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THE RAW MILK QUALITY FROM ORGANIC AND CONVENTIONAL AGRICULTURE

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Abstract

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In the experiment the parameters of milk quality from organic and conventional dairy farm were analyzed. The number of somatic cells was 219. 10^3.ml^{-1} in the organic milk and 242. 10^3.ml^{-1} in the conventional milk. It seems that conditions of organic farming could be able to have a positive effect of health of mammary gland. We found the highest number of somatic cells at the end of the year (336.10^3.ml^{-1} in organic milk in December, respectively 336.10^3.ml^{-1} in conventional milk in November). The total bacteria count was higher in organic milk (86.10^3 CFU.ml^{-1}) than conventional (51.10^3 CFU.ml^{-1}) likewise the number of coliform bacteria. Number of coliform bacteria was by conventional milk under 1000 CFU.ml^{-1} for all samples. The highest number of coliform bacteria in organic milk was achieved in February (1000 CFU.ml^{-1}). We found higher content of fat (4.23 g.100g^{-1}) and protein (3.41 g.100g^{-1}) by organic milk in comparison with the conventional milk (4.11 g.100g^{-1}, resp. 3.39 g.100g^{-1}). The higher content of protein and fat in organic milk and the higher protein content in conventional milk were determined in December. The heat resistance was determined by 96 % ethanol required to coagulation of 2 ml of milk. The conventional milk has significantly lower heat resistance (1.38 ml) than the organic one (1.86 ml). Better heat stability by organic milk and higher content of Ca (144.29 mg.100g^{-1}) correspond with higher technological quality of organic milk.

microbiological quality, fat, protein, heat stability, calcium

The demands of consumers for an organic product were increased and create new market for agricultural products mainly in Western Europe and USA. Organic farming is defined as form of agriculture with the aim to create integrated, human, environmentally sustainable agricultural production system. The main advantages of organic farming are: the market price for such products are higher, the way in which they are produced involves less intensive use of land and better protection of environment. Production of grass as fodder in North Slovakia is by far the most important use of organic land where is important milk production.

The milk quality is influenced by many factors. The digestibility, metabolite blood concentration and process in the mammary gland are affected by the content of easy degradable carbohydrates, fibre and proteins in feeding rations (Kološta et al., 2003). The fat content varied between 2.33 and 5.25% (Kráčmar and Zeman, 2004). But in the ewe's milk is higher 6.63–7.24% (Šustová et al., 2005, Gajdůšek et al., 2003). The milk fat is produced mainly from acetic acid. Acetic acid is produced in the rumen. The optimal production of acetic acid occurs by 18–20 % fibre content in feeding ration (2/3 in the structural form). It means at least 3 kg of fibre in the forage (Sommer and Gallo; 2000). Ellis et al. (2006) analyzed fatty acid composition of organic and conventional milk. Organic milk had a higher proportion of polyunsaturated to monounsaturated fatty acids than conventional milk and contained a consistently lower n–6 : n–3 faty acids ratio compared with conventional milk. The milk proteins are formed in the mammary gland epithelium and consist of casein and whey proteins (Sommer, Gallo, 2000). The forage proteins quantitatively and qualitatively influence the content of milk proteins mainly at the beginning of lactation. The important factors are microbial proteins synthesis in the rumen, content of the nondegradable proteins in rumen and energy of feeding rations (Valent, 1995). The content of essential amino acids in the milk is 2048.8 mg.100 ml^{-1} and nonessential

2173.7 mg.100 ml^{-1} (Kráčmar et al., 2007). Mineral content of milk is about 0.7 %. The most important mineral element is calcium. The calcium content in milk is about 0.12 %. In the case of mastitis milk calcium decreased to 0.04 % (Vasiľ, 2000). Calcium in milk occurs in the two forms, as micelles and in soluble form. Casein micelles content nonsoluble calcium phosphates and holds micelle structure. The calcium content is important for milk processing (Jamrichová, 2001). The absorption of calcium is mainly in the two forms calcium compound. Calcium chlorine is dissociated to ions and amount of dissociated calcium is directed by vitamin D, parathormon and calcitonin. Calcium phosphor is very important for absorption too. Calcium content is about 0.12% and phosphor 0.10% (Kovačik, 1997).

