LATVIJAS LAUKSAIMNIECĪBAS UNIVERSITĀTE
LATVIA UNIVERSITY OF AGRICULTURE

PĀRTIKAS TEHNOLOĢIJAS FAKULTĀTE
FACULTY OF FOOD TECHNOLOGY

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BIOLOĢISKAJĀ LAUKSAIMNIECĪBĀ IEGŪTĀ PIENA KVALITĀTES IZVĒRTĒJUMS

THE EVALUATION OF ORGANIC MILK QUALITY

Promocijas darba kopsavilkums
inženierzinātņu doktora zinātniskā grāda iegūšanai
Pārtikas zinātnē

Summary of doctoral thesis
for acquiring the Doctor’s degree of Engineering Sciences
in sector of Food Sciences

Jelgava
2007

Promocijas darba zinātniskā vadītāja /
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Promocijas darba izstrāde un noformēšana veikta ar ESF granta atbalstu.
Doctoral thesis has been worked out by financial support of ESF.

Promocijas darba aizstāvēšana notiks 2007.gada **19.septembrī plkst.13.00** LLU Pārtikas zinātnes promocijas padomes atklātajā sēdē Jelgavā, Lielajā ielā 2, Pārtikas tehnoloģijas fakultātē, 251. auditorijā.

The defence of the Doctor thesis in an open session of the Promotion Council of Food Science of Latvia University of Agriculture will be held **on September 19, 2007, at 1 p.m.** in Room 251, Latvia University of Agriculture, 2 Liela street, Jelgava.
Ar promocijas darbu un kopsavilkumu var iepazīties LLU Fundamentālajā bibliotēkā, Lielā ielā 2, Jelgavā, LV 3001 un http://llufb.llu.lv/llu-theses.htm.
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The doctoral thesis is available at the Fundamental Library of Latvia University of Agriculture, 2 Liela street , Jelgava and http://llufb.llu.lv/llu-theses.htm.
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SATURS

CONTENT

PĒTĪJUMA AKTUALITĀTE

Bioloģiskā lauksaimniecība kā patstāvīga nozare Latvijā pastāv kopš 20. gs. deviņdesmitajiem gadiem, un tās mērķis ir radīt integrētu, humānu, videi draudzīgu un ekonomiski līdzsvarotu lauksaimnieciskās ražošanas sistēmu, kas balstās uz vietējās izcelsmes atjaunojamiem resursiem un nodrošina optimālu kultūraugu aizsardzību pret kaitēkļiem un slimībām un lauksaimniecības dzīvniekus – ar barības vielām. Attīstot bioloģisko lauksaimniecību, iespējams mazināt lauksaimniecības tehnoloģiju negatīvo ietekmi uz vidi un uzlabot iegūtās produkcijas kvalitāti, jo tā rada iespēju izvairīties no minerālmēslu, pesticīdu, augšanas stimulatoru, veterināri farmaceitisko medikamentu, tajā skaitā antibiotiku, lietošanas. Laikā, kad sabiedrības uzticība lauksaimniecības produktiem mazinās ģenētiski modificētas produkcijas, kā arī dažādu dzīvnieku slimību dēļ, pieprasījums un interese pēc bioloģiskās lauksaimniecības produktiem palielinās.

Pēdējos gados ir ievērojami pieaudzis pieprasījums pēc pārtikas, kas ražota bioloģiskā lauksaimniecības sistēmā, arvien vairāk pieaug to patērētāju skaits, kuri piešķir lielāku nozīmi augstākai pārtikas kvalitātei un vēlas zināt, kā tā tiek ražota. Bioloģisko ražošanu galvenokārt raksturo skaidri pamatprincipi un caurredzamība attiecībā uz produktu izcelsmi, ražošanu un pārstrādi. Latvijā ir visi nepieciešamie priekšnosacījumi – lauksaimniecībai piemērota zeme, izveidoti vairāki šķirnes dzīvnieku ganāmpulki, ekoloģiskā situācija, lai ražotu kvalitatīvu lopkopības produkciju iekšējam tirgum, kā arī eksportam.

Zinātnieki no dažādām pasaules valstīm izsaka ļoti pretrunīgus viedokļus par bioloģiskajā lauksaimniecībā iegūtā piena ķīmisko sastāvu un kvalitāti. Latvijā patlaban bioloģiskajā lauksaimniecībā iegūtā piena (turpmāk ekopiens) ķīmiskā sastāva izvērtējums un salīdzinājums ar konvencionālajā lauksaimniecībā iegūto pienu nav veikts, trūkst arī objektīva un pamatota saražotā ekopiena kvalitātes izvērtējuma. No šā viedokļa raugoties, svarīgi ir novērtēt bioloģiskajā lauksaimniecībā iegūtā piena kvalitāti, lai nodrošinātu patērētājus ar drošiem uzturlīdzekļiem un palīdzētu bioloģiskās lauksaimniecības speciālistiem attīstīt piena ražošanu.

Apkopojot literatūrā esošos teorētiskos spriedumus un eksperimentālos datus, izvirzīts **promocijas darba mērķis** – noteikt un izvērtēt bioloģiskajā lauksaimniecībā iegūtā piena kvalitāti.

Pētījuma uzdevumi:

1) noteikt un izvērtēt bioloģiskajā lauksaimniecībā iegūtā piena ķīmisko sastāvu;
2) noteikt imunoglobulīnu IgA, IgG, IgM, laktoferīna un lizocīma saturu bioloģiskajā lauksaimniecībā iegūtā pienā;
3) izvērtēt bioloģiskajā lauksaimniecībā iegūtā piena somatisko šūnu skaitu un mikrobiālo kvalitāti;

4) analizēt bioloģiskajā lauksaimniecībā iegūtā pienā aflatoksīna M_1, smago metālu un mikroelementu (Cd, Zn, Pb, Cu, Fe) saturu;
5) salīdzināt un izvērtēt bioloģiskajā lauksaimniecībā iegūtā piena sastāvu un ķīmisko piesārņojumu ar konvencionālajā lauksaimniecībā iegūto pienu.

Pētījuma **novitāte**:

1) Latvijā kompleksi izvērtēta bioloģiskajā lauksaimniecībā iegūtā piena kvalitāte, pirmo reizi vērtēts IgA, IgG, IgM, laktoferīna un lizocīma saturs bioloģiskajā lauksaimniecībā iegūtā pienā;
2) analizētas un studētas piena ķīmiskā sastāva rādītāju potenciālās atšķirības, balstoties uz ēdināšanas, proti, barības sastāva, un dzīvnieku asins analīžu datiem;
3) skaidrotas divās lauksaimniecības sistēmās iegūtā govju piena sastāva un kvalitātes atšķirības Latvijā.

Darba **zinātniskais nozīmīgums** – pētīts bioloģiskajā lauksaimniecībā iegūtā piena ķīmiskais sastāvs, t. sk., kalcija, IgA, IgG, IgM, laktoferīna, lizocīma un urīnvielas saturs; izvērtēta bioloģiskajā lauksaimniecībā iegūtā piena mikrobiālā kvalitāte un somatisko šūnu skaits; novērtēts bioloģiskajā lauksaimniecībā iegūtā piena ķīmiskais piesārņojums. Iegūtie pētījumu rezultāti pierāda, ka, saimniekojot šajā sistēmā, ir iespējams bez speciālām barības piedevām iegūt pienu ar normālu sastāvu.

Darba **tautsaimnieciskā nozīme** – izvērtēta bioloģiskajā lauksaimniecībā iegūtā piena kvalitāte, kas ļaus pamatoti runāt par tā nozīmi cilvēku uzturā.

ZINĀTNISKĀ DARBA APROBĀCIJA

Par darba rezultātiem ziņots sešās starptautiskajās zinātniskajās, zinātniski praktiskajās konferencēs un kongresos Latvijā, Slovēnijā, Turcijā, Polijā, Ungārijā un Grieķijā.

1. Zagorska J. (2007). The comparison of chemical composition between organic and conventional milks / J. Zagorska, I.Ciproviča // *5th International Congress on Food Technology*", Greece, Thessaloniki, 8–11 March 2007 (stenda referāts / poster presentation).
2. Zagorska J. (2006). Antibodies in organic and conventional milk / J. Zagorska I. Ciproviča, J. Bikova, N. Aleksandrova // *1st European Chemistry Congress 2006*, Hungary, Budapest, 27–31 August 2006 (stenda referāts / poster presentation).
3. Zagorska J. (2005). An evaluation of microbiological contamination in Latvian organic milk / I. Ciproviča, J. Zagorska // *5th International Conference Culinary Arts and Science ICCAS 05*, Warszawa Agricultural University, Poland, from June 27 to July 1 2005 (referāts / oral presentation).
4. Zagorska J. (2005). Heavy Metals in Latvian Organic Milk / J. Zagorska, I. Ciproviča // *1st International Food and Nutrition Congress – Food Safety*

and Quality through the Food Chain, Istanbul, Turkey, 15–18 June 2005 (stenda referāts / poster presentation).

5. Zagorska J. (2005). The comparison of chemical pollution between organic and conventional milk / J. Zagorska, I. Ciproviča // *International Scientific Conference „Research for Rural Development 2005",* LUA, Latvia, 18–21 May 2005 (referāts / oral presentation).
6. Zagorska J. (2004). The Study of Microbiological Contamination with *Staphylococci* in Latvian Organic Milk / I. Ciproviča, J. Zagorska**,** I.H. Konošonoka // *19th International ICFMH symposium Food Micro*, Portorož, Slovenia, 12–16 September 2004 (stenda referāts / poster presentation).

Pētījumu rezultāti apkopoti un publicēti sešos vispāratzītos recenzējamos zinātniskajos izdevumos latviešu un angļu valodā, no tiem trijos starptautiskos ārvalstu un Latvijas Zinātnes Padomes atzītos zinātniskajos izdevumos:

1. Zagorska J. (2007). Baktericīdo vielu un antivielu satura izvērtējums dažādās lauksaimniecības sistēmās turēto govju pienā / J. Zagorska, I. Ciproviča, V. Miķelsone // LLU raksti, Publikācija, Latvija, 2007. – 45.–50. lpp
2. Zagorska J. (2007). The comparison of chemical composition between organic and conventional milks / J. Zagorska, I. Ciproviča // *5th International Congress on Food Technology*", Proceedings, Thessaloniki, Greece, 2007. -p.332–337.
3. Zagorska J. (2006). Heavy metals in organic milk / J. Zagorska, I. Ciproviča, D. Kārkliņa // *ISEKI – FOOD book „Case studies in food safety and environmental health"*, Publication, Portugal, 2006. - p. 75–79.
4. Ciproviča I. (2005). An evaluation of microbiological contamination in Latvian organic milk / I. Ciproviča, J. Zagorska // *5th International Conference Culinary Arts and Science ICCAS 05*, Proceedings, Warszawa Agricultural University, Poland, 2005. - p. 250–253.
5. Zagorska J. (2005). The comparison of chemical pollution between organic and conventional milk / J. Zagorska, I. Ciproviča // *Research for Rural Development 2005*, Proceedings, LUA, Latvia, 2005.-p. 196–198.
6. Zagorska J. (2004). The investigation of risk factors on organic milk production / J. Zagorska, I. Ciproviča // *Pārtikas produktu inovatīvās attīstības tendences*. LLU, PTF, Referāti, Jelgava, 2004. - 189.–192. lpp.

MATERIĀLI UN METODES

Pētījumu norises laiks un vieta

Eksperimenti veikti laikā no 2003. gada oktobra līdz 2006. gada novembrim. 2006. gada laikā tika apkopoti un statistiski apstrādāti dati un sagatavots promocijas darbs.

Pētījumi tika veikti:

- LLU Pārtikas tehnoloģijas fakultātē Zinātniski pētnieciskajā laboratorijā;
- LLU Pārtikas tehnoloģijas fakultātē Ūdens analīžu laboratorijā;
- LLU Agronomisko analīžu zinātniskajā laboratorijā;
- LLU Biotehnoloģijas un veterinārmedicīnas zinātniskā institūta „Sigra” Veterinārmedicīnas nodaļas mikrobioloģijas laboratorijā;
- Latvijas Universitātes Bioloģijas institūta Bioķīmijas un dzīvnieku fizioloģijas laboratorijā;
- Rīgas reprodukcijas centrā;
- A/s „Siguldas ciltslietu un mākslīgās apsēklošanas stacijā”;
- PVD Nacionālā diagnostikas centra laboratorijās.

Bioloģiskajā, pārejas perioda un konvencionālajā lauksaimniecībā iegūtā piena paraugu analīzēm izvēlētas dažādas zemnieku saimniecības: „Lejasrembēni”, „Jaunbitēni”, „Kalna Gauriņi”, „Alejas”, „Čemuri”, kuras atrodas Ķeipenes pagastā, Ogres rajonā, kā arī izmantoti Rīgas, Cēsu, Jelgavas, Bauskas rajona individuālo govju turētāju dzīvnieku piena paraugi.

Pētījumā izmantoti dažādu šķirņu govju piena paraugi, procentuālais sadalījums: 61% − *Latvijas brūnās*, 2% − *Holšteinas*, 37% − abu šķirņu krustojums. Latvijā pietiekamā apjomā ir veikti pētījumi par dzīvnieku šķirnes ietekmi uz piena sastāvu un īpatnībām, tāpēc šajā darbā tas netika vērtēts. Piena paraugu ņemšanas un analizēšanas shēma izvēlēta tā, lai izslēgtu iespējas analizēt laktācijas sākuma un beigu posmā iegūto pienu.

Analizēto piena paraugu skaits un analīžu standarti doti 1.tabulā.

