Acta Veterinaria (Beograd), Vol. 61, No. 4, 415-421, 2011.

DOI: 10.2298/AVB1104415P UDK 619:637.12.04/.07

THE EFFECT OF ORGANIC MILK PRODUCTION ON CERTAIN MILK QUALITY PARAMETERS

POPOVIĆ-VRANJEŠ ANKA*, SAVIĆ MILA**, PEJANOVIĆ R*, JOVANOVIĆ S** and KRAJINOVIĆ G*

*University of Novi Sad, Faculty of Agriculture, Department for Animal Science, Serbia
**University of Belgrade, Faculty of Veterinary Medicine, Serbia

(Received 22nd November 2010)

In recent years there is growing interest of consumers for the consumption of organic milk, because of its favorable content of fatty acids that has a positive effect on human health. The aim of this study was to examine the content of fatty acids, vitamins A, C and α – tocopherol in milk which was obtained in different production systems, organic and conventional. The samples of conventional and organic milk were collected from farms located in Vojvodina, throughout all seasons. The prepared samples were analyzed using gas chromatography with mass spectrometry and high – performance liquid chromatography. The results proved that the milk produced in accordance with the principles of organic production had a higher content of polyunsaturated and omega-3 fatty acids compared with conventional milk ($p<0.01$) during the whole examination period, while the greatest differences were perceived in the pasture season. Also, organic milk had a higher content of vitamins A, C and α - tocopherol compared with the conventionally produced milk, although there was no statistically significant difference.

Key words: conventional milk, fatty acids, organic milk, vitamins

INTRODUCTION

Milk production based on the principles of organic production shows a tendency of increase in the world, especially evident in the EU countries (Pentelescu, 2009; Dangour *et al.,* 2010; Collomb *et al*., 2008; Soil Association, 2005). Organic milk, compared with conventional milk, has a more favourable fatty-acid composition, as it contains more polyunsaturated fatty acids with the group of omega-3 fatty acids (Ellis *et al*., 2006; Baltušnikiene *et al*., 2008; Prandini *et al*., 2009). These fatty acids are beneficial in many ways for human health as they are important for protection of the organism against cardiovascular diseases, as well as for prevention against certain types of malignant diseases and autoimmune diseases, such are lupus, rheumatoid arthritis, etc. (Rose *et al*., 1999; Hu *et al*., 2002; Pariza *et al*., 2003; Connor *et al*., 2009; Kummeling *et al*., 2010). Studies show that cow nutrition in organic farming, which is based on extensive use of pasture, has the highest effect on fatty-acid content of milk, as it

increases the content of polyunsaturated fatty acids, especially omega-3 fatty acids and conjugated linoleic acid (Jahreis *et al*., 1997; White *et al*., 2001; Thorsdottir *et al*., 2004; Cattell *et al*., 2009).

Apart from the advantages regarding the content of fatty acids, it was reported that organic milk also contains a higher content of certain vitamins, primarily α – tocopherol and vitamin A (Butler *et al.,* 2006; Pentelescu, 2009).

MATERIAL AND METHODS

A total of thirty milk samples were collected periodically, each month, from dairy organic farms, as well as sixty samples from conventional farms in Vojvodina. During the pasture season the nutrition of cows in organic production system included grazing natural pastures, supplemented with concentrates, while during the indoor season the diet was based on silage, hay and concentrate feed. The diet of cows in the conventional system, throughout all seasons, was based on silage, hay and concentrate feed.