The organic farming used primary on farm derived renewable resources. The organic farming is covered by Council Regulations 2092/91. This regulation sets out strict requirements for agricultural products and foods produced in the EU or imported from third countries. Good health and welfare are important in the cow rearing. For the good health is important the outdoor rearing, cows have to be minimally 150 days per year on the pasture. For indoor rearing is important loose housing system, minimally 6m^2 pre cow. Minimally 60% of dry matter of feeding ration has to be forage. Genetically modified organisms, their products and synthetic amino acids are forbidden. The cleaning and disinfection can minimally effect on environment and dairy production. The steam, hot water (85°C) or 0.5% solution of nitrous acid or 0.5% solution of lye are preferred. Ray et al. (2006) analyzed the antimicrobial sensitivity of S*almonella* from organic and conventional dairy farms. The probability of appearance of *Salmonella* isolates with greater resistance to streptomycin (30.4%) and sulfamethoxazole (29.0%) was higher on conventional farms than organic farms.

The antibiotic resistance status needs to be monitored in the organic farms as well as conventional farms and production farms need to be evaluated. Although antibiotic resistance patterns may reflect the antibiotics used for mastitis prevention and treatment (Rajala-Schultz et al., 2004), convincing evidence is lucking that the use of antibiotics for the treatment or prevention of mastitis has resulted in development of resistance to antibiotics (Hillerton and Berry, 2005). Roesch et al. (2006) studied antibiotic resistance of udder pathogens in dairy cows from organic and conventional farms. Obvious differences in the percentage of antibiotic resistance are mainly species-related and differ in *Streptococcus uberis,* which exhibited significantly more single resistance (compared with no resistant) when isolated from cows kept on organic farms (6/10 isolates) than on conventional farms (0/5 isolates).

The aim of this study was to determine the effect of organic conditions on milk quality. In organic production are not used nondegradable detergents and in this view were analyzed microbiological quality of milk.

MATERIAL AND METHODS

In the experiment the organic milk quality parameters were analyzed. The milk samples from the following farms were analyzed:

- Organic farm – Slovak Pinzgau cattle (approximately 100 cows),
- Conventional farm – Slovak Pinzgau cattle (approximately 100 cows).

Both farms are situated in the south part of Slovakia.

The organic farm is in the system of organic agriculture and is under the organic control. Organic farming in Slovakia is administered by Council regulations 2092/1991 EU.

Bulk tank milk samples were obtained after cooling to the temperature of 4 °C – 8 °C in accordance with STN EN ISO 707. The bulk milk samples from morning and evening milk were sampled by methodic requirements for raw cow milk. The milk samples were analyzed from May to February, two times per month and the results in given month were averaged. The milk samples were obtained by trained operator from the Slovak Agricultural University.

The samples were analyzed in the laboratory of the Slovak Agricultural Centre in Nitra and in the laboratory of Department Animal Products Evaluation and Processing of Slovak Agricultural University in Nitra.

In the raw milk were analyzed:

- Somatic cell count (SCC) by disc cytometer Fossomatic 90,
- Total bacteria count by culture method on the culture medium GTKA at 30°C (STN EN ISO 4833),
- Content of fat, protein and lactose in milk by MilkoScan (g.100g^{-1}),
- heat stability was determined by 96% ethanol (ml) required to coagulation of 2 ml of milk,
- Calcium content by colorimetric method STN 57 0530.

Results of observations were evaluated by t-test, statistical program Statgraphics.

RESULTS AND DISCUSSION

SCC was lower (219.10^3. ml^{-1}) in the organic milk than the conventional milk (242.10^3. ml^{-1}) but this difference was not statistically significant (table I). Kološta (2002) presented higher content of somatic cells in the milk produced in the Slovakia 312.10^3. ml^{-1}. The lowest content of somatic cells in the organic milk was in the May 96.0^3. ml^{-1} and in the conventional milk was in November 79.10^3.ml^{-1}. We found the highest number of somatic cells at the end of the year (336.10^3.ml^{-1} in organic milk in December, respectively 336.10^3.ml^{-1} in conventional milk in November). These results were in the agreement with limits (400.10^3.ml^{-1}) determined by the Council regulations 1662/2006. Kološta and Golecký (2005) found only 139.10^3.ml^{-1} somatic cells in the milk of cows pastured plus grain feed

(August) and more higher content of somatic cells ($507.10^3.ml^{-1}$) in the milk of cows only pastured without another feed. The conditions of organic farming are suitable for reach acceptable content of somatic cells, because in organic farming is important good health and welfare of animals.