1. tabula / Table 1

Analizēto piena paraugu skaits un analīžu standarti
The standards of analyses and the number of analysed milk samples

Rādītāji / Indicators	**Paraugu skaits / The number of samples**			**Standarts / Standard**
	Piena paraugi tika iegūti: / The milk samples are obtained from:			
	Bioloģiskajā lauksaim-niecībā / Organic agriculture	Konven-cionālajā lauksaim-niecībā / Conven-tional agriculture	Pārejas perioda lauksaim-niecībā / Agriculture of transitional period	
Laktozes saturs / The content of lactose	25	-	-	LVS ISO 5765-1:2003

1.tabulas turpinājums / The continuation of table 1

Rādītāji / Indicators	**Paraugu skaits / The number of samples** Piena paraugi tika iegūti: / The milk samples obtained from:			**Standarts / Standard**
	Bioloģiskajā lauksaim-niecībā / Organic agriculture	Konven-cionālajā lauksaim-niecībā / Conven-tional agriculture	Pārejas perioda lauksaim-niecībā / Agriculture of transitional period	
Olbaltumvielu saturs/ The content of protein	55	-	-	LVS EN ISO 8968-5:2002
Tauku saturs / The content of fat	55	-	-	LVS ISO 2446:1976
Urīnvielas saturs / The content of urea	25	-	-	LVS EN ISO 8968-4:2002
Kalcija saturs / The content of calcium	20	20	20	ISO 12081:1998
Tiamīna saturs / The content of thiamin	10	10	-	AOAC 986.27
Riboflavīna saturs / The content of riboflavin	10	10	-	AOAC 970.65
IgA saturs / The content of IgA	20	20	20	Turbo-dimetriskā metode / Turbidimetric method
IgG saturs / The content of IgG	20	20	20	
IgM saturs / The content of IgM	20	20	20	
Laktoferīna saturs / The content of lactoferrin	20	20	20	Imuno-fermentatīvā metode / Immuno-fermentative method
Lizocīma saturs / The content of lysozyme	10	10	10	Turbo-dimetriskā metode / Turbidimetric method

1.tabulas nobeigums / The end of table 1

Rādītāji / Indicators	**Paraugu skaits / The number of samples**			**Standarts / Standard**
	Piena paraugi tika iegūti: / The milk samples obtained from:			
	Bioloģiskajā lauksaimniecībā / Organic agriculture	Konvencionālajā lauksaimniecībā / Conventional agriculture	Pārejas perioda lauksaimniecībā / Agriculture of transitional period	
Somatisko šūnu skaits / Somatic cell count	73	-	-	LVS EN ISO 13366-3:1997
Koloniju veidojošo vienību skaits / The total plate count	87	-	-	LVS 179:1999
Staphylococcus aureus	102	-	-	IDF 145:1990
Svina saturs / The content of lead	10	10	-	ISO/PRF TS 6733
Kadmija saturs / The content of cadmium	10	10	-	ISO 10349-5:1992
Vara saturs / The content of copper	10	10	-	ISO 5738:2004
Cinka saturs / The content of zinc	10	10	-	ISO 1813:1998
Dzelzs saturs / The content of iron	10	10	-	ISO 6732:1985
Aflatoksīna M_1 saturs/ The content of aflatoxin M_1	11	11	-	LVS EN ISO 14501:2001
Blīvums / Density	25	-	-	LVS 186:1999
Skābums / Acidity	25	-	-	LVS ISO 6091:2003
Analizēto paraugu skaits kopā / The total number of analysed milk samples	**648**	**191**	**110**	**-**

Ņemot vērā ievērojamo analizēto piena paraugu skaitu, ne visiem piena paraugiem tika noteikti visi izmeklējamie rādītāji. Tie analizēti izlases kārtībā trijos atkārtojumos, rēķinot vidējo aritmētisko vērtību, lai vērtētu iespējamo analizēto rādītāju atšķirības.

Lai salīdzinātu bioloģiskajā lauksaimniecībā iegūtā piena tauku, olbaltumvielu, laktozes saturu un somatisko šūnu skaitu ar konvencionālajā lauksaimniecībā iegūto pienu, rezultāti tika salīdzināti ar vidējiem pārraudzībā esošo Latvijas govju piena rādītājiem (sk. 2. tab.) tajā pašā laika periodā (01.07.2004. – 30.06.2005.).

2. tabula / Table 2

Pārraudzībā esošo Latvijas govju piena vidējie rādītāji konvencionālajā lauksaimniecībā
The mean parameters of conventional milk from Latvia's state agency „Agricultural data center"

Govju skaits / The number of cows	Izslaukums / The yield, kg	Rādītāji			
		Tauku saturs / The content of fat, %	Olbaltumvielu saturs/ The content of protein, %	Laktozes saturs / The content of lactose, %	Somatisko šūnu skaits / The somatic cell count, ml^{-1}
94956	5050	4.42	3.34	4.67	391 000

Latvijā darbojas tikai viens bioloģiskajā lauksaimniecībā iegūtā piena pārstrādes uzņēmums, kas atrodas Ogres rajonā, Ķeipenes pagastā. Šim uzņēmumam pienu piegādā šādas saimniecības: „Alejas", „Kalna Gauriņi", „Lejasrembēni", „Jaunbitēni". Ņemot vērā, ka šo saimniecību piegādātais piena daudzums kopā sastāda 100% no Latvijā bioloģiskajā lauksaimniecībā pārstrādājamā piena daudzuma, tad analizētie piena kvalitātes rādītāji ļaus objektīvi spriest par tā sastāvu un kvalitāti (tādēļ analizēto paraugu skaitu var pieņemt par ģenerālkopu).

Datu apstrāde veikta, izmantojot SPSS programmu paketi SPSS 11.0. un MS EXCEL.

PĒTĪJUMU REZULTĀTI UN DISKUSIJA

Bioloģiskajā lauksaimniecībā iegūtā piena ķīmiskā sastāva izvērtējums

Literatūrā apkopotais ļauj secināt, ka, mainoties lauksaimniecības sistēmai (no konvencionālās uz bioloģisko), dzīvnieku turēšanas apstākļiem, barības sastāvam, tiek būtiski ietekmēta arī galveno piena sastāvdaļu sintēze un to saturs produktā.

Laktozes, olbaltumvielu un tauku saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā dots 3. tabulā.

3. tabula / Table 3

Laktozes, olbaltumvielu un tauku saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā
The content of lactose, protein and fat in organic and conventional milk

Rādītājs / Value	**Bioloģiskajā lauksaimniecībā iegūtais piens / Organic milk**				**Konvencionālajā lauksaimniecībā iegūtā piena vidējā vērtība / Mean value of conventional milk, %**
	Vidējā vērtība / Mean value, %	Standart-kļūda / Standard error, %	Vērtība / Value, %		
			Min	Max	
Laktozes saturs / The content of lactose	4.85	0.04	4.19	5.88	4.67
Olbaltum-vielu saturs / The content of protein	3.30	0.04	2.24	4.99	3.34
Tauku saturs/ The content of fat	4.98	0.08	3.50	7.69	4.42

Vidējais **laktozes** saturs bioloģiskajā lauksaimniecībā iegūtā pienā 4,85±0,04% būtiski atšķiras no konvencionālajā lauksaimniecībā iegūtā piena ($p<0,05$). Pētījuma rezultāti sasaucas ar *Olivo* atziņām, ka laktozes saturs bioloģiskajā lauksaimniecībā iegūtā pienā ir būtiski lielāks. Savukārt tas nesakrīt ar *Byström, Toledo-Alonzo* darbu rezultātiem, kuri apgalvojuši, ka laktozes saturs abās lauksaimniecības sistēmās iegūto govju pienā neatšķiras.

Laktozes saturs pienā ir vismazāk pakļauts svārstībām. Palielināto laktozes saturu ekopienā var izskaidrot ar bioloģiskajās saimniecībās zāles lopbarībā konstatēto lielāku cukura koncentrāciju. Palielināto laktozes saturu arī izskaidro kā gremošanas procesa neveiksmīgu regulāciju.

Vidējais **olbaltumvielu** saturs bioloģiskajā lauksaimniecībā iegūtā pienā bija 3,30±0,04%, kas būtiski neatšķiras no pārraudzības rezultātiem ($p>0,05$).

Iegūtie rezultāti sasaucas ar *Haggar, Kristensen, Byström, Mogensen, Toledo-Alonzo* un *Ellis* pētījumu rezultātiem, ka olbaltumvielu saturs konvencionālajā un bioloģiskajā lauksaimniecībā iegūtā pienā būtiski neatšķiras. Iegūtie rezultāti saskan ar pētījumu rezultātiem, kur bioloģiskajā lauksaimniecībā turēto govju asinīs tika konstatēts mazāks kopējo olbaltumvielu saturs – 7,74±0,07%, bet konvencionālajā – 8,54±0,09%. Pētījuma rezultāti ir pretrunā ar *Olivo* apgalvojumu, ka olbaltumvielu saturs ir lielāks konvencionālajā lauksaimniecībā iegūtā pienā.

Kā vienu no iemesliem pazeminātam olbaltumvielu saturam pienā jāatzīmē ar cukuriem bagātas, sulīgas barības izēdināšanas trūkums, tas, savukārt, stimulē sviestskābes veidošanu, kas mazākā mērā tiek izmantota dažādu piena sastāvdaļu, bet galvenokārt − piena olbaltumvielu sintēzei. Šoreiz par barības trūkumu un nepietiekamo sabalansētību nevar runāt, jo bioloģiskajā lauksaimniecībā iegūtā zāles lopbarībā tika konstatēts lielāks šo barības vielu saturs.

Vidējais **tauku** saturs bioloģiskajā lauksaimniecībā iegūtā pienā ir 4,98±0,08%, tas ir būtiski lielāks nekā Latvijas pārraudzībā esošo govju pienā tajā pašā laikā periodā ($p<0,05$).

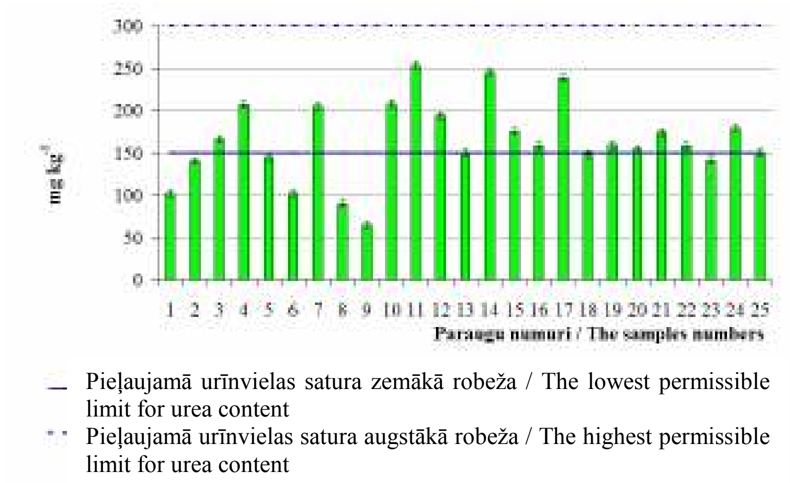
Iegūtie rezultāti ir pretrunā ar vairāku autoru – *Kristensen, Mogensen, Toledo-Alonzo* un *Olivo* – atziņām, ka tauku saturs ir lielāks konvencionālajā lauksaimniecībā iegūtā pienā. Savukārt citi autori – *Haggar, Byström* un *Ellis* – uzskatījuši, ka būtisku atšķirību tauku saturā starp bioloģiskajā un konvencionālajā lauksaimniecībā iegūto pienu nav.

Palielināto tauku saturu bioloģiskajā lauksaimniecībā iegūtā pienā var izskaidrot ar ēdināšanas un turēšanas apstākļiem: govīm izēdinātā rupjā barība bagāta ar kokšķiedrām, pareizi sabalansēta, pietiekamā daudzumā, nesasmalcināta, barība ir pieejama visu diennakti, govis – rūpīgi izslauktas.

Urīnvielas saturu ietekmē vairāki faktori: barības sastāvs un deva, dzīvnieka svars, piena izslaukums, sezona, mēnesis un laktācijas periods. Urīnvielas saturs bioloģiskajā lauksaimniecībā iegūtā pienā parādīts 1. attēlā.

Urīnvielas saturs bioloģiskajā lauksaimniecībā iegūtā pienā bija robežās no 64,90 līdz 252,56 mg kg^{-1}. Vidējais urīnvielas saturs analizētajā bioloģiskajā lauksaimniecībā iegūtā pienā bija 167,43±5,36 mg kg^{-1}, kas iekļāvās vispārpieņemtās urīnvielas satura robežās pienam – no 150 līdz 300 mg kg^{-1}. 32% bioloģiskajā lauksaimniecībā turēto govju piena paraugu urīnvielas saturs bija vidēji par 29,6 mg kg^{-1} mazāks par minimālo robežu – 150 mg kg^{-1}. Ja urīnvielas saturu pienā salīdzinām ar minimālajiem *Rajala-Schultz* noteiktajiem lielumiem, tad tikai 8% analizēto ekopiena paraugu neiekļāvās robežās no 103 mg kg^{-1} līdz 154 mg kg^{-1}.

Iegūtie rezultāti sasaucas ar *Toledo-Alonzo* darba rezultātiem, kuros autore konstatējusi būtisku atšķirību divās lauksaimniecības sistēmās iegūtā govju pienā. Tas, savukārt, izskaidro pazemināto urīnvielas saturu pienā ar samazinātu kombinētās barības devu – 40% no dienas barības devas sausnas satura bioloģiskajā lauksaimniecībā, bet konvencionālajā – līdz 65%.



1. att. Urīnvielas saturs bioloģiskajā lauksaimniecībā iegūtā pienā
Fig. 1. The content of urea in organic milk

Lielākai kombinētās barības devai ir negatīva ietekme uz spurekļa darbības funkcijām un piena ražošanu. Mazāks urīnvielas saturs bioloģiskajā lauksaimniecībā iegūtā pienā var būt izskaidrojams arī ar zemāku ganāmpulka produktivitāti bioloģiskajās saimniecībās, ko apstiprina *Jemeļjanova* pētījumu rezultāti, proti, bioloģiskajā lauksaimniecībā turētām govīm neatkarīgi no gadalaika tika konstatēts mazāks piena izslaukums nekā konvencionālajā lauksaimniecībā turētām.

Pēc lopkopības speciālistu domām, urīnvielas saturam pienā ir jābūt līdz 150 mg kg^{-1}, pretējā gadījumā tas var apgrūtināt apsēklošanas un govs reprodukcijas funkcijas. Tātad, no šā viedokļa raugoties, analizētajos bioloģiskajā lauksaimniecībā iegūtā piena paraugos urīnvielas saturs bija normas robežās.

Pazemināto urīnvielas saturu 32% bioloģiskajā lauksaimniecībā iegūtā piena paraugu var skaidrot ar zemo šķīstošā slāpekļa daudzumu izēdinātajā barībā un piena sastāva sezonālo svārstību ietekmi. Vismazākais urīnvielas saturs pienā, pēc *Goddena* datiem, tika konstatēts laikā no aprīļa līdz jūnijam. Vairāki autori skaidrojuši samazināto urīnvielas saturu arī ar zemo kopproteīna saturu barībā. Pēc *Dursta* pētījumiem var spriest, ka pie olbaltumvielu satura, kas tika konstatēts bioloģiskajā lauksaimniecībā iegūtā pienā – 3,18%, zemais urīnvielas saturs jāsaista ar samazinātu kopproteīna daudzumu barībā. Tas neapstiprinās ar *Blūzmaņa* pētījuma rezultātiem, kur bioloģiskajā lauksaimniecībā iegūtajā zāles lopbarībā kopproteīna saturs (3,26±0,21%) ir lielāks nekā konvencionālajā lauksaimniecībā iegūtajā (2,99±0,30%).

Hojman atzīmējis, ka urīnvielas saturs korelē ar tauku saturu pienā. Lai pārbaudītu *Hojman* apgalvojumu, ka urīnvielas saturs korelē ar tauku saturu, pētījumā tika lietota regresijas analīze. Korelācijas koeficients ir 0,246, kas norāda uz vāju sakarību. Faktors – tauku saturs – nav būtiski nozīmīgs ($p>0,05$) urīnvielas satura izmaiņām pienā, līdz ar to var secināt, ka iegūtais modelis nav statistiski nozīmīgs.

Tātad šo pētījumu ietvaros sakarību starp urīnvielas un tauku saturu nevar uzskatīt pat par tendenci. *Hojman* apgalvojums, ka urīnvielas saturs pienā korelē ar tauku saturu šo pētījumu ietvaros netika apstiprināts.

Kalcija saturu pienā ietekmē barības sastāvs, gadalaiks un dzīvnieka fizioloģiskās īpatnības. Kalcija saturs bioloģiskajā lauksaimniecībā iegūtā pienā parādīts 4. tabulā.