The extraction of milk fatty acids from milk was done using heptane. The esterification process was performed according to the method SRPS EN ISO 5509:2007. The methylation process was done using Boron Trifluoride (BF_3). The prepared samples were analyzed using gas chromatography with mass spectrometry system GC/MS Thermo DSQ II /Focus GC/ TriPlus autosampler, according to the method JUS ISO 5508:2002. A fused silica capillary column Agilent Innowax (30 m x 0.32 mm x 0.25 μm film thickness) was used. Temperature regime was as follows: the injector temperature was 220°C, the initial temperature was held at 150°C for 2 min, the rate was 35°C/min, and the final temperature of 250°C for 5 min. Ion source temperature was 230°C. Detection: MS full scan 50-450 m/z. Fatty acids were identified through comparison of retention times with standard fatty acids. Concentrations of vitamin C, vitamins A and α-tocopherol were determined by HPLC according the procedure described by Fedele *et al*, 2001.

The results on the content of fatty acids and vitamins were statistically processed using the program Statistica 9, while the significance of difference was determined by t-test, and presented as statistically significant ($p<0.05$) and statistically highly significant ($p<0.01$).

RESULTS

The average content of saturated, monounsaturated, polyunsaturated, omega-6 and omega-3 fatty acids in the raw milk (organically and conventionally produced) is presented in Table 1.

According to the results presented in Table 1, it is evident that there was no statistically significant difference between the milk produced in organic and conventional production systems in respect to the content of saturated and omega-6 fatty acids. The average content of monounsaturated fatty acids was higher in the conventional milk (30.76±1.04%) compared with organic milk

(29.25±1.02%), and this difference was statistically significant. By containing 3.57±0.32% polyunsaturated fatty acids and 0.91±0.11% omega-3 fatty acids, organic milk was richer compared to conventional milk (3.13±0.26% polyunsaturated; and 0.53±0.08% omega-3 fatty acids), which proved to be statistically highly significant.

Table 1. Saturated, monounsaturated, polyunsaturated, omega-6 and omega-3 fatty acids content (%) in conventional and organic milk

Fatty acid, %	Organic milk n=30			Conventional milk n=60		
	Average	min-max	SD*	Average	min-max	SD*
Saturated fatty acids	66.91 ^{a}	64.99-68.83	1.18	66.24 ^{a}	64.41-68.07	1.71
Monounsaturated fatty acids	29.25 ^{b}	27.54-30.96	1.02	30.76 ^{a}	29.03-32.49	1.04
Polyunsaturated fatty acids	3.57 ^{B}	3.10-4.035	0.32	3.13 ^{A}	2.70-3.56	0.26
Omega-6 fatty acids	2.65 ^{a}	2.32-2.98	0.22	2.48 ^{a}	2.13-2.83	0.20
Omega-3 fatty acids	0.91^{B}	0.77-1.06	0.11	0.53 ^{A}	0.40-0.66	0.08

*standard deviation; $^{a, b}$ statistically significant at the level $p<0.05$; $^{A, B}$ highly significant at the level $p<0.01$; ^{aa} the differences between the values with the same letters are statistically insignificant

In organic milk, the content of polyunsaturated and omega-3 fatty acids started increasing in May, when the cows were put out on pastures. The highest values were achieved in August, when the content of polyunsaturated fatty acids was 4.035%, and the content of omega-3 fatty acids was 1.056%. In conventional milk, during the whole period of the research, the content of polyunsaturated fatty acids with the group of omega-3 was lower compared with organic milk (Figure 1). Simultaneously with the increase of the content of polyunsaturated fatty acids in organic milk during the pasture period, the content of saturated fatty acids was gradually decreasing from 68.83%, which was the amount in February, to 64.99% in August, when the lowest value was recorded.

At the beginning of September, the content of polyunsaturated and omega-3 fatty acids started decreasing. The ratio between omega-6 and omega-3 fatty acids in organic milk was 2.80:1 on average, while in the milk of conventional production this ratio was 4.71:1. Milk produced in accordance with the principles of organic production contained a higher content of vitamin C, α-tocopherol and vitamin A compared with conventional milk, although the statistical difference was not at the level of significance, Figure 2.