Total bacteria count was 86.10^3 CFU.ml^{-1} in organic milk and 51.10^3 CFU.ml^{-1} in conventional milk (table I). Total bacteria count was under the limit 100 10^3 CFU.ml^{-1} in all samples (Council regulations 853/2004). Total number of bacteria in Slovak conditions range from 117.10^3 CFU.ml^{-1} (Kološta, 2002) to $135.10^3.ml^{-1}$ (Hofericová, 2003). In the 2004 had milk in Slovakia better microbiological quality (55.45 % of raw milk–class Q, 40.28 % in the class 1 and 4.27 % was nonstandard milk). In the 2005 microbiological quality of raw milk increased because only 33.12 % was in the 1 class and amount of nonstandard milk decreased to 3.68 % (Masár, 2005). The microbiological quality is based mainly on total number of bacteria and results of cited author indirectly corresponded to our results.

Number of coliform bacteria in the organic milk was 554.CFU.ml^{-1} and in the conventional milk 269 CFU.ml^{-1}. Number of coliform bacteria in conventional milk in all samples was under the 1000.ml^{-1} and in the organic milk was the highest number in the February (1000.ml^{-1}). The European legislative does not determine number of coliform bacteria. The number of coliform bacteria in Slovak is to the limit 1000.ml^{-1} according to standard (STN 57 0529). The number of coliform bacteria is an indicator of faecal contamination.

Physical and chemical raw milk parameters are presented in the Table II. Fat content in the organic milk was 4.23 % and in the conventional milk 4.11 %. The lower fat content in organic milk was in the May (3.4 %) and in the conventional milk in the May and August equally 3.7 %. The reason of the lower fat content 3.45 % in the organic milk in the May was the opening of pasture season and young pasture with lower fibre content. The content of fibre is the main factor affecting content of fat in milk (Sommer, 1997). The optimal fiber content in the feed ration is 18–22%. The highest variability of fat content was in organic milk (v% = 9.66). It could be caused by less balanced feed ration in the year. Olesen et al. (1999) found similar results. They determined fat content from 3.62 to 4.22 %.

Protein content in the organic milk was 3.41 % and in conventional milk 3.39%. In the organic milk was the lover protein content in the August (3.18 %) and in the conventional in the May (3.05 %) analogous to Foltys (1996). Olesen et al. (1999) found higher protein content (3.15 – 3.25 %) in the organic milk. The highest protein content was in December for organic milk (3.75 %) and conventional milk too (3.65 %). The main effect on protein milk content has feed energy (Sommer, 1999). Fat content was higher for organic milk in the winter (December 4.86 g.100g^{-1}, January 4.5 g.100g^{-1} and February 4.33 g.100g^{-1}). It seems that the high fat content is in relation to high fibre content in the feed ratios (up to 22 %) and it could decreased milk production. In the conventional milk was high fat content in the November (4.62 g.100 g^{-1}). Protein content in the organic milk was 3.41 g.100g^{-1} and in the conventional 3.39 g.100 g^{-1}. The lower protein content in the conventional milk was in the May (3.05 g.100 g^{-1}) likewise Foltys (1996).

Content of lactose was in the organic milk 4.72 g.100g^{-1} and in the conventional 4.81 g.100g^{-1}. The lower lactose content in the organic milk was in October and November equally 4.61 g.100g^{-1} and in the conventional milk in January (4.7 g.100g^{-1}). Foltys (1996) found out the lower lactose content in the June (4.6 g.100g^{-1}). Content of nonfat solids was in the organic milk 8.85 g.100g^{-1} and in the conventional milk 8.92 g.100g^{-1}. The lower content of nonfat solids in organic milk was in the October (8.63 g.100g^{-1}) and the higher in the December (9.12 g.100g^{-1}). In the conventional milk was the lowest content of nonfat solids in the May (8.66 g.100g^{-1}).

