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EFFECT OF ORGANIC FARMING ON SELECTED RAW COW MILK COMPONENTS AND PROPERTIES

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Abstract

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Organic dairying is an alternative for friendly exploitation of environment. This paper was focused on impacts of organic dairying on milk composition and properties. The conventional (C) cow milk was compared to organic (O) milk. Holstein bulk milk samples (BMSs) from winter and summer season in 4 C and 4 O (n = 32 and 32 BMSs; 2 years) herds were investigated. 6 herds were grazed and 2 C herds were not grazed. Mean O cow milk yield (MY, 305 lactation days) was 7037.3 ± 421.5 and C MY 7015.8 ± 1068.1 kg. Higher values ($P < 0.05$) in O milk had: log acetone (0.7321 > 0.6048); titration acidity (8.34 > 7.82 ml 0.25 mol.l^{-1} NaOH); alcohol stability (0.6 > 0.44 ml); time for enzymatic coagulation (150.75 > 115.03 second); whey protein (0.54 > 0.49%); fat/crude protein (1.2 > 1.15); milk fermentation ability (FAM) by titration (31.45 > 22.18 ml 0.25 mol.l^{-1} NaOH). Lower values ($P < 0.05$) in O milk had: solids–not–fat (8.64 < 8.73%); urea content (19.91 < 29.03 mg.100ml^{-1}); electrical conductivity (3.66 < 4.08 mS.cm^{-1}); whey volume (32.03 < 34.53 ml); crude protein (3.16 < 3.25%); casein (2.47 < 2.58%); non–protein nitrogen compounds (0.15 < 0.18%); urea nitrogen in non-protein nitrogen ratio (40.81 < 49.0%); casein numbers for crude protein and true protein (78.12 < 79.58 and 81.99 < 84.11%); coli bacteria count in normal and logarithm form (330.56 < 1502.92 CFU.ml^{-1} and 1.484 < 2.5823); actual yoghurt acidity (4.71 < 4.8). O cows suffered probably from lower energy and nitrogen compounds intake due to feeding under mentioned conditions. O milk could be a little better environment for yoghurt cultivation.

organic dairying, cow, milk, fat, protein, somatic cell count, acetone, urea, citric acid, technological properties

Current organic farming is only renovated alternative in world conditions and historical sense (Hanuš *et al.*, 2008 a, c). Organic farming as production system is a form of farming that arose as a result of global warming hypothesis (Thomassen and Boer, 2005; Aptroot and Herk, 2007; Bartholy and Pongrácz, 2007; Betts *et al.*, 2007; Delarue *et al.*, 2007; Goubanova and Li, 2007; Micheels *et al.*, 2007; Normand *et al.*, 2007) and the fact of environmental pollution activities of human communities (Geller *et al.*, 2006; Levy *et al.*, 2007). Consumers, especially in the richer countries, paradoxically sometimes are afraid of civilization impact (environmental pollution and conventional (C) agriculture) and call for „healthier" foods. Therefore consumption of organic foods is growing in the USA (Winter and Davis, 2006) but also in other countries for example in Austria (Kirner *et al.*, 2007) including the Czech Republic.

Organic farming is controlled by relevant law (No. 242/2000 Coll.) which allows certain forms of taking care of soil, plants and animals and prohibits the other risk procedures. Such national laws are harmonized in the EU. The production of healthier foods is presupposed under mentioned controlled conditions as implicit. However, it was not always confirmed (Rosati and Aumaitre, 2004). It was shown that organic (O) milk production which had been carried out according to European and national regulations on organic farming affects mainly livestock production systems, animal feed, roughage feed production, reproductive behaviour and health of animals in recent years. The authors also discussed animal welfare, product quality, environmental issues and economic results of organic dairying. They noted that there are only a few experimental data comparing the biological, technical and economic indicators between these two systems organic (O) and conventional (C), which are available in the literature. On the other hand the descriptive data published in several countries (Switzerland, Austria, France, etc.). Rosati and Aumaitre (2004) mentioned that the quality of dairy products in the European dairying has not been changed through the application of environmental regulations. However, more natural management of organic farming improves animal welfare and health. Larger use of grazing in O system as compared to more intensive dairying system in C herds certainly improves the animal welfare but due to limitations in the use of drugs in O system the animal health is not always improved. Organic farming systems are still friendly to the environment than conventional ones, especially for lower eutrophysation potential of the O herds. Nevertheless, Hajšlová *et al.* (2005) mentioned the production of markedly "healthier" potatoes in O production system for their higher vitamin C content and lower nitrate concentration. Also higher levels of calcium and magnesium in milk of O farms were found (Hlásný, 1996; Hanuš *et al.*, 2008 b, d; Čuboň *et al.*, 2008).

Positive effects of O farming on agricultural products were supported also by Leifert (2006). He mentioned higher risk of mould occurrence by 8% due to application of industrial mineral fertilizers (nitrogen, phosphorus, potassium) and pesticides in wheat growing technology in C agriculture as compared to their absence in technology of O farming. This result is quite unexpected under mentioned circumstances. Also opposite conclusion would not be surprising for instance because of former agriculture technological knowledge. He reported also increase of loading in winter–wheat by fusarious mycotoxin as deoxynivalenon by 8–18 $\mu g.kg^{-1}$ under similar conditions. However, the mentioned assumptions can and do not have to be valid under certain circumstances. On the other hand Reksen *et al.* (1999) reported aggravated reproduction performance of dairy cows in O herds as compared to C herds. Nevertheless, they also mentioned that O farming had been more effective in converting of roughage onto milk and mean percentage of cows on higher lactations had been higher.

