyraźnego wpływu na cechy organoleptyczne wyprodukowanych jogurtów. Natomiast jogurty z mleka krów żywionych systemem TMR zawierały więcej aldehydu octowego i w większości odznaczały się większą twardością.

Słowa kluczowe: żywienie krów, mleko, jogurt

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