4. tabula / Table 4

Kalcija saturs bioloģiskajā, pārejas perioda un konvencionālajā lauksaimniecībā iegūtā pienā
The content of calcium in milk obtained from organic, transitional period and conventional agriculture

Lauksaimniecības sistēma / Agricultural system	Paraugu skaits / Number of samples	Kalcija saturs / The content of calcium, mmol l^{-1}			
		Vidējais ± standartkļūda/ Mean ± standard error	Min	Max	Literatūras dati* / Data from literature*
Konvencionālā lauksaimniecība / Conventional agriculture	20	20.80±0.32	14	23	30.00
Pārējas perioda lauksaimniecība / Transitional period	20	20.80±0.23	16	24	
Bioloģiskā lauksaimniecība / Organic agriculture	20	21.90±0.22	20	25	

*(Neville M. *et al.,* 1994)

Kalcija saturs bioloģiskajā lauksaimniecībā iegūtā pienā bija robežās no 20 līdz 25 mmol l^{-1}, vidējais kalcija saturs – 21,9±0,22 mmol l^{-1}. Tomēr starp bioloģiskajā un konvencionālajā lauksaimniecībā iegūto pienu statistiski nozīmīga atšķirība kalcija saturā netika konstatēta – 20,8±0,32 mmol l^{-1}. Tajā pat laikā jāuzsver, ka kalcija saturs piena paraugos, kuri iegūti atšķirīgās lauksaimniecības sistēmās, ir būtiski mazāks, salīdzinot ar literatūras datiem ($p<0,05$) – 30 mmol l^{-1}.

Gorbatova savos darbos min, ka kalcija saturs vasaras periodā iegūtā pienā ir zemāks nekā ziemas periodā iegūtā, tas varētu izskaidrot samazināto kalcija saturu piena paraugos, kas tika ņemti vasaras un rudens mēnešos un ietekmē vidējo rādītāju. Samazinātu kalcija saturu pienā var izraisīt arī mastīti, tā saturs var samazināties par 9%.

Kalcija saturs pienā palielinās, mainoties lauksaimniecības sistēmai no konvencionālās uz bioloģisko. Salīdzinot kalcija saturu dažādās lauksaimniecības sistēmās iegūtā govju pienā, būtiskas atšķirības netika konstatētas ($p>0,05$). Bioloģiskajā lauksaimniecībā turētām govīm netiek dotas minerālpiedevas, līdz ar to imunitātes paaugstināšana ir saistīta tikai ar dabisko pašregulācijas procesu veicināšanu. Ar tās palīdzību bioloģiskajā lauksaimniecībā var sasniegt līdzīgu rezultātu kā konvencionālajā, kur galvenokārt notiek dzīvnieku ārstēšana, nevis slimību profilakse.

Blūzmanis atzīmējis, ka bioloģiskajā lauksaimniecībā govju asins serumā kalcija un fosfora attiecības ir labākas (2:1) nekā konvencionālās lauksaimniecības govju asins paraugos (2,27:1), ko varētu attiecināt uz pētījumā iegūto atšķirīgo kalcija saturu.

Promocijas darba ietvaros piena paraugos tika izvērtēts arī **tiamīna** (sk. 5. tab.) un **riboflavīna** saturs.

Tiamīna saturs bioloģiskajā lauksaimniecībā iegūtā pienā svārstās plašās robežās – no 0,20 līdz 0,32 mg l^{-1}. Vidējais tiamīna saturs bioloģiskajā lauksaimniecībā iegūtā pienā (0,27±0,01 mg l^{-1}) bija par 34,1% mazāks nekā konvencionālajā lauksaimniecībā iegūtā pienā un būtiski atšķīrās no tā ($p<0,05$), kā arī no literatūras datiem – tas bija mazāks. Tiamīna saturs konvencionālajā lauksaimniecībā iegūtā pienā ir 0,41±0,01 mg l^{-1}, kas, savukārt, atbilst literatūrā dotiem skaitļiem.

5. tabula / Table 5

Tiamīna saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā
The content of thiamin in organic and conventional milk

Lauksaimniecības sistēma / Agricultural system	Paraugu skaits / Number of samples	Tiamīna saturs / The content of thiamin, mg l^{-1}			
		Vidējais ± standartkļūda/ Mean ± standard error	Min	Max	Literatūras dati* / Data from literature*
Konvencionālā lauksaimniecība / Conventional agriculture	10	0.41±0.01	0.35	0.48	0.40
Bioloģiskā lauksaimniecība / Organic agriculture	10	0.27±0.01	0.20	0.32	

* (Schaafma G., 2002)

Riboflavīna satura rādītāji apkopoti 6. tabulā.

6. tabula / Table 6

Riboflavīna saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā
The content of riboflavin in organic and conventional milk

Lauksaimniecības sistēma / Agricultural system	Paraugu skaits / Number of samples	Riboflavīna saturs / The content of riboflavin, mg l^{-1}			
		Vidējais ± standartkļūda/ Mean ± standard error	Min	Max	Literatūras dati* / Data from literature*
Konvencionālā lauksaimniecība / Conventional agriculture	10	2.65±0.10	1.84	3.40	1.80
Bioloģiskā lauksaimniecība / Organic agriculture	10	1.70±0.10	1.28	2.96	

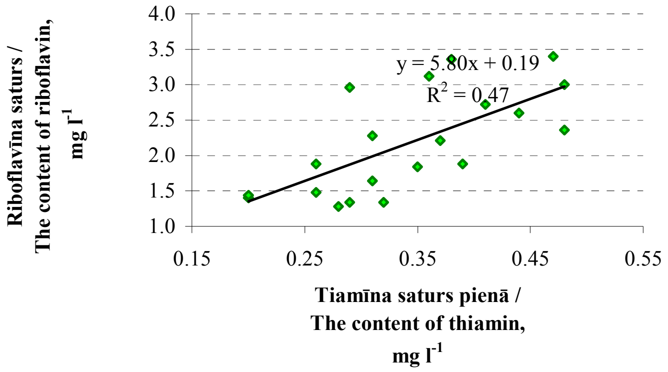
* (Schaafma G., 2002)

Izvērtējot riboflavīna saturu bioloģiskajā lauksaimniecībā iegūtā pienā, var redzēt, ka tas svārstās plašās robežās – no 1,28 līdz 2,96 mg l^{-1}. Tomēr vidējais riboflavīna saturs bija 1,70±0,10 mg l^{-1}, kas bija par 35,8% mazāks nekā konvencionālajā lauksaimniecībā iegūtā pienā un būtiski atšķīrās no tā ($p<0,05$). Salīdzinot ar literatūras datiem, būtiska atšķirība noteiktajam rādītājam netika konstatēta. Riboflavīna saturs konvencionālajā lauksaimniecībā iegūtā pienā ir 2,65±0,10 mg l^{-1}, kas būtiski atšķiras ($p<0,05$) no literatūras datiem.

Vairāki autori uzsvēruši, ka tiamīna un riboflavīna saturs nemainās dažādos gadalaikos un barības sastāvs to praktiski neietekmē. Bet ir pieļaujama iespēja, ka barība tomēr ietekmē tiamīna un riboflavīna saturu pienā, īpaši, ja tiek izbaroti graudi, milti u. c. Tieši samazinātā kombinētās barības deva var negatīvi ietekmēt tiamīna un riboflavīna saturu bioloģiskajā lauksaimniecībā iegūtā pienā. Samazinoties kombinētās barības devai, ko praktizē bioloģiskajā lauksaimniecībā, konstatēts zemāks tiamīna un riboflavīna saturs piena paraugos. Riboflavīna saturs pienā samazinās arī gaismas ietekmē, tātad piena iegūšanas un pirmapstrādes organizācija bioloģiskajā lauksaimniecībā ir viens no būtiskākajiem faktoriem, kas var ietekmēt minētā vitamīna saturu.

Iegūtie rezultāti neļauj izcelt bioloģiskajā lauksaimniecībā iegūto pienu uz citu lauksaimniecības sistēmu govju piena fona. Ļoti bieži bioloģiskās lauksaimniecības sistēmas praktizētāji akcentē produkta veselīgumu un augstāku vitamīnu saturu tajā, taču iegūtie dati par tiamīna un riboflavīna saturu ekopienā to nepierāda. Latvijā stājoties spēkā ES regulai par pārtikas produktu veselīgumu, tas ir īpaši būtiski, jo ikviens izteiktais apgalvojums par ievērojamu vitamīnu u. c. vielu koncentrāciju produktā ir jāapliecina pētījumu rezultātā. Tas ir aktuāli arī pašiem bioloģiskās lauksaimniecības praktizētājiem, izzināt šīs nianses un pētījuma rezultātus, jo tas var palīdzēt akcentēt un popularizēt tieši dabai un videi draudzīgu produktu ieguvi.

Pētījuma ietvaros mēģinājām noskaidrot, vai riboflavīna un tiamīna saturs pienā ir savstarpēji saistīts. Tiamīna un riboflavīna (un otrādi) satura savstarpēja sakarība ir dota 2. attēlā.



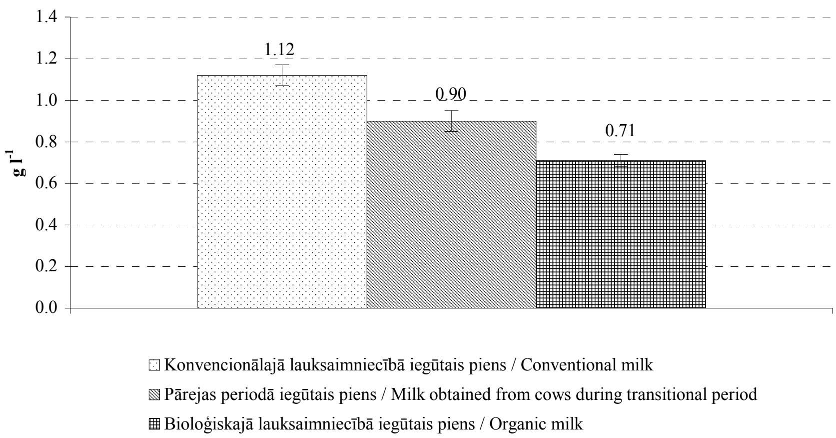
2. att. Korelācija starp tiamīna un riboflavīna saturu pienā
Fig. 2. The correlation between the content of thiamin and riboflavin in milk

Korelācijas koeficients r>0,5 (0,68) liecina par lineāru sakarību starp riboflavīnu un tiamīnu pienā. Tā kā $p<0,05$, tas nozīme, ka, pieaugot tiamīna saturam, palielinās arī riboflavīna saturs, un otrādi. Tajā pašā laikā izmantot šo modeli rādītāja pieauguma prognozēšanai nav korekti, jo determinācijas koeficients ir zems (R^2=0,47), kas liecina par citu faktoru būtisku ietekmi.

Izvērtējot bioloģiskajā lauksaimniecībā iegūtā piena ķīmisko sastāvu, noteikts, ka laktozes un tauku saturs būtiski atšķiras ($p<0,05$) no konvencionālajā lauksaimniecībā iegūtā piena. Kalcija saturs govju pienā, kas iegūts atšķirīgās lauksaimniecības sistēmās, salīdzinot ar literatūras datiem, ir būtiski mazāks ($p<0,05$). Tiamīna un riboflavīna saturs ekopiena paraugos ir būtiski zemāks ($p<0,05$), salīdzinot ar konvencionālajā lauksaimniecībā iegūto pienu. Izvērtējot pētījumu rezultātus, izriet, ka, mainoties lauksaimniecības sistēmai no konvencionālās uz bioloģisko, izmainās arī atsevišķu uzturvielu saturs govju pienā.

Bioloģiskajā lauksaimniecībā iegūtā piena antivielu un baktericīdo vielu satura izvērtējums

Imunoglobulīnu (IgA, IgG, IgM) saturs pienā variē atkarībā no govs vecuma, veselības stāvokļa un laktācijas perioda.



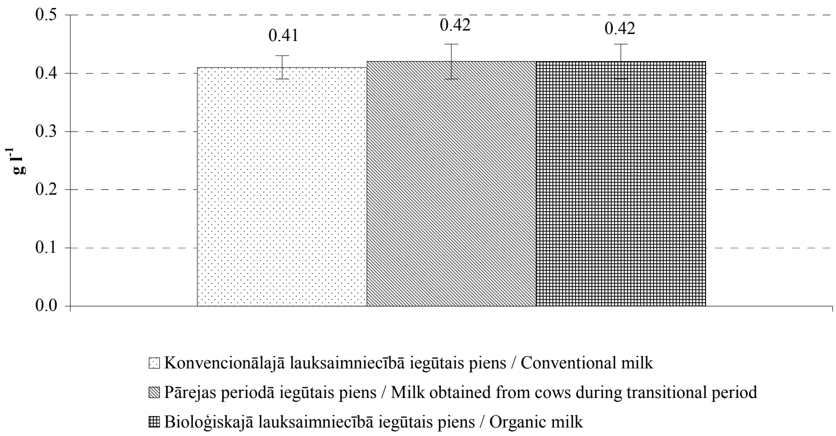
3. att. IgA saturs atšķirīgās lauksaimniecības sistēmās turēto govju pienā
Fig. 3. The content of IgA in milk from different agricultural systems

IgA saturs piena paraugos svārstījās plašās robežās un būtiski ($p<0{,}05$) atšķīrās dažādu lauksaimniecības sistēmu govīm. Lielākais IgA saturs tika konstatēts konvencionālajā lauksaimniecībā turēto govju pienā – 1,12±0,07 g l^{-1}. Vislielākajām svārstībām tika pakļauts IgA saturs pienā, kas tika iegūts pārejas periodā no bioloģiskās uz konvencionālo lauksaimniecību.

IgA saturs samazinās piena paraugos šādā secībā: konvencionālajā → pārejas perioda → bioloģiskajā lauksaimniecībā iegūtais piens (sk. 3. att.). Savukārt nepieciešams atzīmēt, ka bioloģiskajā lauksaimniecībā iegūtā piena vidējais IgA saturs ir 5,5 reizes lielāks, salīdzinot ar literatūras datiem (0,13 g l^{-1}). Pārejas perioda un konvencionālajā lauksaimniecībā iegūtā pienā vidējais IgA saturs bija lielāks, attiecīgi 6,9 un 8,6 reizes, kas, savukārt, var liecināt par mastīta problēmām. Palielinātu IgA saturu konvencionālajā lauksaimniecībā iegūtā pienā var mēģināt skaidrot ar dzīvnieku vakcināciju. Līdz ar to, palielināto IgA saturu konvencionālajā lauksaimniecībā iegūtā pienā nav jāsaista ar tesmeņa iekaisumu, jo piena paraugi tika izvēlēti tā, lai izslēgtu iespēju analizēt ar mastītu slimu govju pienu. Proti, piena paraugiem tika noteikta elektrovadītspēja, pēc kuras lielumiem varēja atlasīt piemērotus analizējamā piena paraugus.