The aim of organic farming is also higher friendliness to natural resources such as water. Genčurová *et al.* (2008) and Hanuš *et al.* (2007 a, 2008 c) showed approximately two times lower contamination of drinking water by nitrates in organic farms. It also increased from 2 to 40 $mg.l^{-1}$ along decrease of C farming altitude from higher to lower position (r = –0.39). Also Worthington (2001) pointed on lower concentration of nitrates in O plant products. The O farming improvement is visible mainly in the way of animal housing where better welfare is recorded. There is limited use of chemicals in animal diet and partly also their antibiotic treatment (Kégl *et al.*, 1995; Spranger *et al.*, 2000; Walkenhorst, 2001; Klocke *et al.*, 2003 a, b; Klocke, 2004; Walkenhorst *et al.*, 2004; Stöger, 2007). Furthermore, ruminants have to have freedom and be grazed and their feedstuffs have to be produced in organic way without chemical fertilization and treatment of plants. Hamilton *et al.* (2002) reported that there can be achieved good standards of health and welfare of animals in organic herds. They did not find any clinical symptoms of metabolic disorders in dairy cows in twenty–six O farms. Milk acetone exceeded the high level (0.6 $mmol.l^{-1}$) only occasionally (1.4%). This fact indicated a low incidence of ketosis state. Weller and Cooper (1996) mentioned the low total incidence of production disorders of animals in O herds similarly as also Weller and Bowling (2000) later. Haiger and Sölkner (1995), Haiger (2002, 2005 and 2006) and Knaus (2008) reported that economically better and ecological was animal rearing on higher total life yield than on short–time extremely high yield.

Generally the mentioned differences of O from C agriculture could affect the milk composition and properties, especially those that are influenceable by nutrition (Sehested *et al.*, 2003; Janů *et al.*, 2007; Pozdíšek *et al.*, 2008; Hanuš *et al.*, 2008 a; Sojková *et al.*, 2010). Also an impact on selected health indicators such as protein, urea, acetone, or certain elements as Ca, Mg or I could be significant (Hanuš *et al.*, 2007 b, 2008 a, b, c, d). Therefore, the aim of this study was to assess a potential impact of O farming on wide scale of milk constituents and properties. At this procedure also the payment of particular attention to selected health indicators as presupposition for high milk quality production from healthy cows is essential for food raw material for demanding milk product consumers.

MATERIAL AND METHODS

Dairy herds, animals and bulk milk samples

Bulk milk samples (BMSs) were collected twice a winter and twice a summer feeding season from the four organic (O) dairy herds during two years (32 BMSs). As reference data were obtained BMSs in similar conventional (C) dairy farms (32 BMSs). From 25 to 400 Holstein dairy cows were kept in these eight investigated herds under experimental observation. Cows were fed in typical way for C and O herds in the Czech Republic. This was according to practice conditions: maize (O 0 kg, C from 15 to 30 kg per head), alfalfa (O 5–8 kg, C 15–30 kg) and clover and grass (O 15–40, C 10–30 kg) silage, hay (O 2–3, C 0–2 kg), and concentrates (O 5–10, C 8–14 kg) and mineral feed additives were fed in accordance with standard demands according to milk yield (MY). Main climate conditions of dairy herds are collected in Tab. I. Mean MY of C and O dairy herd was comparable under the conditions of observation. The O herds were grazed during the summer feeding season and two of the C herds were also grazed during the summer (from 25 to 65 kg of grass per head).

Cows were housed in tie stall in one C herd and in free stables in other C herds. O herds were housed in free stables as it is prescribed by law on organic farming (Act on Organic Farming No. 242/2000 Coll.). All dairy cows were milked twice a day.

I: *Basic characteristics of organic (O) and conventional (C) Holstein dairy herds*

	A (m)	TAR (mm)	MAT (°C)	MY (kg)
O 1	465	763	6.2	7 601
O 2	600	800	7.0	7 000
O 3	650	624	4.3	6 580
O 4	500	812	6.7	6 968
x O	**553.8**	**749.8**	**6.1**	**7 037.3**
sd	**86.0**	**86.4**	**1.2**	**421.5**
	A (m)	**TAR (mm)**	**MAT (°C)**	**MY (kg)**
C 1	520	720	4.8	5 638
C 2	390	650	5.5	7 511
C 3	286	670	9.6	8 124
C 4	250	700	7.8	6 790
x C	**361.5**	**685.0**	**6.9**	**7 015.8**
sd	**121.2**	**31.1**	**2.2**	**1 068.1**

(altitude (A) of herd in m over sea level; total annual rainfall (TAR) in mm; mean annual temperature (MAT) in °C; mean milk yield per standardized lactation (MY, 305 days) in kg; x = arithmetic mean; sd = standard deviation)

Milk analyses and methods

BMSs were analyzed for milk indicators in the accredited National Reference Laboratory for Raw Milk (according to ISO/IEC 17025) in Research Institute for Cattle Breeding in Rapotín (Sojková *et al.*, 2010). Besides the basic components and properties of milk also technological parameters, especially the rennet ability, milk fermentation ability were determined according to abbreviations which are identified under Tab. II.