I: *Number of somatic cells and total bacteria count in the organic and convention milk. Počet somatických buniek, celkový počet mikroorganizmov a počet koliformných mikroorganizmov v ekologickom a konvenčnom mlieku.*

[1]Parameters	[2]Somatic cells (1000.ml^{-1})		[3]Total bacteria count (1000.ml^{-1})		[4]Coliform organisms	
	[5]Organic milk	[6]Convention milk	[5]Organic milk	[6]Convention milk	[5]Organic milk	[6]Convention milk
n	10	10	10	10	10	10
$\bar{x}$	219	242	86	51	554	269
s	74.86	85.79	9.11	28.4	279.57	191.69
s_x	23.67	27.13	2.88	8.98	88.41	60.62
v%	34.22	35.53	10.61	56.02	50.46	71.37
t-test	-		++		+	

[1] Ukazovateľ, [2] Somatické bunky, [3] Celkový počet mikroorganizmov, [4] Koliformné mikroorganizmy, [5] Ekologické mlieko, [6] Konvenčné mlieko

Calcium content was significantly higher in the organic milk (144.29 mg.100g^{-1}) than in the conventional milk (130.66 mg.100g^{-1}) (table III). Kološta and Golecký (2005) determined lower calcium content in the milk of pastured cows (125.48 mg.100g^{-1}).

Heat resistance was significantly lower in the conventional milk (1.38 ml) in comparison with the organic milk (1.86 ml) (table III). The lower heat resistance was in the November for both types of milk (organic 0.8 ml and convent milk 0.5 ml). The changes of heat resistance are affected by calcium, magnesium and anions phosphorous acid balance (Kološta et al., 2003).

II: *Chemical composition of organic and convention milk. Chemické zloženie ekologického a konvenčného mlieka.*

[1]Parameters		n	$\bar{x}$	s	s_x	v%	t-test
[2]Fat (g.100g^{-1})	[7]Organic milk	10	4.23	0.41	0.13	9.66	-
	[8]Convention milk	10	4.11	0.28	0.09	6.79	
[3]Protein (g.100g^{-1})	[7]Organic milk	10	3.41	0.17	0.05	4.93	-
	[8]Convention milk	10	3.39	0.17	0.05	5.04	
[4]Lactose (g.100g^{-1})	[7]Organic milk	10	4.72	0.11	0.03	2.28	-
	[8]Convention milk	10	4.81	0.08	0.02	1.60	
[5]Solids (g.100g^{-1})	[7]Organic milk	10	13.08	0.44	0.14	3.40	-
	[8]Convention milk	10	13.03	0.42	0.13	3.26	
[6]Nonfat solids (g.100g^{-1})	[7]Organic milk	10	8.85	0.17	0.06	7.96	-
	[8]Convention milk	10	8.92	0.18	0.06	2.05	

[1] Ukazovateľ, [2]Tuk, [3] Bielkoviny, [4] Laktóza, [5] Sušina, [6] Beztuková sušina, [7] Ekologické mlieko, [8] Konvenčné mlieko

III: *Heat stability and Calcium content in the organic and convention milk. Termostabilita a obsah vápnika v ekologickom a konvenčnom mlieku.*

[1]Parameters	[2]Heat stability (ml)		[3]Calcium (mg.100g^{-1})	
	[4]Organic milk	[5]Convention milk	[4]Organic milk	[4]Convention milk
n	10	10	10	10
$\bar{x}$	1.86	1.38	144.29	130.66
s	0.62	0.46	7.79	5.74
s_x	0.20	0.15	2.46	1.81
v%	33.33	33.33	5.40	4.39
t-test	-		++	

[1]Ukazovateľ, [2]Termostabilita, [3]Vápnik, [4] Ekologické mlieko, [5]Konvenčné mlieko