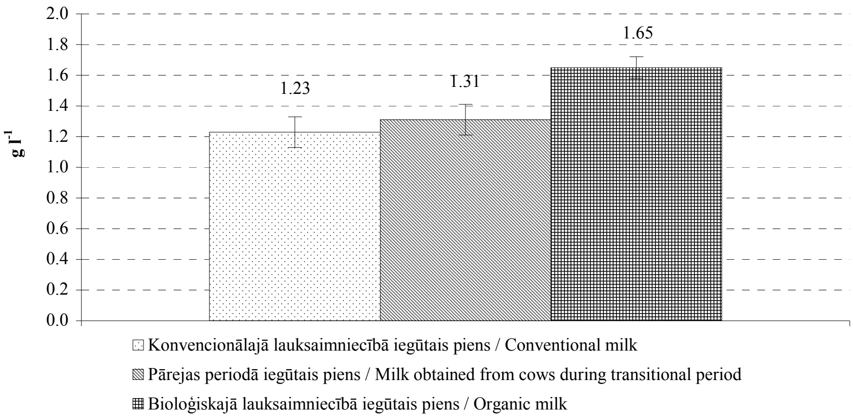
Izmantojot dispersijas analīzi, tika konstatētas būtiskas atšķirības ($p<0{,}05$) IgA saturā starp bioloģiskajā un konvencionālajā lauksaimniecībā iegūto pienu.

IgG saturs govju pienā palielinās secībā no konvencionālās uz pārejas perioda un bioloģisko lauksaimniecības sistēmu (sk. 4. att.).



4. att. IgG saturs atšķirīgās lauksaimniecības sistēmās turēto govju pienā
Fig. 4. The content of IgG in milk from different agricultural systems

IgG saturs pienā neatkarīgi no lauksaimniecības sistēmas atbilst literatūrā minētājiem datiem – no 0,15 līdz 0,80 g l^{-1}. IgG saturs bioloģiskajā, konvencionālajā un pārejas perioda lauksaimniecībā iegūtajā pienā būtiski neatšķīrās ($p>0,05$).



5. att. IgM saturs atšķirīgās lauksaimniecības sistēmās turēto govju pienā
Fig. 5. The content of IgM in milk from different agricultural systems

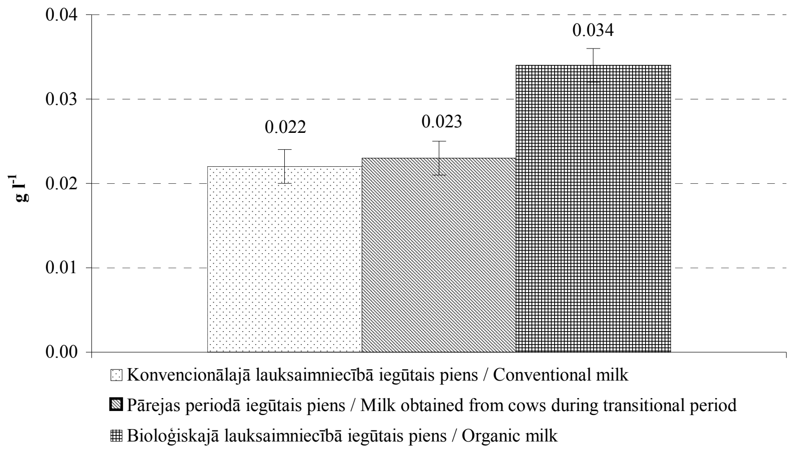
Vidējais **IgM** saturs bioloģiskajā lauksaimniecībā iegūtā pienā ir vislielākais – 1,65 g l^{-1} un, salīdzinot ar konvencionālajā un pārejas periodā iegūtā piena paraugiem, vismazāk pakļauts svārstībām.

IgM saturs palielinās piena paraugos šādā secībā: konvencionālā → pārejas perioda → bioloģiskā lauksaimniecības sistēma (sk. 5. att.).

IgM saturs govju piena paraugos būtiski atšķīrās ($p>0,10$) atkarībā no praktizētās lauksaimniecības sistēmas. Vidējais IgM saturs visos govju piena paraugos neatkarīgi no lauksaimniecības sistēmas ir lielāks par literatūras datiem – no 0,04 līdz 1,00 g l^{-1}.

Augsto imunoglobulīnu saturu pienā jāvērtē pozitīvi, jo pēdējā laikā ir palielinājusies interese par apzinātu govju imunizāciju ar mērķi celt antivielu saturu pienā un paaugstināt piena uzturvērtību.

Laktoferīna saturs pienā svārstās ļoti plašās robežās neatkarīgi no lauksaimniecības sistēmas – no 0,003 līdz 0,071 g l^{-1}. Laktoferīna saturs govju pienā palielinās šādā secībā: konvencionālā → pārējas perioda → bioloģiskā lauksaimniecības sistēma (sk. 6. att.).

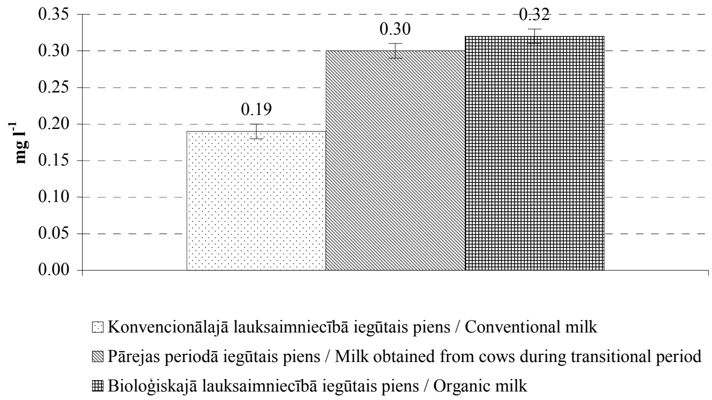


6.att. Laktoferīna saturs atšķirīgās lauksaimniecības sistēmās turēto govju pienā
Fig. 6. The content of lactoferrin in milk from different agricultural systems

Laktoferīna saturs būtiski atšķīrās ($p<0,05$) govju pienā atkarībā no praktizētās lauksaimniecības sistēmas. Bioloģiskajā lauksaimniecībā iegūtā pienā laktoferīna saturs (0,03 g l^{-1}) ir 1,5 reizes lielāks nekā konvencionālajā lauksaimniecībā iegūtā pienā (0,02 g l^{-1}).

Laktoferīna saturs pienā neatkarīgi no praktizētās lauksaimniecības sistēmas iekļāvās literatūrā minētajās robežās – no 0,02 līdz 0,35 g l^{-1}. Laktoferīna satura palielinājums bioloģiskajā lauksaimniecībā iegūtā pienā nav saistīts ar tesmeņa iekaisumu, to izraisīja citi faktori, proti, turēšanas apstākļi, imunitātes stiprināšanas pasākumi u. c. Laktoferīns inhibē baktērijas, kuru vairošanās apstākļiem un eksistencei ir nepieciešama augsta dzelzs jonu koncentrācija, piemēram, koliformas un citas, tādējādi ievērojamā laktoferīna koncentrācija bioloģiskajā lauksaimniecībā iegūtā pienā norāda uz potenciālā antimikrobiālā aģenta nozīmi izejvielā.

Lizocīma saturs pienā svārstās ļoti plašās robežās – no 0,02 līdz 0,77 mg l^{-1} neatkarīgi no praktizētās lauksaimniecības sistēmas.



7. att. Lizocīma saturs atšķirīgās lauksaimniecības sistēmās turēto govju pienā
Fig. 7. The content of lysozyme in milk from different agricultural systems

Lizocīma saturs ir nozīmīgs piena kvalitātes rādītājs, kas ietekmē piena uzglabāšanas ilgumu un piena pārstrādes procesus. Lizocīms ir samērā termostabils, 75% lizocīma aktivitātes saglabājas, karsējot pienu +75 °C 15 min vai +80 °C 15 s. Tas nozīmē, ka arī termiski apstrādātā pienā šā enzīma koncentrācija ir pietiekama, lai ierobežotu virkni mikroorganismu un veicinātu produkta kvalitātes saglabāšanos. Iegūtie pētījumu rezultāti pierādīja, ka bioloģiskajā lauksaimniecībā iegūtā pienā ir ievērojams lizocīma saturs, kas kā antimikrobiāla viela zināmu laiku spēj nodrošināt piena kvalitātes saglabāšanos.

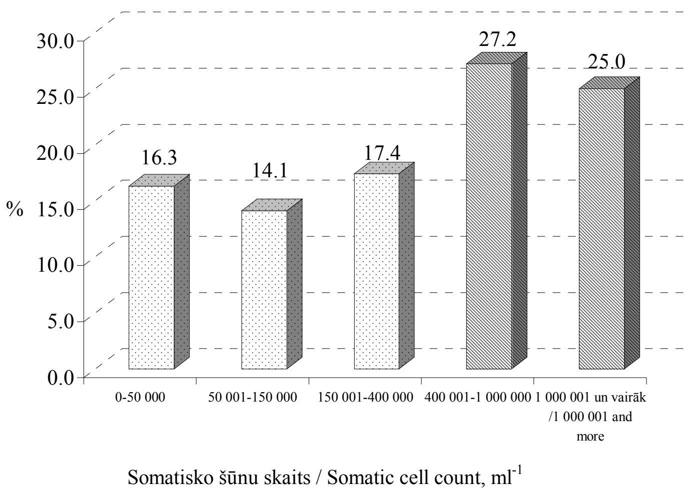
Lai gan datu statistiskās apstrādes rezultāti neuzrādīja būtiskas atšķirības lizocīma saturā konvencionālajā un bioloģiskajā lauksaimniecībā iegūtā pienā ($p>0,05$), tomēr iezīmējas tendence, ka lizocīma saturs pienā palielinās šādā secībā: konvencionālā → pārejas perioda → bioloģiskā lauksaimniecība (sk. 7.att).

Gan bioloģiskajā, gan konvencionālajā lauksaimniecībā tiek praktizēta dzīvnieku imunitātes paaugstināšana, atšķirīgas ir tikai pielietotās metodes, ar kuru palīdzību lauksaimnieki to mēģina panākt. Konvencionālajā lauksaimniecībā tiek praktizēta dzīvnieku vakcinācija pret dažādām slimībām, savukārt bioloģiskajā lauksaimniecībā dzīvnieku imunitāte tiek palielināta ar dabiskiem paņēmieniem. Tā rezultātā atšķiras arī baktericīdo vielu un antivielu saturs analizēto lauksaimniecības sistēmu govju piena paraugos.

Bioloģiskajā lauksaimniecībā iegūtā piena mikrobioloģiskā un ķīmiskā piesārņojuma izvērtējums

Promocijas darba ietvaros pienā tika noteikts somatisko šūnu un koloniju veidojošo vienību skaits, kadmija, svina, cinka, vara, dzelzs un aflatoksīna M_1 saturs.

Somatisko šūnu skaits (SŠS). Saimniekojot bioloģiskajā lauksaimniecībā – ierobežojot tesmeņa dezinfekcijas līdzekļu lietošanu, atturīgi izmantojot antibiotiku terapiju mastītu ārstēšanai, nepraktizējot cietstāvēšanas perioda antibiotiku terapiju mastītu profilaksei – var palielināties somatisko šūnu skaits un mastīta izraisītāju spektrs pienā. Somatisko šūnu skaita izkliede bioloģiskajā lauksaimniecībā iegūtos piena paraugos parādīta 8. attēlā.



8. att. Ekopiena paraugu procentuālais sadalījums pēc somatisko šūnu skaita
Fig. 8. The distribution of organic milk samples by somatic cell count

47,8% bioloģiskajā lauksaimniecībā iegūtā piena paraugu iekļāvās Eiropas Parlamenta un Padomes Regulas Nr. 853/2004, ar ko nosaka īpašus higiēnas noteikumus attiecībā uz dzīvnieku izcelsmes pārtiku, noteiktajās pieļaujamajās robežās. Tomēr 52,2% piena paraugu somatisko šūnu skaits bija lielāks par 400 000 ml^{-1}, tajā skaitā 25% gadījumu SŠS – lielāks par 1 000 000 ml^{-1}.

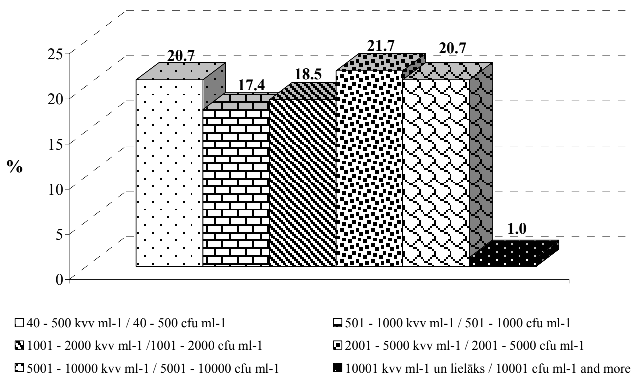
Somatisko šūnu skaits ekopienā bija robežās no 4 000 līdz 1 413 000 ml^{-1}, vidējais SŠS – 351 123±40 057 ml^{-1}, kas ir mazāks nekā atbilstošā laika periodā pārraudzībā esošo govju pienā – 391 000 ml^{-1}.

Pēc *Norman* un *Schaik* domām, veselu govju pienā somatisko šūnu skaits ir līdz 200 000 ml^{-1}, *Konošonoka* savā darbā minējusi, ka veselu govju pienā SŠS ir līdz 300 000 ml^{-1}, lielāks somatisko šūnu skaits liecina par mastīta risku attiecīgo saimniecību govju pienā. Subklīnisko mastītu gadījumā tas veido 1 490 000 ml^{-1}, klīnisko mastītu gadījumā – 2 740 000 ml^{-1}. Vairāki autori uzsvēruši, ka SŠS izmanto kā indikatoru mastīta konstatēšanai govju ganāmpulkos.

Galvenais faktors, kas ietekmē somatisko šūnu skaitu, ir dzīvnieka veselības stāvoklis. Bioloģiskajās saimniecībās ir ierobežota antibiotiku lietošana arī mastītu ārstēšanā. Antibiotiku aizliegšana var pozitīvi ietekmēt dzīvnieka veselības stāvokli, jo bioloģiskā lauksaimniecība galvenokārt ir orientēta uz dzīvnieka imunitātes stiprināšanu un slimību profilaksi. Tādā veidā ir iespējams samazināt pret antibiotikām izturīgo mastīta patogēnu klātbūtni govs tesmenī un arī pienā.

Turklāt patlaban, pieaugot govju vakcinēšanai, izmantojot dažādas vakcīnas, piemēram, *Staphylococcus aureus* un citas, vieni no mastīta izraisītājiem tiek iznīcināti, bet citi vairojas nepiespiesti. Universālas vakcīnas mastītu novēršanai šodien nav un diez vai tuvākajā laikā būs, turklāt dabā nekas nezūd un nemainās, vienmēr kādu mikroorganismu lomu mastītu izraisīšanā nomainīs un uzņemsies citi. Varbūt arī, no šā viedokļa raugoties, 21. gs. ir jāmeklē citi ceļi mastītu ārstēšanā un profilaksē, un antibiotiku aizliegšana nav jāuzskata par anomāliju. Bez tam, ja ar šādām metodēm iespējams ierobežot potenciālos jaunveidojamos mastītu patogēnus, tad tas var būt tikai apsveicami.

No otras puses, antibiotiku aizliegšanai var būt negatīva ietekme, jo nepieciešamības gadījumā vajadzīgā ārstēšana nenotiek un rezultātā paaugstinās somatisko šūnu un mastītu izraisošo patogēnu skaits pienā.