The analytical procedures were in the case of milk components and physical – chemical and technological properties of milk carried out according to the following methods:

- the fat, lactose and solids–not–fat (F, L and SNF) were measured using MilkoScan 133B (Foss Electric, Denmark), which was regularly calibrated according to reference method results (Hanuš *et al.*, 2009; standard ČSN 57 0536 by the Gerber's method for fat content, Kjeldahl's method for crude protein content and polarimetric and gravimetric method for lactose and SNF contents, according to standard ČSN 57 0530). The instrument was included in proficiency testing with regularly successful results. The wide–spread result uncertainties were: ± 2.77% for fat (± 0.101 for original unit), ± 2.59% for protein (± 0.085) and ± 2.77% for lactose (± 0.115);
- the crude and true protein and casein (CP, TP and CAS) were determined by reference Kjeldahl's method using the instrument line Tecator with Kjeltec Auto Distillation unit 2 200 (Foss–Tecator AB, Sweden) according to ČSN 57 0530. The instrument was included in international proficiency testing (APLAC and ICAR–CECALAIT) with regularly mostly successful results;
- the somatic cell count (SCC) was determined using Fossomatic 90 instrument (Foss Electric, Denmark) according to ČSN EN ISO 13366–3 (Hanuš *et al.*, 2009). This instrument was included in proficiency testing with regularly good results. The wide–spread result uncertainty was ± 9.3% for SCC $\leq$ 900 thousand.ml^{-1};
- the urea (U) was determined by spectrophotometry at 420 nm wavelength. The specific reaction solution was prepared as a sour mixture with the p–dimethylaminobenzaldehyde. Spekol 11 instrument (Carl Zeiss Jena, Germany) was calibrated by six samples in the scale with the U increase from 6 to 60 mg.100 ml^{-1};
- the acetone (Ac) was investigated by spectrophotometry at 485 nm wavelength. The Ac was absorbed in alkali solution of KCl with salicylaldehyde after to 24 hours microdiffusion in special vessels (at 20 °C in darkness). Spekol 11 was calibrated by five points on the scale with Ac increase from 1 to 20 mg.l^{-1};
- the citric acid (CA) was determined by spectrophotometry at 428 nm wavelength. Milk was coagulated by trichloracetic acid and the adventitious filtrate then allowed reacting with pyridine and acetanhydride (30 minutes at 32 °C). Citric acid generates with pyridine a yellow colored complex in acetanhydride medium. The Spekol 11 was calibrated by seven points of concentrations from 1.5 to 20.0 mmol.l^{-1}, in other words from 0.03 to 0.36%;
- the milk freezing point depression (MFP) values were analyzed using a top cryoscope Cryo–Star automatic Funke–Gerber (Germany). The selected measurement mode was Plateau Search (with parameters: interval = 23 second and delta t = 0.4 m°C). The instrument was regularly calibrated by standard NaCl solutions (Funke–Gerber) and included in proficiency testing with regularly successful results. The wide–spread result uncertainty of measurement (1.96 times the combined uncertainty as standard deviation with probability level 95%) was ± 0.006 08 °C or ± 1.18%;

- the electric conductivity (EC) was measured using OK 102/1 (Radelkis, Hungary) conductometer at 20 °C (in $mS.cm^{-1}$) with the help of a geometrical exactly defined bell glass electrode with platinum ring contacts. The instrument was calibrated by the appropriate salt (KCl) solution (10.2 $mS.cm^{-1}$) for measurement of each milk sample set;
- the active acidity (pH) was measured using the pH–meter CyberScan 510 (Eutech Instruments) at 20 °C. This instrument was regularly calibrated by standard buffer solutions (pH 4.0 and 7.0 Hamilton Duracal Buffer, Switzerland) for measurement of each milk sample set;
- the titration acidity (TA) was measured by milk titration (100 ml) using alkaline solution up to a light pink colour of the mixture (in ml of the 0.25 $mol.l^{-1}$ $NaOH.100ml^{-1}$). The method was performed according to the standard ČSN 57 0530;
- the milk alcohol stability (AS) was determined with the help of the milk titration (5 ml) by 96% ethanol to the creation of the first visible milk protein precipited flakes (expressed in ml of alcohol) as substitution of classical thermo stability test;
- the fermentation ability (FAM–L, FAM–S and FAM–TCM; carried out according to standard ON 57 0534 by slightly modified procedure with thermophilic yoghurt culture YC–180–40–FLEX = *Streptococcus thermophilus*, *Lactobacillus delbrueckii* subsp. *lactis* and *L. d.* subsp. *bulgaricus*) was investigated by calculating of the colony forming units (CFU) using the classical plate cultivation method (at 30 °C for 72 hours) with GTK M (Milcom Tabor) agar with the glucose monohydrate, triptone–peptone, dehydrated yeast extract and skim milk powder, according to standard ČSN ISO 6610.

Statistical evaluation of data files

Mean group differences in milk indicators were investigated by t–test. Group frequency distributions of milk indicators with significant differences were demonstrated by graphs. Statistical data processing included the determination of basic parameters and tests of differences by t–test in Microsoft Excel.

In the case of assuming of absence of normal frequency data distributions of some milk indicators such as somatic cell count (SCC), acetone and microbial figures these were evaluated in original values and also in logarithmically transformed form (Ali and Shook, 1980; Shook, 1982; Raubertas and Shook, 1982; Reneau, 1986; Wiggans and Shook, 1987; Reneau *et al.*, 1988). Use of geometric means followed in addition to arithmetic means.

RESULTS AND DISCUSSION

Hygienic milk quality is characterized by the total number of microorganisms. The average value 106 678.13 ± 319 659.777 $CFU.ml^{-1}$ is quite comparable with milk from conventional farms (90 833.33 ± 95 818.695 $CFU.ml^{-1}$). However variability was higher in O herds. These both values are relatively higher. It could be caused by sample transport a little as well. Total bacterial count in bulk milk samples should be ≤ 100 $10^3.CFU.ml^{-1}$. There can be also value ≤ 300 $10^3.CFU.ml^{-1}$ after raw milk transport and storage immediately before pasteurization. The higher average value with higher standard deviation indicates the presence of abnormally high readings of several BMSs from O farming, which may indicate the presence some milking hygiene troubles somewhere and sometimes on the observed farms. Although all the C and O farms were equipped by relevant and modern milking technique and produced good milk hygiene quality, there were observed some manual hygienic discrepancies in milking performance of staff sometimes during experiment as well.