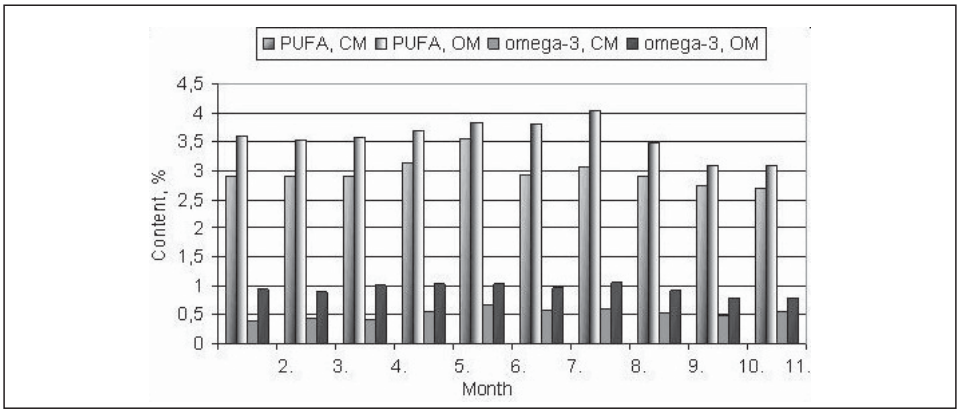

Figure 1. Content of polyunsaturated (PUFA) and omega-3 fatty acids in organic milk (OM) and conventional milk (CM), %

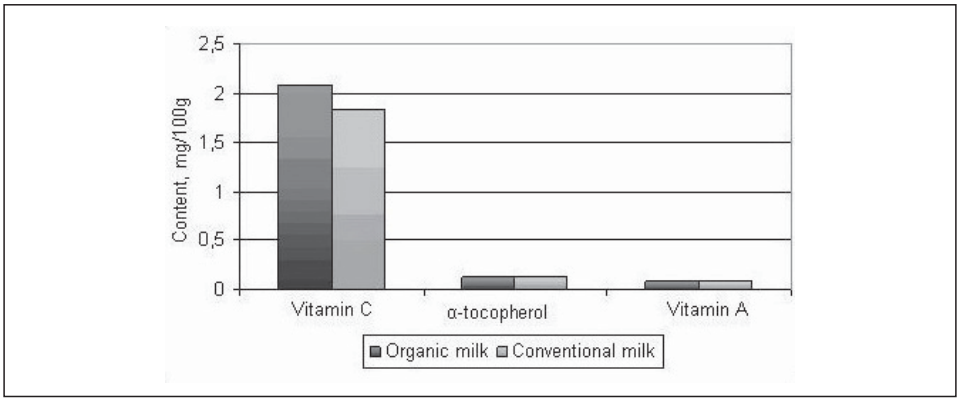

Figure 2. Content of vitamin C, α-tocopherol and vitamin A in organic and conventional milk, mg/100g

DISCUSSION

The results of our research are in accordance with a number of studies (Ellis *et al.,* 2006; Pentelescu, 2009; Man *et al.,* 2009), which proved that milk produced by principles of organic production contains more polyunsaturated and omega-3 fatty acids compared with conventionally produced milk. Baltušnikiene *et al.* (2008) also indicate that there are higher levels of the aforementioned fatty acids in organic milk and milk of cows which are put out to pastures, in relation to conventional milk and milk from cows which are not put out to graze. Pentelescu (2009) pointed out that the fatty-acid content of milk is mostly influenced by nutrition. This has been substantiated by the results of this research, since the

nutrition of cows in the pasture season affected the fatty-acid content of organic milk, regarding the increase of the content of polyunsaturated and omega-3 fatty acids, and the decrease of the content of saturated fatty acids. On the other hand, during the same season, the cows fed on mixed meals and without pasture in conventional conditions, produced milk with a lower content of the stated fatty acids.