9. att. Ekopiena paraugu sadalījums pēc stafilokoku skaita
Fig. 9. The distribution of organic milk samples by amount of staphylococci

Bioloģiskajās saimniecībās, tika noteikts stafilokoku skaits ekopiena paraugos. Procentuālais paraugu sadalījums pēc stafilokoku skaita parādīts 9. attēlā.

No iegūtajiem rezultātiem var secināt, ka piena paraugi, kuros tika konstatēts palielināts stafilokoku skaits (virs 2 000 kvv ml^{-1}), var liecināt par tesmeņa iekaisumu. Lai noskaidrotu galvenos mikroorganismus, kas prevalē ekopiena paraugos tika identificētas stafilokoku sugas.

Staphylococcus aureus tika izolēts 34 ekopiena paraugos, koagulāzes negatīvie stafilokoki (KNS) – 63 gadījumos. Tikai 5 paraugos netika izolētas *Staphylococcus spp*. Daži no izolētajiem stafilokokiem tika identificēti līdz sugai (sk. 7. tab.).

7. tabula / Table 7

***Staphylococcus aureus* un KNS bioloģiskajā lauksaimniecībā iegūtā piena paraugos**
***Staphylococcus aureus* and CNS isolated from organic milk samples**

Izolētās stafilokoku sugas / Isolated species of staphylococci	Paraugu skaits / Number of samples	% no visiem izolētajiem / % from all isolates
Staphylococcus aureus	34	**33**
KNS, ieskaitot / CNS, including:	63	62
Staphylococcus felis	2	2
Staphylococcus simulans	2	2
Staphylococcus haemolyticus	8	8
Staphylococcus xylosus	1	1
Staphylococcus schleiferi spp. schleiferi	1	1
Staphylococcus epidermidis	1	1
Staphylococcus lentus	1	1
Citi līdz sugai neidentificēti KNS / Other species of CNS not identified	47	46
Citi mikroorganismi / Other microorganisms	5	5
Kopā / Total	102	100

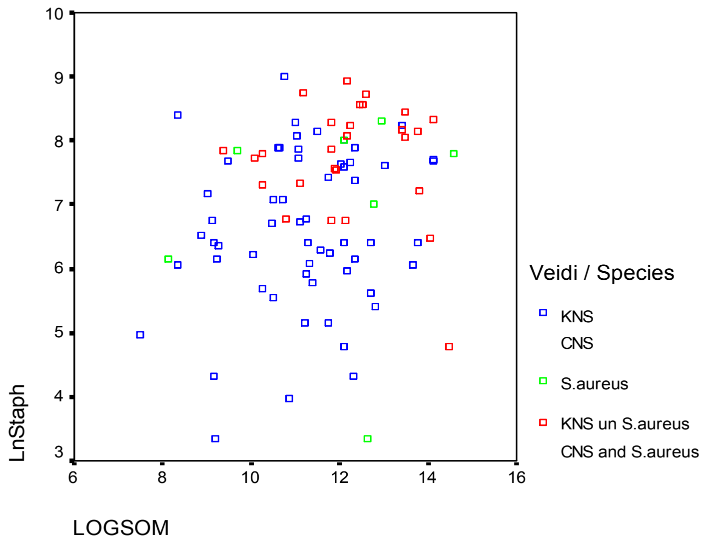
No iegūtajiem pētījumu rezultātiem var secināt, ka galvenā loma mastīta ierosināšanai bioloģiskajā lauksaimniecībā iegūtā pienā ir KNS (62%) un *Staphylococcus aureus* (33%), kas sasaucas ar *Smoldera* pētījumu rezultātiem, kur galvenie mikroorganismi, kas prevalē gan bioloģiskajā, gan konvencionālajā lauksaimniecībā iegūtā pienā ir KNS, attiecīgi 46,0% un 40,9%, bet *Staphylococcus aureus* – attiecīgi 15,8% un 18,6%.

Somatisko šūnu skaits pienā izmainās dažādu faktoru ietekmē, proti, laktācijas periods, barība, dzīvnieku veselības, turēšanas apstākļi, vecums u.c.

vairāki autori uzskatījuši, ka palielinātais somatisko šūnu skaits korelē ar stafilokoku skaitu.

Pētījumu ietvaros noskaidrots, ka korelācijas koeficients r<0,5 (0,204) liecina par vāju lineāro sakarību starp somatisko šūnu un stafilokoku skaitu. Determinācijas koeficients R^2=0,042 norāda tikai uz tendenci, kāda pastāv starp rezultatīvo un faktoriālo pazīmi. Tā kā b_0 koeficienta p-vērtība 0,051 ir lielāka par 0,05, tad ar varbūtību 95% var teikt, ka koeficients ir vienāds ar nulli. Tas nozīmē, ka šo pētījumu ietvaros sakarību starp SŠS un stafilokoku skaitu pat nevar uzskatīt par tendenci.

Ne vienmēr stafilokoku skaits nosaka somatisko šūnu skaita pieaugumu pienā. Tas galvenokārt ir atkarīgs no mastītu ierosinātāju dabas, agresijas un citiem faktoriem. Citu autoru pētījumu rezultāti ir pierādījuši, ka vidēji cieša sakarība pastāv starp *Staphylococcus aureus* un somatisko šūnu skaitu pienā. Tajā pat laikā vesela virkne KNS var izraisīt klīniskos mastītus, neveicinot strauju somatisko šūnu skaita palielinājumu. Tādējādi, lai iegūtu objektīvus rezultātus, kopsakarības ir jāmeklē starp potenciālo patogēnu un SŠS.



10. att. Korelācija starp SŠS un *Staphylococcus ssp.* bioloģiskajā lauksaimniecībā iegūtā pienā
Fig. 10. The correlation between SCC and the species of staphylococci in organic milk

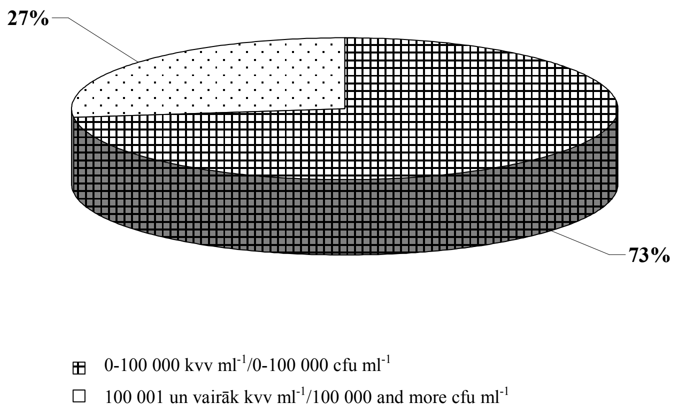
Somatisko šūnu skaita un stafilokoku sugas sakarība grafiski attēlota 10. attēlā. Korelācijas koeficients r<0,5 (0,296) liecina par vāju lineāro sakarību starp SŠS un stafilokoku sugu. Determinācijas koeficients ir R^2=0,088. Tas nozīmē, ka 8,8% somatisko šūnu skaita izmaiņas var skaidrot ar stafilokoku skaita izmaiņām atkarībā no stafilokoku sugas, tomēr ar šādu determinācijas koeficienta lielumu nevar meklēt sakarību, bet var aprakstīt tendenci. Abu koeficientu (b_0 un b_1) p-vērtības ir mazākas par 0,05, tātad ar varbūtību 95% var galvot, ka koeficienti nav vienādi ar nulli, līdz ar to tendence starp stafilokoku sugu un SŠS pastāv.

Ar 99% varbūtību būtiskākā atšķirība ir novērota ekopiena paraugos, no kuriem tika izolētas KNS vai KNS un *Staphylococcus aureus* asociācijas.

Lielākais somatisko šūnu skaita pieaugums tika novērots ekopiena paraugos, kuros tika izolēti *S.aureus* un KNS. Lielākais stafilokoku skaits pienā neatkarīgi no izolētās stafilokoku sugas ievērojamu somatisko šūnu skaita pieaugumu neizraisīja. Tātad pastāv vāja lineārā sakarība starp izolēto mikroorganismu sugu un somatisko šūnu skaitu pienā.

Koloniju veidojošās vienības ir rādītājs, pēc kura var spriest par sanitāri higiēnisko noteikumu ievērošanu fermā. Koloniju veidojošo vienību skaits bioloģiskajā lauksaimniecībā iegūtā pienā ir dots 11. attēlā.

Neskatoties uz augstajiem piena mikrobiālās kvalitātes rādītājiem, jāatzīmē, ka 27% ekopiena paraugu koloniju veidojošās vienības pārsniedza Eiropas Parlamenta un Padomes Regulā (EEK) 853/2004, ar ko nosaka īpašus higiēnas noteikumus attiecībā uz dzīvnieku izcelsmes pārtiku, noteikto pieļaujamo robežu – 100 000 ml^{-1}.



11. att. Bioloģiskajā lauksaimniecībā iegūtā piena paraugu sadalījums pēc koloniju veidojošo vienību skaita
Fig. 11. The distribution of organic milk samples by total plate count

Turklāt jāuzsver – lai nodrošinātu piena kvalitāti, nepietiek to īsā laika posmā (20–30 min) atdzesēt līdz +4+6 ºC. Piena sākotnējo kvalitāti nosaka sanitāri higiēnisko noteikumu ievērošana piena ieguves procesā, iekārtu tīrība un personīgās higiēnas noteikumu ievērošana. Tikai godprātīgs darbs un tīrība var šo pienu izcelt citās lauksaimniecības sistēmās iegūto govju piena vidū.

Aflatoksīns M_1. Bioloģiskajā lauksaimniecībā dzīvnieku barības sagatavošanā ir ierobežota konservantu lietošana. Bioloģiskajā lauksaimniecībā ir iespējams samazināt nezāļu un *Pyralidae* daudzumu, izmantojot augu seku u. c., bet palielinās iespējamība, ka govs barība tiek piesārņota ar aflatoksīniem. Rezultātā arī pienā nonāks aflatoksīns M_1. Tā saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā dots 8. tabulā.

8. tabula / Table 8

Aflatoksīna M_1 saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā piena paraugos
The level of aflatoxin M_1 in organic and conventional milk samples

Produkts / Product	Paraugu skaits / The number of samples	**Aflatoksīna M_1 saturs / The level of aflatoxin M_1, µg kg^{-1}**			
		Vidējais ± standartkļūda/ Mean± standard error	Min	Max	Maksimāli pieļaujamais*/ Permisible level*
Bioloģiskajā lauksaimniecībā iegūtais piens / Organic milk	11	0.0050± 0.0001	0.0040	0.0070	0.0500
Konvencionālajā lauksaimniecībā iegūtais piens / Conventional milk	11	0.0053± 0.0001	0.0040	0.0080	0.0500

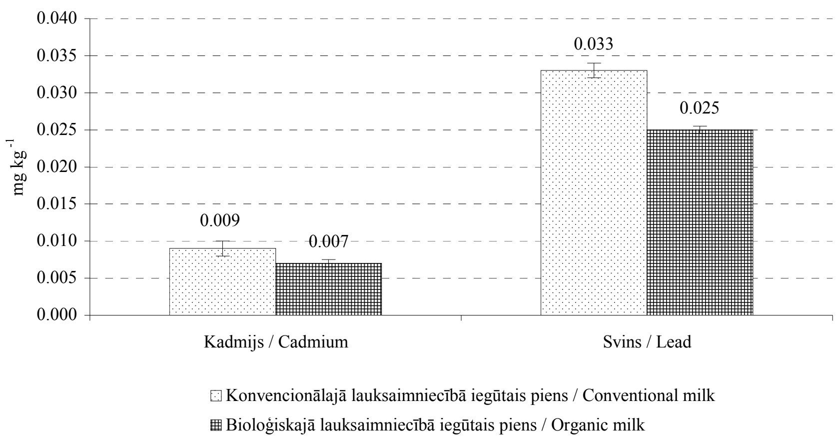
* EEK Regula 466/2001 / EU Regulation 466/2001

Iegūtie rezultāti parādīja, ka aflatoksīna M_1 saturs analizētajos piena paraugos nepārsniedza pieļaujamo robežu 0,05 µg kg^{-1}. Būtiska atšķirība ($p>0,05$) starp bioloģiskajā un konvencionālajā lauksaimniecībā iegūto pienu netika konstatēta. Iegūtie rezultāti sasaucās ar *Wyss* atzinumu, ka, saimniekojot ar dažādām metodēm, būtiskas atšķirības aflatoksīna M_1 saturā pienā nav. *Martini* savos pētījumos konstatējis, ka 92% gadījumu gan bioloģiskajā, gan konvencionālajā lauksaimniecībā iegūtais piens ir piesārņots ar aflatoksīnu M_1. Savukārt *Ghidini* apgalvo, ka ekopiena piesārņojums ar aflatoksīnu M_1 ir būtiski lielāks, salīdzinot ar konvencionālajā lauksaimniecībā iegūto pienu. To var izskaidrot ar vietu, kur tika veikti pētījumi, proti, Itālijā ir pietiekami mitrs un silts klimats, kas ir optimāls *Aspergillus flavus* vairošanās apstākļiem.

Iegūtie pētījuma rezultāti liecina, ka, maksimāli samazinot skābbarības sagatavošanai izmantoto konservantu daudzumu, ir iespējams iegūt skābbarību ar aflatoksīnu saturu, kas nepārsniedz EEK regulā 466/2001, ar ko nosaka atsevišķu piesārņotāju maksimālos pieļaujamos līmeņus pārtikas produktos, noteiktās maksimāli pieļaujamās robežas. Neatkarīgi no lauksaimniecības sistēmas laba lauksaimniecības, pārstrādes un uzglabāšanas prakse ir nepieciešama, lai maksimāli samazinātu pelējuma attīstības risku un piena piesārņojumu ar aflatoksīnu M_1.

Smagie metāli un mikroelementi pienā. Neatkarīgi no godprātīga darba un apkārtējās vides uzlabošanas pasākumiem, kas ir primāri bioloģiskajā lauksaimniecībā, arī šī sistēma un tās produkti nav pasargāti no gaisa, ūdens, augsnes piesārņojuma, proti, agrākā mantojuma, skābajiem lietiem, ozona cauruma u. c. Līdz ar to dažādu nevēlamu vielu, t. sk. smago metālu, klātbūtne ir novērojama arī bioloģiskā lauksaimniecībā iegūtā pienā.

Svina un kadmija saturs piena paraugos, kas ir iegūti atšķirīgās lauksaimniecības sistēmās, dots 12. attēlā.



12. att. Kadmija un svina satura salīdzinājums bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā
Fig. 12. The comparision of level of lead and cadmium in organic and conventional milk

Vidējais svina saturs bioloģiskajā lauksaimniecībā iegūtā pienā veidoja 0,025±0,002 mg kg^{-1}, savukārt konvencionālajā lauksaimniecībā iegūtā piena paraugos – 0,033±0,001 mg kg^{-1}. Abos gadījumos tika pārsniegta EEK regulā

466/2001, ar ko nosaka atsevišķu piesārņotāju maksimāli pieļaujamos līmeņus pārtikas produktos, noteiktās maksimāli pieļaujamās robežas (maksimāli pieļaujamā robeža – 0,020 mg kg^{-1}). Svina saturs ekopienā būtiski atšķīrās ($p<0,10$) no tā satura konvencionālajā lauksaimniecībā iegūtā pienā. Iegūtie rezultāti ir pretrunā ar *Ghidini* secinājumiem, ka svina saturs neatkarīgi no praktizētās lauksaimniecības sistēmas būtiski neatšķiras analizētā piena paraugos.