The milk yield (MY) is an important economic factor which is closely connected with the health status of dairy cows, their nutrition, reproduction performance, longevity and milk composition and properties (Janů *et al.*, 2007). MY of C and O dairy herds was comparable under the observation conditions on average. Mean MY of C herds was 7016 ± 1068 and O herds 7 037 ± 422 kg per lactation (305 days). This fact is advantageous for carried out result comparison.

Milk urea (U) is used as a tool for monitoring of dairy cow nutrition. Regularly and significantly lower urea content 19.91 < 29.03 $mg.100ml^{-1}$ (Tab. II; Fig. 1; $P \leq 0.001$) in O herds showed probably a sustained protein (nitrogen matters) deficiency in their nutrition. This is probably specific problem of O dairying under the Czech conditions. Also higher acetone (Ac) content was found in O milk 6.31 > 4.66 $mg.l^{-1}$ (Tab. II; Fig. 1). This difference reflects no significance but logarithm of Ac concentration shows significance ($P < 0.05$). However the milk Ac concentration is distinctively higher than results in similar previous observations in conventional farming (Janů *et al.*, 2007). It could show on energy deficiency in nutrition especially in beginning of lactation in O herds. There is probably necessity of better energy nutrition solution (Hanuš *et al.*, 2007). In addition to elevated ketogenesis, further metabolic changes such as decreased amount of tricarbonic acid cycle (TCA-cycle) intermediates might be expected in the extracellular fluids during energy deficiency (Baticz *et al.*, 2002). The citric acid (CA) is an important member of TCA-cycle but the difference between citric acid content in milk from O and C herds was not significant (Tab. II; $P > 0.05$).

This observed suspicion on malnutrition (in relation to current MY) could be connected with problems how to obtain enough concentrates (grain – energy source) under acceptable economic circumstances for necessary dairy cow feeding ration supplementation in less favourable areas. Also soya (protein source) cow feeding ration supplementation is practically limited under O conditions. All concentrates have to be produced

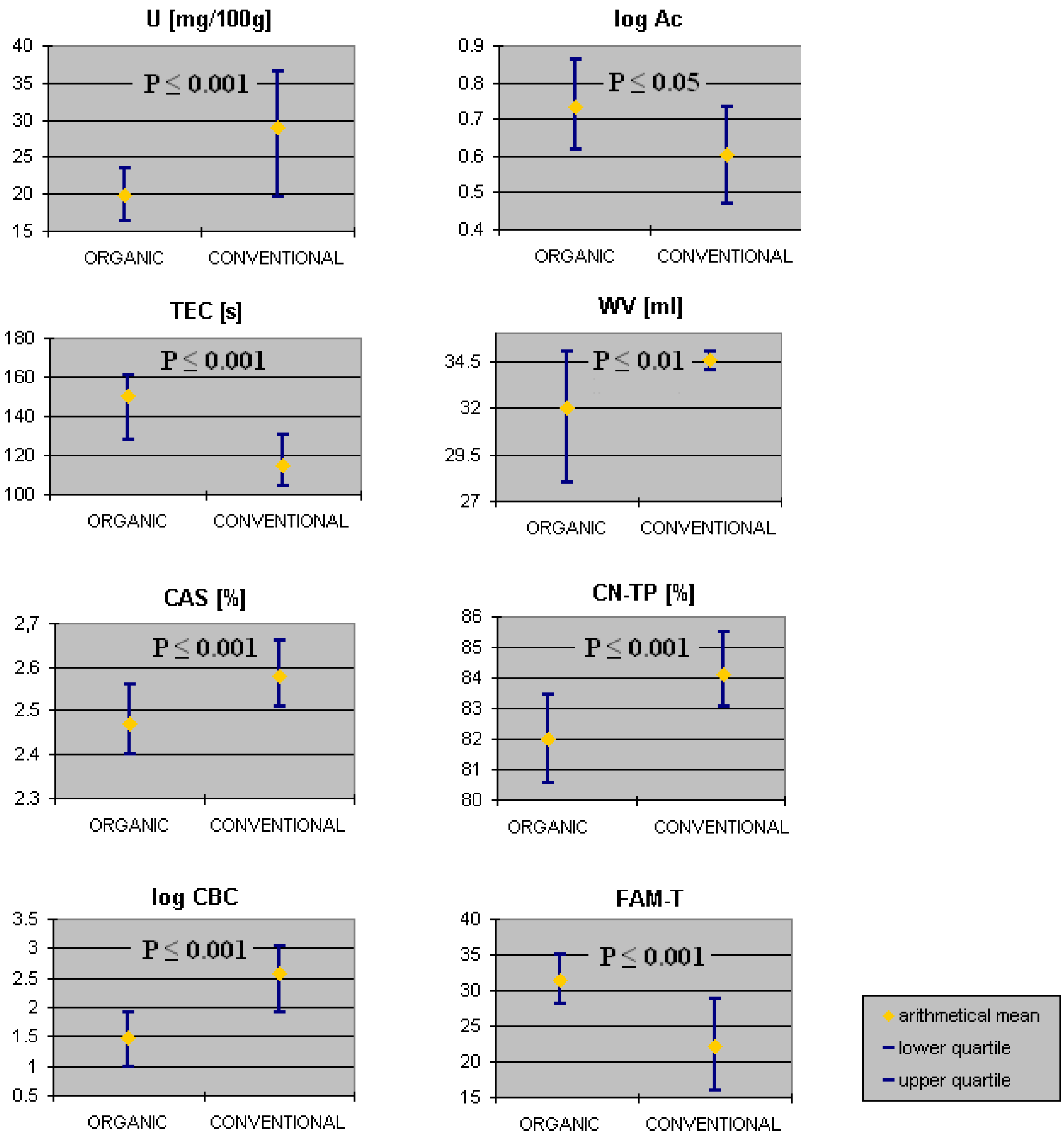
II: *Values of milk indicators according to different breeding conditions, the result of t–test and statistical significance of differences*