Milk fat of cows whose nutrition was based on conserved food (silage) and concentrate has the ratio between omega-6 and omega-3 fatty acids around 4:1 (Ledoux *et al.,* 2005). However, in the summer season, when cows are fed in pastures and have a higher amount of fresh grass intake, this ratio can decrease to around 2:1 (Jensen *et al.,* 1995). In organic milk, this ratio between omega-6 and omega-3 fatty acids is lower compared with conventional milk, which may result from the nutrition of cows in organic farming, which is primarily based on pasture. The nutrition including pastures and higher consumption of fresh grass in the organically farmed cows resulted in a higher content of vitamins C, A and α-tocopherol in organic milk than in conventional milk. However, the differences in the content of vitamins between the organic and conventional milk were not sufficiently large to be statistically significant. In the researches conducted by Woese *et al.* (1997) the difference in the content of vitamin E between organic and conventional milk was not statistically significant, although organic milk was richer in this vitamin. However, certain other researches (Butler *et al.,* 2006; Bergamo *et al.,* 2003) showed that organic milk contains substantially a higher content of vitamin A and α-tocopherol compared with conventional milk.

ACKNOWLEDGEMENTS:
This research was conducted within the projects TR31085 and TR31095, financed by the Ministry of Science and Technological Development of the Republic of Serbia.

Address for correspondence:
Professor Dr Anka Popović-Vranješ
Department of Animal Husbandry
Faculty of Agriculture, University of Novi Sad
Trg Dositeja Obradovića 8
21000 Novi Sad, Serbia
E-mail: anka.popovic@gmail.com

REFERENCES

1. *Baltušnikiene A, Bartkevičiûte Z, Černauskiene J*, 2008, Fatty acids content and composition of milk fat from cows consuming pasture and total mixed ration, *Veterinarija IR Zootechnika,* 42, 64, 28-33.
2. *Bergamo P, Fedelea E, Iannibellib L, Marzillob G*, 2003, Fat-soluble vitamin contents and fatty acid composition in organic and conventional Italian dairy products, *Food Chem,* 82, 625-31.
3. *Butler G, Stergiadis S, Eyre M, Leifert C,* 2006, Effect of production system and geographic location on milk quality parameters, *Aspects Appl Biol*, 80, 189-93.
4. *Cattell MB, Nelson AJ,* 2009, The Organic Dairy Advantages: Part 2. Organic Milk Has Higher CLA Content, http://www.wodpa.org/newsletters/Organic Difference