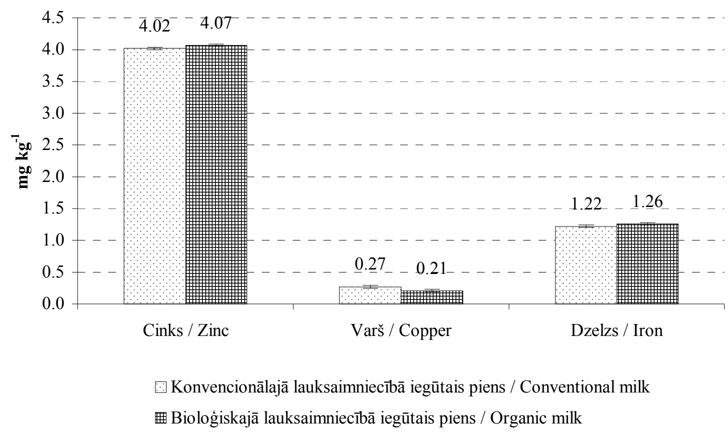
Galvenie svina piesārņojuma avoti ir industrija, rūpniecības un transporta izplūdes gāzes, degviela, kas satur svina savienojumus, dūmi un putekļi, kuri tiek radīti, kurinot ar gāzi, krāsas un laku rūpniecības izmeši. Piena piesārņojums gan konvencionālajā, gan bioloģiskajā lauksaimniecībā notiek caur piesārņotu lopbarību, kas, savukārt, audzēta ceļu vai rūpniecības uzņēmumu tuvumā. Govs organisms ir labs bioloģiskais filtrs, kas ar lopbarību uzņemto svinu asimilē lielākā mērā kaulos, nevis pienā.

Vidējais kadmija saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā piena paraugos bija attiecīgi 0,007±0,001 mg kg^{-1} un 0,009±0,001 mg kg^{-1}. Neatkarīgi no praktizētās lauksaimniecības sistēmas kadmija saturs bija ļoti mazs. Kadmijam, tāpat kā svinam, ir iespēja uzkrāties cilvēka organismā, tāpēc, regulāri lietojot uzturā pārtiku pat ar nelielu kadmija saturu, pastāv drauds patērētāja veselībai. Tomēr, salīdzinot ar svinu, precīzo toksiskuma līmeni kadmijam nav iespējams noteikt. Svarīgi ir, vai organismā notiek esošā kadmija absorbcija. Pirmkārt, tas ir atkarīgs no lietotā uztura sastāva, otrkārt, no kadmija komponentu klātbūtnes. Līdzīgi kā svina gadījumā, govs organisms darbojas arī kā bioloģiskais filtrs, rezultātā pienā nonāk tikai neliela daļa kadmija.

Cinka, vara un dzelzs saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā parādīts 13. attēlā.

Vidējais dzelzs saturs bioloģiskajā lauksaimniecībā iegūtā pienā bija 1,26±0,02 mg kg^{-1}, kas ir par 0,04 mg kg^{-1} lielāks nekā konvencionālajā lauksaimniecībā iegūtā piena paraugos – 1,22±0,03 mg kg^{-1}.

Vidējais vara saturs bioloģiskajā lauksaimniecībā iegūtā pienā bija 0,210±0,005 mg kg^{-1}, savukārt konvencionālajā lauksaimniecībā iegūtā piena paraugos – 0,270±0,007 mg kg^{-1}. Vara saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā piena paraugos būtiski atšķīrās ($p<0,05$). Iegūtie dati sasaucās ar Blūzmaņa pētījuma rezultātiem, kur bioloģiskajās saimniecībās esošo govju asins serumā, salīdzinot ar konvencionālajās saimniecībās esošajām, tika konstatēts lielāks dzelzs saturs – 38,20 mg%, savukārt mazāks vara saturs – 0,06 mg%.



13. att. Cinka, vara un dzelzs saturs bioloģiskajā un konvencionālajā lauksaimniecībā iegūtā pienā
Fig. 13. The comparison of the level of zinc, copper and iron in organic and conventional milk

Cinka saturs gan bioloģiskajā (4,07±0,08 mg kg^{-1}), gan konvencionālajā lauksaimniecībā iegūtā piena paraugos (4,02±0,08 mg kg^{-1}) būtiski neatšķīrās, tomēr ekopiena paraugos bija nedaudz lielāks (par 0,05 mg kg^{-1}) cinka saturs. Iegūtie rezultāti sasaucās ar Blūzmaņa pētījumiem, kurš konstatējis atšķirību starp cinka saturu govju asinīs, proti, bioloģiskās lauksaimniecības dzīvnieku asins paraugos 0,32 mg%, konvencionālās lauksaimniecības – 0,19 mg%.

Daži mikroelementi, piemēram, varš, dzelzs, cinks u. c. ļoti nelielā koncentrācijā ir nepieciešami organismu dzīvības procesu nodrošināšanai. Bieži vien tiek aizmirsts, ka lielākā koncentrācijā vai atrodoties organiskajos savienojumos tie var būt diezgan toksiski.

Gan bioloģiskajā, gan konvencionālajā lauksaimniecībā iegūtā pienā smago metālu, izņemot svinu, maksimāli pieļaujamais līmenis netika pārsniegts.

Iegūtie rezultāti pierādīja, ka atsevišķi piena sastāva (laktozes, tauku, IgM un laktoferīna) un kvalitātes rādītāji ir zemāki konvencionālajā lauksaimniecībā iegūtā pienā, tajā pat laikā bioloģiskajā lauksaimniecībā iegūtā pienā ir mazāks tiamīna, riboflavīna un IgA saturs, un tas nedod tiesības izcelt kādā no lauksaimniecības sistēmām iegūtā govju piena kvalitāti un noniecināt citu.

SECINĀJUMI

1. Konvencionālajā un bioloģiskajā lauksaimniecībā iegūtā pienā būtiski atšķiras atsevišķu uzturvielu saturs.
2. Skaitliski lielāko piena sastāvdaļu – laktozes un tauku – saturs bioloģiskajā lauksaimniecībā iegūtā pienā ir būtiski lielāks ($p<0{,}05$).
3. Bioloģiskajā lauksaimniecībā iegūtajā pienā tiamīna koncentrācija ir par 34,1% un riboflavīna – par 35,8% zemāka, salīdzinot ar konvencionālajā lauksaimniecībā iegūto. To var izskaidrot ar piena ieguves un uzglabāšanas procesu organizāciju un samazinātu kombinētās barības daudzumu dzīvnieku ēdināšanā bioloģiskajās saimniecībās.
4. Vidējais urīnvielas saturs bioloģiskajā lauksaimniecībā iegūtā pienā ir 167,4±9,6 mg kg^{-1}. 32% paraugu tas ir mazāks par literatūrā minēto minimālo robežu – 150 mg kg^{-1}, kas ir izskaidrojams ar samazinātu kombinētās barības devu, ko praktizē bioloģiskajās saimniecībās, ar zemāku govs produktivitāti un gadalaika ietekmi uz piena ķīmisko sastāvu.
5. Bioloģiskajā lauksaimniecībā iegūtā pienā konstatēto palielināto laktoferīna, imunoglobulīna M un lizocīma saturu var izskaidrot ar dzīvnieku piemērošanos apkārtējās vides nosacījumiem un organisma atbildes reakciju pret to.
6. Bioloģiskajā lauksaimniecībā iegūtā pienā prevalē *Staphylococcus aureus* (33%) un KNS (62%), kas atstāj būtisku ietekmi uz analizēto piena paraugu somatisko šūnu skaitu. Vairāk nekā 50% analizētā piena paraugu somatisko šūnu skaits pārsniedza 400 000 ml^{-1}.
7. Nepietiekami ievērojot higiēnas noteikumus bioloģiskajās saimniecībās, pat pienu strauji atdzesējot līdz +4+6 ºC, vidējais koloniju veidojošo vienību skaits pārsniedza 100 000 kvv ml^{-1} analizētajos piena paraugos.
8. Apkārtējā vide kā nopietns piena piesārņojuma radītājs ietekmē svina saturu abās lauksaimniecības sistēmās iegūtajā govju pienā, kas vairākkārt pārsniedza, bet vara, dzelzs, kadmija un cinka saturs pienā nepārsniedza likumdošanā noteiktās pieļaujamās robežas.

TOPICALITY OF THE RESEARCH

Organic agriculture as an independent sector in Latvia exists from the 20th century nineties. The aim of organic agriculture is to create an integrated, human and environmentally friendly, economically well – balanced agricultural system, which is based on renewable raw materials of a local origin. Organic agriculture protects the cultivated plants from pests and illnesses, and provides agricultural animals with high quality feed. By developing of organic agriculture it is possible to reduce the negative influence of agricultural technology on environment and to improve the quality of obtained products, because the use of pesticides, organic compounds, exciters for growing, veterinary drugs and antibiotics are restricted in organic agriculture. During the decrease of public trust in genetically modified products, as well as due to animal diseases, the demands for organic food and the interest in them increase.

During the last years, the demand for organic food and the number of consumers, who assign more attention for high quality food and would like to know how it is produced, are significantly increasing. Organic agriculture is characterized by clear basic principles and the transparency of product origin, production and processing. There are all the necessary conditions in Latvia for production of qualitative livestock products for the internal market and as well as for export: land suitable for agriculture, multi-breed animal herds and ecological situation.

Scientists from different countries have very contradictory opinions about the chemical composition and quality of organic milk. The evaluation of chemical composition and quality of organic milk and its comparison with conventional milk has not been performed in Latvia by now. There is also lack of objective and grounded information about organic milk quality. Therefore it is necessary to evaluate the organic milk quality in order to provide consumers with safe nutrients and to help organic farmers to develop organic food production.

After summarizing theoretical judgements and experimental data from literature, **the aim of the research work** was set as follows - to determine and to evaluate the quality of organic milk.

The **tasks of the research**:

1) to investigate the chemical composition of organic milk;
2) to determine content of IgA, IgG, IgM, lactoferrin and lysozyme in organic milk;
3) to investigate somatic cell count and the microbiological quality of organic milk ;
4) to determine the level of aflatoxin M_1 and heavy metals and trace elements (Cd, Zn, Pb, Cu, Fe) in milk;

5) to compare and to investigate the chemical composition and chemical contamination of organic milk and conventional milk.

Novelty of the research – the quality of organic milk in Latvia has been evaluated in complex, the concentration of antibodies in organic milk was determined for the first time. The potential differences of chemical composition of organic milk have been analysed and studied, taking as a basis feeding, namely, the data of composition of forage and cows' blood tests. Differences of chemical composition and quality of milk obtained from two various agricultural systems in Latvia have been explained.

The scientific importance of the research – the chemical composition, including the content of calcium, IgA, IgG, IgM, lactoferrin and lysozyme and urea was investigated, the microbiological quality of organic milk and somatic cell count was established, the evaluation of chemical contamination of organic milk was carried out. The research results show that it is possible to get milk with normal chemical composition without using food additives.

The economic significance of the research – the quality of organic milk is evaluated and this evaluation enables to make grounded conclusions about the significance of organic milk in consumers' diet.

APPROBATION OF THE RESEARCH WORK

The results have been presented at six international scientific conferences, symposiums and congresses in Latvia (Latvia University of Agriculture), Slovenia, Poland, Turkey, Hungary and Greece (see the list on pages 5-6)

The research results are reflected in six established and reviewed scientific publications in Latvian and English, three of them are published in the editions approved by international external and Latvian Council of Science. The list of publications is presented on page 6.

MATERIALS AND METHODS

The research work was being performed from October 2003 till November 2006. During 2006, the data were summarized and statistically processed, and the Doctor Thesis was prepared.

The researches were made at:

- Latvia University of Agriculture, Faculty of Food Technology, Scientific - Research Laboratory,
- Latvia University of Agriculture, Department of Chemistry, Laboratory of Water Analysis,
- Latvia University of Agriculture, Research Laboratory of Agronomy Analysis;

- Latvia University of Agriculture, Institute of Biotechnology and Veterinary Medicine „Sigra", Microbiological Laboratory of the Department of Veterinary Medicine;
- University of Latvia - Institute of Biology, The Laboratory of Biochemistry and Physiology of Animals,
- Riga Center of Reproduction,
- JSC „Sigulda station of breeding and artificial insemination",
- The Laboratories of National Diagnostic Centre at the Food and Veterinary Service.

The organic milk, conventional milk and milk obtained during transitional period (in further – the transitional period milk) were obtained from the farms "Lejasrembeni", "Jaunbiteni", „Kalna Gauriņi", "Alejas", „Cemuri", which are located in Ķeipenes rural district, Ogres region. Individual milk samples were collected from Riga, Cesis, Jelgava and Bauska region farmers.

Milk samples from different breeds of cows were used for the research: 61% of *Latvian Brown*, 2% of *Holsteins Black* and 37% crosses of *Latvian Brown* and *Holsteins Black*. There are sufficient researches about the influence of cow's breed on the milk composition and quality; therefore the factor of breed was not taken into consideration in this work.

Considering the huge amount of the analyzed milk samples, all investigated parameters were not detected for all milk samples. To evaluate the significant difference, the parameters were randomly arranged; parameters were detected for three duplications, the mean value of parameters was calculated.

The number of analysed milk samples and standards of analysis are given in Table 1.

The mean of protein, fat, lactose and somatic cell count in organic milk was determined and compared with the data for the same time period from Latvia's State Agency "Agricultural data centre" (Table 2).

There is only one company, which processes organic milk in Latvia, and the company is located at Ķeipenes rural district, Ogres region. The organic milk for this company is delivered by the following farms: "Lejasrembeni", "Jaunbiteni", „Kalna Gauriņi", "Alejas". Taking into consideration that the amount of organic milk obtained from the mentioned farms is 100% from all organic milk processed in Latvia, the analyzed quality factors will enable to consider the organic milk quality in Latvia (in this connection the number of the analysed milk samples could be assumed as the general multitude).

The data were processed by using the SPSS software package SPSS 11.0. and MS EXCEL.

RESULTS AND DISCUSSION

The evaluation of chemical composition of organic milk

According to the data in literature, when changing the agricultural system (from conventional to organic), animal keeping conditions and feed composition, synthesis of the main chemical components in organic milk and their content in the product are influenced to a great extent.

The content of lactose, protein and fat in organic milk and conventional milk is given in Table 3.

The mean content of **lactose** in organic milk samples was 4.85±0.04%, it significantly differs ($p<0.05$) from those of conventional milk. The results of research relate to *Olivo* statement that the content of lactose in organic milk is significantly higher. At the same time, the research results do not conform to *Byström's, Toledo – Alonzo's* research results, where the authors affirm, that the content of lactose in organic and conventional milk have no significant difference.

The content of lactose in milk is the least subjected to changes. The higher content of lactose in organic milk can be explained by the higher concentrations of sugar in feed grasses of organic farms.

The mean content of **protein** in organic milk was 3.30±0.04%, which is not significantly different from conventional milk ($p>0.05$).