MILK INDICATOR	ORGANIC	CONVENTIONAL	T-TEST	SIGNIFICANCE
F	3.8 ± 0.247	3.72 ± 0.289	1.15	ns
L	4.9 ± 0.11	4.9 ± 0.08	0	ns
SNF	8.64 ± 0.16	8.73 ± 0.128	2.4	*
TS	12.44 ± 0.255	12.45 ± 0.338	0.13	ns
SCC	260.88 ± 108.896	282.56 ± 95.128	0.82	ns
log SCC	2.372 7 ± 0.204 8	2.426 ± 0.150 5	1.15	ns
U	19.91 ± 5.228	29.03 ± 10.021	4.42	***
Ac	6.31 ± 3.594	4.66 ± 3.128	1.9	ns
log Ac	0.732 1 ± 0.246 3	0.604 8 ± 0.223 3	2.1	*
AS	0.6 ± 0.113	0.44 ± 0.16	4.47	***
TA	8.34 ± 0.896	7.82 ± 0.664	2.55	*
EC	3.66 ± 0.287	4.08 ± 0.236	6.2	***
pH	6.68 ± 0.034	6.66 ± 0.104	1	ns
MFP	-0.524 9 ± 0.009 2	-0.525 9 ± 0.003 7	0.55	ns
TEC	150.75 ± 35.744	115.03 ± 20.079	4.77	***
CQ	2.69 ± 0.726	2.56 ± 0.658	0.73	ns
CF	1.82 ± 0.051	1.83 ± 0.058	0.71	ns
WV	32.03 ± 4.164	34.53 ± 1.118	3.18	**
SG	1.031 1 ± 0.001	1.030 8 ± 0.001	1.18	ns
CP	3.16 ± 0.131	3.25 ± 0.129	2.68	**
CAS	2.47 ± 0.128	2.58 ± 0.109	3.58	***
TP	3.01 ± 0.131	3.07 ± 0.114	1.89	ns
WP	0.54 ± 0.068	0.49 ± 0.071	2.77	**
NPN	0.15 ± 0.042	0.18 ± 0.042	2.75	**
UNPN	40.81 ± 12.694	49 ± 16.339	2.17	*
F/CP	1.2 ± 0.096	1.15 ± 0.083	2.15	*
CN-CP	78.12 ± 2.115	79.58 ± 2.401	2.5	*
CN-TP	81.99 ± 2.209	84.11 ± 2.197	3.73	***
TCM	106 678.13 ± 319 659.777	90 833.33 ± 95 818.695	0.23	ns
log TCM	4.313 2 ± 0.714 6	4.665 1 ± 0.538	1.95	ns
CBC	330.56 ± 1 385.197	1 502.92 ± 2 563.733	2.11	*
log CBC	1.484 ± 0.843 7	2.582 3 ± 0.801 2	4.69	***
S. aureus	87.81 ± 98.321	60.63 ± 207.499	0.65	ns
Str. agal.	0 ± 0	35 ± 147.076	1.3	ns
FAM-T	31.45 ± 4.604	22.18 ± 6.751	6.22	***
FAM-pH	4.71 ± 0.182	4.8 ± 0.152	2.08	*
FAM-L	28 375 000 ± 14 258 221.313	29 718 750 ± 14 818 135.795	0.36	ns
log FAM-L	7.405 4 ± 0.197 9	7.417 3 ± 0.225 1	0.22	ns
FAM-S	727 500 000 ± 243 631 381.394	776 562 500 ± 354 899 716.249	0.62	ns
log FAM-S	8.819 1 ± 0.235 7	8.861 3 ± 0.147 5	0.83	ns
FAM-TCM	755 875 000 ± 248 845 176.515	806 281 250 ± 357 087 457.282	0.63	ns
log FAM-TCM	8.839 ± 0.222 1	8.879 ± 0.144 2	0.83	ns
FAM-RSL	29.903 9 ± 14.486 4	33.010 3 ± 20.928 6	0.67	ns
CA	8.75 ± 1.354	8.72 ± 0.708	0.11	ns