5. *Collomb M, Bisig W, Butikofer U, Sieber R, Bregy M, Etter L,* 2008, Fatty acid composition on mountain milk from Switzerland: Comparison of organic and integrated farming systems, *Int Dairy J*, 18, 976-82.
6. *Connor WE,* 2009, Importance of n-3 fatty acids in health and disease, *The Am J Clin Nutr,* 71, 1, 171S-5S.
7. *Dangour AD, Dodhia SK, Hayter A, Allen E, Lock K, Uauy R*, 2010, Nutritional quality of organic foods: a systematic review, *Am J Clin Nutr*, 92, 203-10
8. *Ellis KA, Innocent G, Grove-White D, Cripps P, McLean WG, Howard CV et al.,* 2006, Comparing the fatty acid composition of organic and conventional milk, *J Dairy Sci,* 89, 1938-50.
9. *Fedele E, Bergamo P*, 2001. Protein and lipid oxidative stress during chesse manufacture, *J Food Sci*, 66, 932-5.
10. *Hu FB, Willett WC,* 2002, Optimal diets for prevention of coronary heart disease, *J Am Med Assoc,* 288, 20, 2569-78.
11. *Jahreis G, Fritsche J, Steinhard H,* 1997, Conjugated linoleic acid in milk fat: High variation depending on production system, *Nutr Res,* 17, 1479-84.
12. *Jensen RG, Newburg DS,* 1995, Bovine milk lipids. In Handbook of milk composition Edited by: Jensen R. G. Academic Press, USA, 543-75.
13. *Kummeling I, Thijs C, Huber M, van de Vijver LP, Snijders BE et al*., 2010, Consumption of organic foods and risk of atopic disease during the first 2 years of life in the Netherlands, *Br J Nutr*, 99, 3, 598-605.
14. *Ledoux M, Chardigny JM, Darbois M, Soustre Y, Sebedio JL, Laloux L,* 2005, Fatty acid composition of French butters with special emphasis on conjugated linoleic acid (CLA) isomers, *J Food Composition Anal,* 18, 5, 409-25.
15. *Man C, Hicea S, Ciupe M,* 2009, Data Regarding the Nutritional, Functional and Sensory Quality of Bio Milk, *Anim Sci Biotechnol,* 66, 1-2, 119-25.
16. *Pariza MW,* 2003, The biological activities of conjugated linoleic acid, in Advances in Conjugated Linoleic Acid Research (2nd), ed. by Christie WW, AOCS Press, Champaign, IL, 12-20.
17. *Pentelescu NO*, 2009, Fatty acid, retinol and carotene content of organic milk, *Int J Bioflux Soc,* 1, 1, 21-6.
18. *Prandini A, Sigolo S, Piva G*, 2009, Conjugated linoleic acid (CLA) and fatty acid composition of milk, curd and Grana Padano cheese in conventional and organic farming systems, *J Dairy Res,* 76, 278-82.
19. *Rose D, Connolly JM,* 1999, Omega-3 fatty acids as cancer chemo preventive agents, *Pharmacol Ther,* 83, 217-44.
20. *Thorsdottir I, Hill J, Ramel A,* 2004, Omega-3 fatty acid supply from milk associates with lower type 2 diabetes in men and coronary heart disease in women, *Prev Med,* 39, 3, 630-4.
21. *Soil Association*, 2005, The nutritional benefits of organic milk – a review of the evidence, Soil Association Organic Standards. Revision 15. Soil Association, Bristol, www.soilassociation.org
22. *Woese K, Lange D, Boess C, Bögl KW,* 1997, A comparison of organically and conventionally grown foods - results of a review of the relevant literature, *J Sci Food Agricult*, 74, 281-93.
23. *White SL, Bertrand JA, Wade MR, Washburn SP, Green JP, Jenkins TC,* 2001, Comparison of fatty acid content of milk from Jersey and Holstein cows consuming pasture or a total mixed ration, *J Dairy Sci,* 84, 2295-301.

EFEKAT ORGANSKE PROIZVODNJE MLEKA NA NEKE PARAMETRE KVALITETA MLEKA

POPOVIĆ-VRANJEŠ ANKA, SAVIĆ MILA, PEJANOVIĆ R, JOVANOVIĆ S i KRAJINOVIĆ G

SADRŽAJ

Poslednjih godina raste interes potrošača za konzumiranje organskog mleka, zbog povoljnijeg sadržaja masnih kiselina koje imaju pozitivan efekat na zdravlje ljudi. Cilj ovog rada je bio da se ispita sadržaj masnih kiselina, vitamina A, C i α-tokoferola u mleku koje je dobijeno u različitim sistemima proizvodnje, organskom i konvencionalnom. Uzorci konvencionalnog i organskog mleka sakupljani su na farmama u Vojvodini tokom čitave godine. Analiza uzoraka je vršena primenom metoda gasne hromatografije i tečne hromatografije.

Rezultati su pokazali da je mleko proizvedeno po principima organske proizvodnje tokom celog perioda praćenja imalo veći sadržaj polinezasićenih i omega-3 masnih kiselina u odnosu na konvencionalno mleko ($p<0,01$), s tim što su najveće razlike bile u sezoni paše. Sadržaj vitamina A, C i α-tokoferola bio je veći u organskom mleku od sadržaja u mleku iz konvencionalne proizvodnje, mada nije utvrđena statistička značajnost ovih razlika.