The research results relate with *Haggar, Kristensen, Byström, Mogensen, Toledo-Alonzo* and *Ellis,* that the content of protein in organic and conventional milk samples have no significant difference. The obtained results conform to the results of research where the total amount of proteins in blood of the cows treated by organic farming was less in comparison to those of conventional - 7.74±0.07% and 8.54±0.09% accordingly. The research results contradict with *Olivo* statement that the content of protein is higher in conventional milk samples. It is not strange, that different results have been reported regarding to the protein content of organic milk, since organic milk production varies in feeding regimes. The reason for lower content of protein can be lack of sugar-rich juicy feed, which stimulates production of butyric acid used for protein synthesis. At the same time, according to *Bluzmanis's* research results, the sugar content in feed grasses obtained from organic farms is higher.

The mean content of **fat** was 4.98±0.08%; which is significantly higher than in conventional milk samples.

The research results contradict with *Kristensen, Mogensen, Toledo-Alonzo, Olivo* statement that fat content is higher in conventional milk. *Haggar, Byström, Ellis* found no significant difference between the organic and conventional milk samples.

The higher content of fat in organic milk could be explained with the differences in keeping and feeding conditions: high quality feed, well balanced and rich in cellulose, not chopped, in sufficient amount was available in organic farms; cows were always milked.

The content of **urea** is influenced by following factors: feed composition and dose, the weight of cows, milk yield, season, month and lactation period. The content of urea in organic milk samples is shown in Figure 1.

The urea content in organic milk samples ranged between 64.90 and 252.56 mg kg^{-1}. The mean content of urea in the analyzed organic milk was 167.43±9.64 mg kg^{-1}, which fitted in the common limits set for milk - from 150 to 300 mg kg^{-1}. In 32% of organic milk samples the content of urea was for 29.6 mg kg^{-1} lower than the minimum limit - 150 mg kg^{-1}. Only 8% of analysed organic milk samples did not fit within *Rajala – Schultz* data limits from 103 mg kg^{-1} to 154 mg kg^{-1}.

The research results relate with *Toledo – Alonzo* results, where the author determines a significant difference in the content of urea in milk from different agricultural systems. The difference between the urea content in organic and conventional milk samples can be explained by stricter rules regarding to the amount of mixed feed allowed in organic farms in comparison with the conventional farms – accordingly 40% and up to 65% of the dry matter daily.

The higher amount of mixed feed allowed has a negative influence on paunch function and milk production.

The lower production intensity in organic farms, what *Jemeljanovs*' research results affirm, should be a possible explanation of the low milk urea level in organic milk found in this study.

As livestock specialists suppose, the content of urea in milk should be till 150 mg kg^{-1}, otherwise it can burden insemination and reproduction. It means that from this point of view, the urea content in organic milk samples is normal.

The lower content of urea in 32% of organic milk samples could be explained by a low content of soluble nitrogen in feed and by the influence of seasonal changes in milk. The lowest content of urea, according to *Godden's* data, is from April to June. The *Dursts's* research shows that the normal content of protein that was found in organic milk – 3.18%, and low content of urea could be explained by the decreased content of total protein in feed. At the same time, according to *Bluzmanis's* research results, the total protein content in feed grasses obtained from organic farms is higher – 3.26±0.21% in comparison with the conventional – 2.99±0.30%.

Hojman notifies that the content of urea in milk correlates with fat content in milk. To verify this *Hojman*'s statement, the regression analysis was used. The correlation coefficient was 0.246, which pointed to a weak connection. The factor - fat content in milk is not significant ($p>0.05$) for the changes of urea content in milk, it means that the model is not statistically significant.

Within the framework of this research, the correlation between the urea and fat content was not found.

The content of **calcium** in milk is influenced by feed components, season and the physiological factors of animal. The content of calcium in milk samples is shown in Table 4.

The content of calcium in organic milk samples ranged between 20 and 25 mmol l^{-1}, the mean content of calcium was 21.90±0.22 mmol l^{-1}. However, a statistically significant difference in the content of calcium between the organic and the conventional milk samples was not found – 20.80±0.32 mmol l^{-1}. The mean content of calcium in milk samples from different agricultural systems was significantly lower if compared with the data from literature ($p<0.05$) – 30 mmol l^{-1}.

Gorbatova mentions that the content of calcium in milk obtained in summer period, is lower in comparison with milk samples obtained in winter, it could explain the decreased calcium content in milk samples taken in summer and autumn months, and it influences also the mean. A lower content of calcium could be caused by mastitis, the content of calcium can decrease then for 9%.

The content of calcium in milk increases in the following order: from conventional to organic agriculture. No significant difference in content of calcium ($p>0.05$) in organic and conventional milk samples was found. The cows kept in organic agriculture did not get mineral additives, so boosting of their immunity was connected only with facilitation of natural self-regulation processes. By means of that it is possible to achieve the same results as in the conventional agriculture, where animals are treated, without prophylaxis of any disease.

Bluzmanis notes that the relation between calcium and phosphorus in blood serum from organic cows is better (2:1) then from the conventional ones (2.27:1).

Within the framework of research the content of **thiamin** (Table 5) and **riboflavin** (Table 6) in milk was determined.

The content of thiamin ranged between 0.20 to 0.32 mg l^{-1}. The content of thiamin in organic milk samples was for 34.1% lower if compared with the conventional milk and it was significantly lower ($p<0.05$) in comparison with the data from literature and conventional milk. The content of thiamin in conventional milk was 0.41±0.01 mg l^{-1}, it conforms to the data from literature.

The parameters of content of riboflavin in milk are given in Table 6. The content of riboflavin in organic milk ranged from 1.28 to 2.96 mg l^{-1}. The mean content of riboflavin in organic milk still was 1.70±0.10 mg l^{-1} and it was for 35.8% lower than in conventional milk, so a statistically significant difference between the organic and conventional milk samples ($p<0.05$) was found. When comparing the parameters available in literature, no significant difference was established. The content of riboflavin in conventional milk was 2.65±0.10 mg l^{-1}, which significantly differs from the data in literature ($p<0.05$).

Many authors have pointed that the content of thiamin and riboflavin do not vary in different seasons and that the feed composition has no significant influence on it. However there is still a possibility that feed can influence the content of thiamin and riboflavin in milk, especially if the feed is rich in grain and flour. The decreased dosage of mixed feed, used in organic farms, can negatively influence the content of thiamin and riboflavin in organic milk. While decreasing the dosage of mixed feed in organic farms, a lower concentration of thiamin and riboflavin in milk was established. Light contributes to decrease of the concentration of riboflavin in milk, therefore milking and pretreatment organization in organic farms is one of the most significant factors, which impact the concentration of this vitamin.

The research results do not enable to raise the organic milk above any other milk obtained in other agricultural systems. Very often the organic farmers emphasize the wholesomeness and higher concentration of vitamins in organic products, however, the research results on the content of thiamin and riboflavin in organic milk do not prove it. It is very important hence the EU Regulation about food wholesomeness comes into force in Latvia. Any claim about higher concentration of vitamins and other substances in a product should be confirmed by research results. It is important for organic farmers too. The research results will help to make the accent and to popularise production of environmentally friendly and natural products.

Within the framework of research, the correlation between concentration of thiamin and riboflavin was proved. The correlation between the concentration of thiamin and riboflavin is shown in Figure 2.

The correlation coefficient $r>0.5$ (0.68) testifies, that there is a linear correlation between the concentration of thiamin and riboflavin. The p–value <0.05, it means, if the concentration of thiamin increases, the concentration of riboflavin increases as well, and vice versa. At the same time, this model cannot be used for forecasting of concentration of vitamins, because the determination coefficient is low ($R^2=0.47$), which is an evidence of a significant influence of other factors.

After evaluation of the chemical composition of organic milk, it was determined that the content of lactose and fat has significant difference ($p<0.05$) if compared with conventional milk. The concentration of calcium in milk samples, obtained from different agricultural systems, compared with data from literature, was significantly lower ($p<0.05$). The concentration of thiamin and riboflavin in organic milk was significantly lower ($p<0.05$), in comparison with conventional agriculture. Research results show, if the agricultural system converts from conventional to organic, the concentration of separate nutrients will convert too.

The evaluation of concentration of antibodies in organic milk

The concentration of immunoglobulins in milk is influenced by a variety of factors, including age, health status and stage of lactation.

The concentration of **IgA** varies from 0.42 to 2.32 g l^{-1} and it has significant differences ($p<0.05$) in milks, obtained from different agricultural systems. The higher concentration of IgA was observed in conventional milk – 1.12±0.07 g l^{-1}. The widest range of concentration of IgA was determined in milk, obtained from transitional period.

The concentration of IgA in milk samples decreases in the order: conventional → transitional period → organic agriculture (Figure 3). The mean concentration of IgA in organic milk was 5.5 times higher, in comparison with the data from literature (0.13 g l^{-1}). The concentration of IgA in milk obtained from transitional period and conventional agriculture was 6.9 and 8.6 times higher, relatively it could testify the mastitis problems in farms, where milk samples were obtained. The high concentration of IgA in conventional milk can relate with cows' vaccination, what is used in this agricultural system. The increased concentration of IgA was not related with mastitis, because milk samples were selected in such way, to eliminate the possibility to analyse milk samples obtained from mastitis cows. The conductivity of milk was detected and the conductivities parameters were used for selecting milk samples for analyses.

The dispersion analysis was used for comparing IgA concentration in milk samples, obtained from different agricultural systems. A significant difference ($p<0.05$) was determined in concentration of IgA in milk samples obtained from organic and conventional milk.

The concentration of **IgG** in milk increases in order: conventional to transitional period and organic agriculture (Figure 4). The concentration of IgG (g l^{-1}) in milk samples obtained from agricultural systems was according to the data from literature – 0.15–0.80 g l^{-1}. The concentration of IgM has not significant difference in milk samples.

The mean concentration of **IgM** in organic milk was the highest - 1.65±0.07 g l^{-1} and comparing with milk obtained from transitional period and conventional agriculture did not have the wide range results. The concentration of IgM increases in order: conventional → transitional period → organic agriculture (Figure 5). The concentration of IgM was significantly higher in organic milk ($p<0.05$). The mean concentration of IgM in milk samples from different agricultural systems was significantly higher ($p<0.05$) in comparison with the data from literature 0.04–1.00 g l^{-1}.

Repeatedly increased IgM concentration in cows' blood could be explained as a reaction of inflammation. The concentration of IgM in blood and in milk is not proportional, therefore the increased concentration of IgM in milk could not be considered as the adverse body reaction caused by pathogens.

Increased concentration of immunoglobulins in milk could be evaluated as positive, because recently the interest for cows' immunization with aim to maximize antibodies concentration in milk has increased.

The concentration of **lactoferrin** was from 0.030 to 0.071 g l^{-1}. The concentration of lactoferrin increases in order: conventional → transitional period → organic agriculture (Figure 6.). There is a significant difference ($p<0.05$) in the concentration of lactoferrin in milk from different agricultural systems. The concentration of lactoferrin in organic milk samples (0.03 g l^{-1}) was 1.5 times higher in comparison with conventional milk samples (0.02 g l^{-1}).

The concentration of lactoferrin in milk obtained from different agricultural systems was from 0.020 to 0.350 g l^{-1}, according to data from literature. The increased concentration of lactoferrin in organic milk was not related with mastitis, it was caused by other factors: cows keeping conditions, immunity boosting measures and others. Lactoferrin inhibits microorganisms, such as coliforms and others, for a high concentration of iron ions is required for existence and reproduction of these microorganisms. Thus a high concentration of lactoferrin in organic milk indicates the role of a potential antimicrobiological agent in raw material.

The concentration of **lysozyme** in milk samples obtained from different agricultural systems was in a wide range from 0.02 to 0.77 mg l^{-1}.

The concentration of lysozyme is important parameter of milk quality; it impacts milk storage duration and milk processing. Lysozyme is termostable, 75% from lysozyme activity preserves after milk heating up to 75 °C 15 min or 80 °C 15 s. It means that in pasteurised milk the concentration of enzyme is sufficient for limiting development of microorganisms and for preserving milk quality. Although there was not found significant difference between organic and conventional milk samples, but there was marked tendency, the concentration of lysozyme increases in order: conventional → transitional period → organic agriculture (Figure 7). The research results show, that the concentration of lysozyme in organic milk is considerable, as antibody providing milk quality in due time.

The obtained results could be explained by different agricultural systems, where farmers used different methods for cow's immunization. The cow's vaccination is used in conventional agriculture, but organic system is based on cow's natural immunity fortification without using medicaments. As a result, the concentration of antibodies in milk were different.

The evaluation of microbiological and chemical contamination of organic milk

The somatic cell count, total plate count, the concentration of cadmium, lead, copper, iron, zinc and the level of aflatoxin M_1 were determined in this research.

Somatic cell count (SCC). Antibiotics and other medicine are forbidden in regular feedstuffs at organic farms, including antibiotic usage for mastitis treatment, disinfection agent usage is restricted too. All this measures can cause the decrease of somatic cell count and wide spectrum of mastitis agents in milk. The dispersion of somatic cell count in organic milk is presented in Figure 8.

47.8% of organic milk samples fitted within the limits of Regulation (EEC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for the hygiene of foodstuffs. However 52.2% of milk samples showed the somatic cell count more than 400 000 ml^{-1}, including 25.0% SCC – above 1 000 000 ml^{-1}.

The somatic cell count in organic milk ranged between 4 000 to 1 413 000 ml^{-1}, the mean SCC was 351 123±40 057 ml^{-1}, it was lower than in conventional milk samples at the same time period – 391 000 ml^{-1}.

Norman and *Schaik* consider, that somatic cell count in milk obtained from healthy cows is not more than 200 000 ml^{-1}, *Konosonoka* mentions in her research, that SCC in healthy cow's milk is 300 000 ml^{-1}. A higher somatic cell count is a measure for the prevalence of mastitis in a dairy herd and is used by regulatory agencies as an indicator of the wholesomeness, safety and suitability of raw milk for human consumption.

The main factor, which influences somatic cell count, is the state of cow's health. In organic agriculture the use of antibiotics for mastitis treatment is restricted. The restriction on antibiotics may lead positively to a more intensive health promotion and disease prevention efforts, and to consequent and early intervention in the case of disease. In this way it is possible to decrease number of antibiotic resistant bacteria in udder and in milk.

Furthermore, the cows' vaccination, using different vaccines, for example *Staphylococcus aureus* and others, increases. As a result some cause of mastitis is eliminated, but other multiply easy. Today there is not prevalent vaccine for mastitis prevention and in the near future will not be. In the nature nothing disappears and changes. Always the role of some microorganisms causing mastitis will replace and take other, therefore for mastitis treatment and prevention is necessary to look other ways, and resignation from antibiotic use is not considered as anomaly. Moreover, if this method will help to limit potential mastitis pathogens, it will be only positive solution.

On the other hand the restrictions on antibiotic use may negatively lead to a non-treatment policy, where animals requiring treatment will not be treated, as result the somatic cells count is higher than in this case.

The staphylococci percentage of distribution in organic milk samples is shown in Figure 9.

From the obtained results it is possible to conclude, that milk samples with increased number of staphylococci (above 2 000 cfu ml^{-1}) can testify about cow's mastitis. Some of coagulase negative staphylococci (CNS) strains were identified for clarifying main cause of mastitis in organic farms.