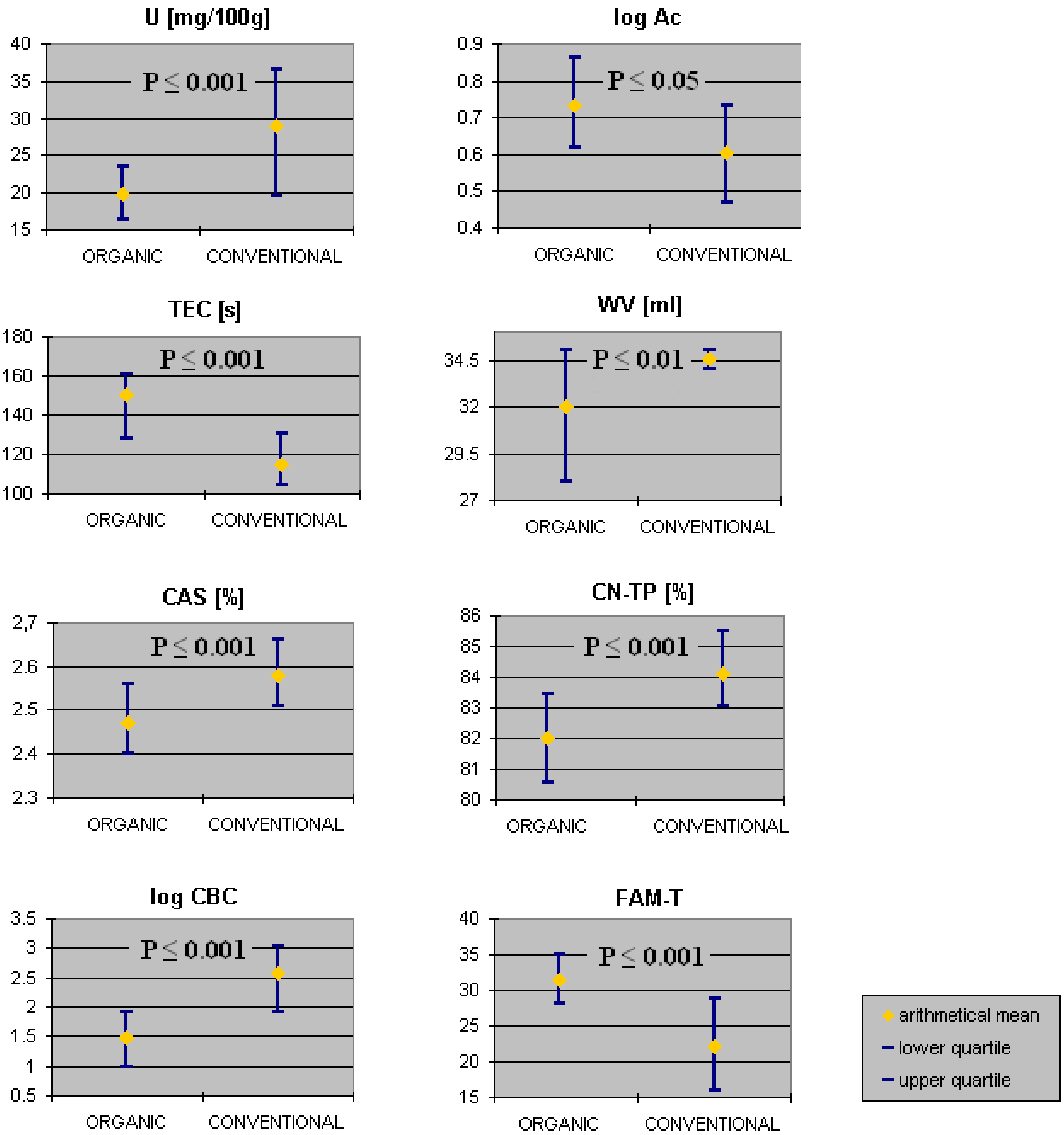
(n = 32 for O; n = 32 for C; arithmetical mean ± standard deviation; statistical significance of differences: *** $P \leq 0.001$; ** $P \leq 0.01$; * $P \leq 0.05$; ns (no significance) $P > 0.05$; F, fat (g.100g^{-1}, %); L, lactose (monohydrate, g.100g^{-1}, %); SNF, solids–not–fat (g.100g^{-1}, %); TS, total solids (g.100g^{-1}, %); SCC, somatic cell count (thousand.ml^{-1}); log SCC; U, urea concentration (mg.100ml^{-1}); Ac, acetone concentration (mg.l^{-1}); log Ac; CA, citric acid concentration (mmol.l^{-1}); AS, alcohol stability (consumption of 96% ethanol to protein coagulation in 5 ml of milk, ml); TA, titration acidity according to Soxhlet–Henkel (ml 0.25 mol.l^{-1} NaOH solution for the titration of 100 ml of milk (ČSN 57 0530)); EC, electrical conductivity (mS.cm^{-1}); pH, actual milk acidity; MFP, milk freezing point (°C); TEC, time for enzymatic (rennin) coagulation (second); CQ, subjective estimation of curd cake quality determined by inspection and touch from 1st (excellent) to 4th (poor) class; CF, cheese curd firmness, depth of penetration of the corpuscle falling into curd cake in the standard way, value expresses the opposite relationship to firmness (cm); WV, whey volume (whey which was ejected during rennet curd cake creation for 60 minutes, ml); SG, specific gravity of milk (g.cm^{-3}); CP, crude protein content (Kjeldahl (ČSN 57 0530), total N.6.38, g.100g^{-1}, %); CAS, casein content (Kjeldahl, casein N.6.38, g.100g^{-1}, %); TP, true protein content (Kjeldahl, protein N.6.38, g.100g^{-1}, %); WP, whey protein content (Kjeldahl, difference TP–CAS, g.100g^{-1}, %); NPN, non protein nitrogen matter (Kjeldahl, CP nitrogen–TP nitrogen.6.38, g.100g^{-1}, %); UNPN, urea nitrogen ratio in non protein nitrogen, %; F/CP, fat/crude protein ratio, %; CN–CP, casein numbers were calculated on the basis of CP, %; CN–TP, casein numbers were calculated on the basis of TP, %; TCM, total count of microorganisms, 10^3.ml^{-1}); log TCM; CBC, coli bacteria count, CFU.ml^{-1}; log CBC, *S. aureus, Staphylococcus aureus*, CFU.ml^{-1}; *Str. agal., Streptococcus agalactiae*, CFU.ml^{-1}; FAM–T = fermentation ability of milk or in other words a yoghurt test with microbial culture (by titration acidity of yoghurt in ml of 0.25 mol.l^{-1} NaOH.100ml^{-1}); FAM–pH (by actual acidity of yoghurt pH); FAM–CL (count of lactobacilli in CFU.ml^{-1}); log FAM–CL; FAM–CS (count of streptococci in CFU.ml^{-1}); log FAM–CS; FAM–TCM (fermenting fine microorganisms in CFU.ml^{-1}); log FAM–TCM; FAM–RSL (streptococci/lactobacilli ratio), all the previous parameters at FAM were measured after the yoghurt test fermentation) under O agriculture legislation and practice conditions. Prices of mentioned feeding products are quite high and there is also lack of such concentrates on the market. Sometimes the practical (economical) production conditions are limited in the less favourable areas where organic dairying is mostly situated (Tab. I). There could be a practical problem. Therefore it is necessary to improve energy supply in diets of O herds.