SUMMARY

The average total bacteria count was 88.10^3 CFU.ml^{-1} in the organic milk and 51.10^3 CFU.ml^{-1} in conventional milk. In accordance to Council regulations EU 2092/1991 in organic agriculture and the processing of nondegradable detergents can not be used because of environmental protection. Total bacteria count in organic milk in every sample is in accordance with Commission regulations 1662/2006 EU and 284/2004. The milk for human consumption can be processed when contains mostly 100.10^3 CFU.ml^{-1} of total bacteria count. Lower somatic cells in organic milk (219.10^3.ml^{-1}) shows that conditions of organic farming are suitable for health of mammary gland. Higher calcium content 144.29 mg.100g^{-1} and better heat resistant (1.86 ml) corresponded with higher technological quality of organic milk. In the organic milk was higher fat content (4.23 g 100g^{-1}), protein (3.41 g.100g^{-1}) and lower lactose content (4.72 g.100g^{-1}). The organic milk had significantly higher content of calcium (144.29 mg.100g^{-1}) and higher milk heat stability (1.38 ml). Technological and chemical parameters of organic milk are more suitable mainly to cheese production.

It seems that better conditions for health state are in the organic farming and this could be one of the important factors for improvement of cow longevity in the future.

SOUHRN

Kvalita surového kravského mlieka z ekologického a konvenčného poľnohospodárstva

V práci sme porovnávali kvalitu mlieka z ekologického a konvenčného chovu. Počet somatických buniek v ekologickom mlieku bol 219.10³. ml⁻¹ a v konvenčnom 242.10³. ml⁻¹. Najvyšší počet somatických buniek v ekologickom mlieku bol v decembri (336.10³.ml⁻¹) a v konvenčnom mlieku v novembri (336.10³ KTJ.ml⁻¹). Celkový počet mikroorganizmov bol v ekologickom mlieku 86.10³ KTJ.ml⁻¹ a v konvenčnom mlieku 51.10³KTJ.ml⁻¹. Počet koliformných baktérií v ekologickom mlieku bol 554 KTJ.ml⁻¹ a v konvenčnom mlieku 269. KTJ.ml⁻¹. Počet koliformných baktérií vo všetkých vzorkách konvenčného mlieka bol pod 1000.ml⁻¹ a v ekologickom mlieku sme zistili najvyššiu hodnotu v mesiaci február (1000 KTJ.ml⁻¹). Priemerný obsah tuku v ekologickom mlieku bol 4,23 g.100g⁻¹ a v konvenčnom 4,11 g.100g⁻¹. Najnižší obsah tuku v ekologickom mlieku sme zistili v mesiaci máj (3,4 g.100g⁻¹) a v konvenčnom mlieku v máji a v auguste zhodne 3,7 g.100g⁻¹. V ekologickom mlieku sme zistili priemerný obsah bielkovín 3,41 g.100g⁻¹ a v konvenčnom 3,39 g.100g⁻¹. V ekologickom mlieku bol najnižší podiel bielkovín v auguste 3,18 g.100g⁻¹ a v konvenčnom v máji 3,05 g.100g⁻¹. Naopak najvyšší podiel bielkovín v ekologickom mlieku bol v decembri 3,75 g.100g⁻¹ a v konvenčnom tiež v decembri 3,65 g.100g⁻¹. Termorezistencia bola v biomlieku signifikantne vyššia (1,86 ml) v porovnaní s konvenčným mliekom (1,38 ml). Nižší počet somatických buniek v ekologickom mlieku (219.10³.ml⁻¹) naznačuje, že pravidlá ekologického poľnohospodárstva a nariadenie rady EU 2092/1991 vytvárajú vhodné podmienky pre zdravotný stav mliečnej žľazy, čo je základnou podmienkou pre výrobu kvalitného mlieka. V biomlieku sme zistili vyšší celkový počet mikroorganizmov (86. 10³. ml⁻¹), avšak ich počet ani v jednom odbere nepresiahol hodnotu stanovenú Nariadením rady EU 1662/2006 (max. 100.10³.ml⁻¹). Je možné konštatovať, že aj pri rešpektovaní prísnejších požiadaviek na čistiace a dezinfekčné prostriedky v ekologickom poľnohospodárstve sú vytvorené vhodné podmienky pre výrobu kvalitného biomlieka. Lepšia termostabilita (1,86 ml) a vyšší obsah vápnika (144,29 mg.100g⁻¹) v biomlieku naznačujú, že je vhodnejšie aj pre výrobu vysokotepelne spracovaných výrobkov a výrobu syrov.

mikrobiologická kvalita, tuk, bielkoviny, termostabilita, vápnik

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