Casein measurement is important for control of dairy cow nutrition and for cheesemaking since the higher casein content in milk supplies the higher cheese yield. There was found lower casein content in O milk as compared to milk from C herds with significant difference (Tab. II; Fig. 1; P < 0.001). This finding is in good accordance with previous interpretations of milk urea and acetone results in terms of estimation of dairy cow nourishment. Very similar result trend as for casein was observed also regarding crude and true protein contents (Tab. II; Fig. 1) and F/CP ratio. In contrast to our finding Čuboň *et al.* (2008) stated comparable crude protein contents between O and C milk in Pinzgau cows in Slovakia. This fact could be caused probably by lower MY of their herds and due to this fact by lower energy demands of corresponding dairy cows.

Technological results showed that O milk may be a slightly better environment for the



1: *Differences in chosen indicators between organic and conventional farms with the representation of statistical significance determined by t–test* fermentation of yoghurt than C milk with regard to the milk fermentation ability (FAM). FAM–T was significantly higher as compared to C milk. FAM–T was 33.45 ± 4.604 for O herds and 22.18 ± 6.751 ml of 0.25 mol.l^{-1} NaOH.100 ml^{-1} for C herds (Tab. II; Fig. 1; $P < 0.001$). The FAM–pH result (Tab. II; $P < 0.05$) is in good accordance with FAM–T finding. Perhaps organic milk can contain less unspecific natural inhibitor substances and yoghurt culture could be sensitive to this substances. However, also the original TA was higher for O milk. It could be in connection with TCM result trend. This phenomenon makes lower practical importance for FAM–T finding on the other hand. Nevertheless, a presence of dangerous inhibitory substances was detected (by Delvo-test method use) in no case in both technologies (O and C). Alcohol stability was better (higher) in O milk (0.6 > 0.44 ml; Tab. II; $P < 0.001$) as compared to C milk. Also Čuboň *et al.* (2008) found better milk protein thermostability for O milk, which is more advantageous for processing of milk products with heat treatment. Also seasonal variations were observed in some cases (Tab. III; Fig. 2). Depending on the season the urea content (higher in summer as pasture phenomenon), citric acid (higher in winter) and FAM–T (higher in winter) were different on higher statistical level (Tab. III; $P < 0.01$) in O herds. Lower significant differences



2: *Differences between summer and winter season in organic milk indicators with the representation of statistical significance determined by t–test*

III: *Significant differences of values of milk indicators between summer and winter season under conditions in organic farming*

	SUMMER	WINTER	T-TEST	SIGNIFICANCE
L	4.86 ± 0.103	4.94 ± 0.103	2.06	*
U	22.52 ± 4.763	17.29 ± 4.28	3.06	**
WV	30.19 ± 4.707	33.88 ± 2.395	2.62	*
FAM-T	29.08 ± 4.418	33.83 ± 3.404	3.19	**
CA	8.05 ± 1.254	9.45 ± 1.052	3.21	**

n = 16 for summer; n = 16 for winter; statistical significance of differences: ** $P \leq 0.01$; * $P \leq 0.05$

were observed between seasons in lactose (higher in winter) and whey volume (higher in winter) during cheesemaking (Tab. III; $P < 0.05$). In general, seasonal differences are caused by different rearing and nutritional conditions during seasons.

The urea content was significantly decreased in O dairy cows and reflects in this way their lack of energy consumption, as already mentioned. In O herds is marked difference in urea content between summer (22.52 ± 4.763) and winter (17.29 ± 4.28 mg.100ml^{-1}; Fig. 2) indicating a lower nitrogen matters consumption of dairy cows in winter seasons, as compared to C herd urea content between summer (30.56 ± 9.864) and winter (27.49 ± 9.941 mg.100ml^{-1}), which is not significant.

In general, numerous works on organic dairy suggested for O farms and milk: 1) a slightly better general health and reproductive performance (Rosati and Aumaitre, 2004; Hanuš *et al.*, 2007 b) and cow longevity indicators; 2) less incidence of inhibitors in milk (Hanuš *et al.*, 2007 b), favourable (higher) calcium and magnesium content (Hanuš *et al.*, 2008 b, d; Čuboň *et al.*, 2008) and significantly lower content of iodine and urea in milk (Toledo *et al*, 2002; Hanuš *et al.*, 2008 a, b, d).

The different composition and properties of O milk can be expected since the mammary secretion is reflecting housing conditions, especially nutrition. This work indicated as main differences ($P \leq 0.05$) for O farms and milk: 1) higher total bacterial count of milk; 2) higher level of acetone; 3) lower levels of urea, casein, crude and also true ($P > 0.05$) protein under the Czech conditions and the resulting estimate of certain energy and protein malnutrition; 4) a better indicators of fermentation skills. Therefore there is a clear need for focus on improving the hygiene of the milking process in some locations, but in general, especially to improve the energy support of O animals by nutrition. Milk produced under different conditions showed the specific advantages and disadvantages in various aspects of the management on both sides of the production type.

Therefore, as compared with the composition and properties of cow milk from C conditions, there were no significant differences ($P > 0.05$; Tab. II) in: content of milk fat, true protein, lactose monohydrate, total solids, citric acid; somatic cell count; milk pH; milk freezing point; subjective estimation of curds cake quality; cheese curd firmness; specific gravity of milk; total count of microorganisms in normal and logarithm form; *S. aureus* and *Str. agalactiae* count; FAM–L; FAM–S; total count of the fermenting noble microorganisms in CFU.ml^{-1}; count of the fermenting noble lactobacilli and streptococci.

O milk shows, as compared with milk from C conditions, better results in terms of technological suitability of milk for the manufacture of fermented dairy products. An important technological characteristic of O milk given by limited use of antibiotics (a prolonged protective space of eventually used drugs) to treat cows is zero occurrence of residues of inhibitory substances (Hanuš *et al.*, 2007 b) which could stop the fermentation process.

CONCLUSION

Altitude, rainfall and temperatures (Tab. I) are characterized by localization of organic farms in mountain or sub-mountain conditions and suggest the use of O dairying in less favourable areas (LFA).

This paper aims to monitor, indicate and assess the basic influence of O farming on raw milk components and properties, which are still only few mapped. According to results of relevant milk indicators the O cows suffered probably from lower energy and nitrogen compounds intake as compared to C cows due to nutrition under mentioned typical conditions in the Czech Republic. O milk could be a little better environment for yoghurt cultivation probably because of lower content of natural inhibitory substances. Both systems, conventional and organic, produced milk with comparable good quality.

Further studies are necessary to clearly demonstration the benefits of O dairy farming. In the case that these benefits exist, must be submitted to the general public to strengthen the positive perception of the quality of O food for more consumers. Increased demand for O products will encourage the development of O farming, improving living conditions and welfare of animals and support the global strategy towards sustainable development and protection of the environment on the Earth.

SUMMARY

Current organic farming is only renovated alternative in world conditions and historical sense. Organic dairying is an alternative for friendly exploitation of environment in the time of presupposed global climate changes. This paper was focused on impacts of organic dairying on milk composition, properties and quality in terms of evaluation of changes especially health milk indicators. In difference testing the conventional (C) cow milk was compared to organic (O) milk. Holstein bulk milk samples (BMSs) from winter and summer season in 4 C and 4 O (n = 32 and 32 BMSs; 2 years) herds were investigated. Six herds were grazed and two C herds were not grazed, other nutrition was typical under the CR conditions. Altitude, rainfall and temperature are characterized by localization of organic farms in mountain or sub-mountain conditions and suggest the use of O dairying in less favourable areas (LFA). The mean O cow milk yield for standardized lactation (MY, for 305 days) was 7037.3 ± 421.5 kg. It is similar as compared to C MY 7015.8 ± 1068.1 kg.

There were significant differences between C and O at 20 milk indicators from 44, higher values ($P < 0.05$) in O milk were for: log acetone (0.7321 > 0.6048); titration acidity (8.34 > 7.82 ml 0.25 mol.l^{-1} NaOH); alcohol stability (0.6 > 0.44 ml); time for enzymatic coagulation (150.75 > 115.03 second); whey protein (0.54 > 0.49%); fat/crude protein (1.2 > 1.15); milk fermentation ability (FAM) by titration (31.45 > 22.18 ml 0.25 mol.l^{-1} NaOH). Lower values ($P < 0.05$) in O milk were for: solids–not–fat (8.64 < 8.73%); urea content (19.91 < 29.03 mg.100ml^{-1}); electrical conductivity (3.66 < 4.08 mS.cm^{-1}); whey volume (32.03 < 34.53 ml); crude protein (3.16 < 3.25%); casein (2.47 < 2.58%); non–protein nitrogen compounds (0.15 < 0.18%); urea nitrogen in non–protein nitrogen ratio (40.81 < 49.0%); casein numbers for crude protein and true protein (78.12 < 79.58 and 81.99 < 84.11%); coli bacteria count in normal and logarithm form (330.56 < 1502.92 CFU.ml^{-1} and 1.484 < 2.5823); actual yoghurt acidity (4.71 < 4.8). No significant differences ($P > 0.05$) were at following indicators: fat; true protein; lactose monohydrate; total solids; citric acid; somatic cell count in normal and logarithm form; actual milk acidity; milk freezing point; curds cake quality; cheese curd firmness; milk specific gravity; total count of microorganisms in normal and logarithm form; *S. aureus* and *Str. agalactiae* count; some other FAM indicators.

According to results of milk indicator O cows suffered probably from lower energy and nitrogen compounds intake as compared to C due to nutrition under mentioned typical conditions in the Czech Republic. O milk could be a little better environment for yoghurt cultivation probably because of lower content of natural inhibitory substances. Both systems, C and O, produced milk with comparable good quality. According to figures of milk obtained from four O farms in the Czech Republic we can confirm that it is suitable for human consumption because it contains all the important nutritional components in comparable quantities, and it is appropriate in terms of hygiene and health indicators. From the technological point of view even more indicators shows better properties than C milk.

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