For isolates percentage, *Staphylococcus aureus* was isolated in 34% and CNS – 63% of analysed organic milk samples. From organic milk samples *Staphylococcus* strains were not isolated in 5 cases. Some of CNS strains were identified (Table 7).

Results have shown that coagulase negative staphylococci and *Staphylococcus aureus* have the leading role for initiate of mastitis in organic milk, what is related to *Smolder's* research results, where the main microorganisms prevailing in organic and conventional milk samples were CNS, respectively, 46.0 % and 40.9%, *Staphyloccocus aureus,* respectively, 15.8% and 18.6%.

Somatic cell count in milk is influenced by many factors. *Bluzmanis* considers that the increasing somatic cell count has a correlation with the amount of staphylococci.

The correlation coefficient $r<0.5$ (0.204) testifies about weak linear correlation between somatic cell count and staphilococci count. B_0 coeficient's p – value (0.051) is higher than 0.05, therefore coefficient is equal to zero. It means that in this research correlation between SCC and the number of staphylococci was not found.

Not always the amount of staphylococci influences the increase of amount of somatic cell count in milk. SCC depends on the nature of mastitis causes, aggression and other factors. The other authors' researches verify that there is the correlation between *Staphylococcus aureus* and somatic cell count in milk. At the same time many CNS can cause clinical mastitis, without the rapid increase of somatic cell count. Therefore, for getting objective research results, it was necessary to look for correlation between pathogens and SCC.

The correlation between somatic cell count and *Staphylococcus* species is shown in Figure 10. The correlation coefficient $r<0.5$ (0.296) testifies about weak linear correlation between SCC and *Staphylococcus* species. The determination coefficient (R^2) is 0.088. It means that in 8.8% cases the changes of somatic cell count could be explained with the changes of amount of staphylococci depending on species of staphylococci. In this case it is not possible to find a correlation, but it is possible to describe the tendency.

p – value of coefficients (b_0 and b_1) was less than 0.05. With probability 95% it could be asserted, that b_0 and b_1 coefficients value is not zero, therefore tendency between SCC and staphylococcus species exists.

With probability of 99% somatic cell count is significantly different in organic milk samples, where CNS and CNS and *Staphylococcus aureus* were isolated.

The highest increase of somatic cell count was in organic milk samples from which *S.aureus* and CNS were isolated. The highest count of staphylococci in organic milk, independently from staphylococci species, did not cause a significant increase of SCC. There is a weak linear correlation between the isolated microorganisms and SCC in milk.

The total plate count is a parameter, which helps to consider the hygienic conditions in the farms. The total plate count in organic milk samples is presented in Figure 11.

Despite the high microbiological quality of organic milk, 27% of organic milk total plate count did not fit within the limits of Regulation (EEC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for the hygiene of foodstuffs – 100 000 cfu ml^{-1}.

In addition, for ensuring high quality milk, it is not enough to cool milk till +4+6°C in a short period of time (20 – 30 min). The initial quality of milk depends on: observing sanitary – hygienic rules during milking, cleanness of equipment and observation of personal hygienic rules. Only honest job and cleanness can make organic milk better than milk obtained from other agricultural systems.

Aflatoxin M_1 (AFM_1). Of course, if there is a restricted usage of the preservatives for preparation of feed in organic agriculture, the risks linked to aflatoxins contamination could be higher in organic production than in conventional production. It appears that there are both advantages and disadvantages, regarding the aflatoxins problem in organic agriculture. Among the advantages included the use of less nitrogen in organic agriculture, and also the use of organic nitrogen. The disadvantages are that, since no herbicides are used in organic farming, there are more weeds, as well as the presence of *Pyralidae*. However, in organic agriculture it is possible to reduce the presence of weeds and *Pyralidae*, by using crop rotations and other agronomic practices.

The level of alflatoxin M_1 in organic and conventional milk samples is given in Table 8.

The obtained results have shown that no AFM_1 values exceeded the permissible level - 0.05 µg kg^{-1} in organic and conventional milk. The study relating to AFM_1 in milk samples found no significant differences ($p>0.05$) between organic and conventional milk. The research results relate with *Wyss's* statement, that the level of alfatoxin M_1 has no significant difference in organic and conventional agriculture obtained milks. *Martini* established that 92% of organic and conventional milk samples were contaminated with aflatoxin M_1. *Ghidini* affirms that the contamination of organic milk with aflatoxin M_1 is significantly higher in comparison with conventional milk.

The research results show, it is possible to get silage with the level of aflatoxin M_1, which does not exceed the maximum levels for certain contaminants in foodstuffs set by Regulation (EC) No 466/2001, maximally decreasing usage of preservatives for feed preparation in organic agriculture.

For producing safe milk for human consumption, the adopting preventive measures, as good agricultural, processing and storage practice, is necessary.

Heavy metals and trace elements. Organic methods are used to minimize pollution of air, soil and water, although they cannot ensure that products are completely free of residues, because of general environmental pollution, including acid rain, ozone hole and other. There are many of chemical hazards associated with foods. Contaminants in animal feeds, such as agricultural and industrial chemicals, heavy metals and other, can give rise to safety hazards in food of animal origin. However, as mentioned above, organic agriculture does not reduce level of persistent environmental pollutants in organically grown products. These may therefore be present in organic feedstuffs and hence in organic food of animal origin.

The concentration of lead and cadmium in milk samples, obtained from different agricultural systems is given in Figure 12.

Means values of ***lead*** concentration in organic and conventional milk samples were 0.025±0.002 mg kg^{-1} wet weight and 0.033±0.001 mg kg^{-1} wet weight. In both cases maximum permissible level for such product (0.020 mg kg^{-1} wet weight) determined by Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs was exceed. The concentration of lead in organic and conventional milk have significant difference ($p<0.10$). The research results are in conflict with *Ghidini* conclusions, that there is no significant difference in the concentration of lead in organic and conventional milk.

The main sources of lead pollution in the environment are: industrial production processes and their emissions, road traffic with leaded petrol, the smoke and dust emissions of gas-fired power stations, the laying of lead sheets by roofers as well as the use of paints and anti-rush agents. The lead contamination in organic and conventional milk samples could happen due to feeding the cows with fodder collected from along the road sides'. The cow acts as a very effective biological filter diverting lead from her feed to her bones rather than to her milk.

The mean concentration of ***cadmium*** in organic and conventional milk samples was 0.007±0.001 mg kg^{-1} and 0.009±0.001 mg kg^{-1} wet weight. The cadmium content in organic and conventional milk samples was very low and fairly constant in all types of milk. Cadmium, like lead, is a cumulative poison, i.e., the danger lies primarily in the regular consumption of foodstuffs with low contamination. However, in contrast with lead, the definition of an exact toxicity limit is not possible for cadmium. The decisive point is whether absorption of the existing cadmium actually takes place. This is, firstly, dependent upon the composition of the diet as a whole and, secondly, on the bio-availability of the cadmium compound present. Again, as with lead, the cow acts as an effective biological filter and the proportion of ingested cadmium finding access to milk is extremely small.

The concentration of iron, copper and zinc in milk samples, obtained from different agricultural systems is given in Figure 13. The concentration of ***iron*** in organic and conventional milk samples was 1.26±0.02 mg kg^{-1} wet weight, what is for 0.04 mg kg^{-1} wet weight higher in comparison with conventional milk – 1.22±0.03 mg kg^{-1} wet weight.

The mean concentration of ***copper*** in organic milk was 0.210±0.005 mg kg^{-1} wet weight, in conventional milk – 0.270±0.007 mg kg^{-1} wet weight. The significant difference between organic and conventional milk samples was established ($p<0.05$). The research results relate *Bluzmanis* results, where author found in blood serum, obtained from organic cows, in comparison with conventional, higher concentration of iron – 38.20 mg%, however lower concentration of copper – 0.06 mg%.

There is not found significant difference between the concentration of ***zinc*** in organic and conventional milk, but the concentration of zinc in organic milk for 0.05 mg kg^{-1} wet weight was higher if compared with conventional milk samples. The research results relate to *Bluzmanis* research results, who determined the higher concentration of zinc in organic milk 0.32 mg%, in comparison with conventional - 0.19 mg%.

Some heavy metals (the so-called trace elements) are essential in very small concentrations for the survival of all life forms, for example, copper, iron, zinc and others. Despite this fact, it is often forgotten that in some circumstances, in higher concentrations, these can also be quite toxic, for example, when they are present in an organic compound.

The legally accepted upper limits for different heavy metals except lead though are not exceeded by any analysed milk sample, not even from conventional bulk milk.

The obtained results verify, that separate parameters of milk chemical composition (lactose, fat, IgM and lactoferrin content) and quality is higher in organic milk samples, at the same time the content of thiamin, riboflavin and IgA is higher in conventional milk. This does not allow to highlight or to slight the quality of milk obtained from one or other agricultural system.

CONCLUSIONS

1. The concentration of separate nutrients in organic milk compared with conventional milk is different.
2. Statistically significant differences ($p<0.05$) between organic and conventional milk were found in content of largest milk component: fat and lactose.
3. The concentration of thiamin and riboflavin was for 34.1% and 35.8%, lower in comparison with conventional milk. It is explained with organisation of milking and milk storage process and with low concentration of silage used in organic herds.
4. The mean content of urea in organic milk was 167.4±9.6 mg kg^{-1}. In the 32% of organic milk samples the urea content was lower in comparison with the data from literature – 150.0 mg kg^{-1}. It is explained with restrictions regarding the amount of concentrate allowed, lower milk yields in organic farms and influence of season on milk chemical composition.
5. Higher concentrations of lactoferrin, IgM and lysozyme in organic milk could be explained by adaptation of cows to the environmental conditions and the response of their body to it.
6. *Staphylococcus aureus* (33%) and CNS (62%) prevail in organic milk. It has significant influence on the somatic cell count. Somatic cell count exceed 400 000 ml^{-1} in more than 50% of analysed milk samples.
7. The mean total plate count exceeds 100 000 cfu ml^{-1}, in the analysed samples, even if, cooling milk till +4+6°C. In general, the hygienic conditions on the farms are the main cause of the high total plate count in milk.
8. The environment, as significant pollution parameter, influences the concentration of lead in organic and conventional milks, which is higher several times than it is legally permissible. Copper, iron, cadmium and zinc concentrations have not exceeded permissible level in legislation.

TOPICALITY OF THE RESEARCH

Organic agriculture as an independent sector in Latvia exists from the 20 century nineties. The aim of organic agriculture is to create integrated, human and environmentally friendly, economically well – balanced agricultural system, which rests on origin renewable raw materials. Organic agriculture protects cultivated plant from pests and illness, and provides animals with high quality feed. The developing of organic agriculture make possible to reduce agriculture's negative influence on environment and to improve quality of products. Because the use of pesticides, organic compounds, exciter for growing, veterinary drugs and antibiotic in organic agriculture are restricted. During decreasing public trust for genetically modified products, animals' diseases, demands and interests for organic food is increasing.

During the last years demand for organic food and the number of consumers, who assign more attention for high quality food and would like to know how it is produced, are significantly increasing. Organic agriculture is characterized by clear basic principles and transparency of product origin, producing and processing. There are all necessary conditions for producing qualitative livestock products for internal market and for export: land suitable for agriculture, chiselled multi-breeds animal herds and ecological situation.

Scientists from different countries have very contradictory opinions about the chemical composition and quality of organic milk. The evaluation of chemical composition and quality of organic milk and comparison with conventional milk in Latvia at the present are not performed. It is the lack of objective information about organic milk quality. Therefore it is necessary to evaluate organic milk quality for insuring consumers with safety nutrients and to help organic farmers to develop organic food production.

After summarizing theoretical adjudgements and experimental data from literature, the **aim of the research work** was set as follows - to determine and to evaluate quality of organic milk.

The **following objectives** are advanced to achieve the set aim:

1). to determine and to investigate the chemical composition of organic milk;

2). to analyse the level of aflatoxin M_1, heavy and trace metals (Cd, Zn, Pb, Cu, Fe) concentration in organic milk;

3). to investigate microbiological quality of organic milk;

4). to determine immunoglobulins: IgA, IgG, IgM, lactoferrin and lysocyme concentration in organic milk;

5). to compare and to investigate the chemical composition and chemical contamination of organic milk with conventional milk.

Novelty of the research – the quality of organic milk in Latvia has been evaluated in complex, at the first time the concentration of antibodies in organic milk was determined. The potential differences of chemical composition of organic milk have been analysed and studied, building on feeding, namely, on composition of forage and cows' blood analysis. Differences of chemical composition and quality of milk obtained from two various agricultural systems in Latvia were explained.

The scientific significance of the research – the chemical composition, including content of calcium, antibodies (IgA, IgG, IgM, lactoferrin and lysocyme) and urea was investigated, the microbiological quality of organic milk was evaluated, the chemical contamination of organic milk was carried out. The research results show, that it is possible to get milk with normal chemical composition without using prophylactic to fortify animal's immunity and feed additives.

The economic significance of the research –organic milk's quality is evaluated and this evaluation enables to make justly conclusions about organic milk significance in consumer's diet.

APPROBATION OF THE RESEARCH WORK

The results have been presented at the six international scientific conferences, symposiums and congress in Latvia (Latvia University of Agriculture), Slovenia, Poland, Turkey, Hungary and Greece (see the list on pages 5-6)

The research results are reflected in six established and reviewed scientific publications in Latvian and English, all of them are published in the editions approved by international external and Latvian Council of Science. The list of publications is presented on page 6.

MATERIALS AND METHODS

The research work has being performed during 2003 October till 2006 November. During the 2006 the data was summarized and statically processed and the doctor thesis was prepared.

The researches were made:

- In Latvia University of Agriculture the Department of Food Technology The Scientific - Research Laboratory,
- In Latvia University of Agriculture the Department of Chemistry The laboratory of Water Analysis,
- In Latvia University of Agriculture Research laboratory of Agronomy Analysis;

- In Latvia University of Agriculture, Institute of Biotechnology and Veterinary Medicine „Sigra” in Microbiological laboratory;
- In University of Latvia Institute of Biology,
- In Riga Center of Reproduction,
- JSC „Siguldas station of breeding and artificial insemination”,
- In National Diagnostic Centre at the Food and Veterinary Service.

Organic milk, conventional milk and milk obtained from transitional period (forward - transitional period milk) were obtained from the farms ”Lejasrembēni”, ”Jaunbiteni”, „Kalna Gauriņi”, “Alejas”, „Čemuri”, which are located in Ķeipenes rural district, Ogre’s district. Individual milk samples were taken from Riga, Cesis, Jelgava and Bauska region’s farmers.

The 61% of Latvian Brown, 2% of Holsteins Black and 37% crosses of Latvian Brown and Holsteins Black were used for the research. There are sufficient researches about the influence of cow’s breed on the milk composition and quality; therefore the factor as breed was not taken to consideration.

Considering a huge amount of milk samples, all investigated parameter were not detected for all milk samples. To evaluate the significant difference, the parameters were randomly arranged; parameters were detected for three duplications, the mean value of parameter was calculated.

The number of analysed milk samples and standards of analysis are given in Table 1.

The mean of protein, fat, lactose and somatic cell count in organic milk was determined and compared with the data for the same time period from Latvia’s State Agency “Agricultural data centre” (Table 2).

There is only one company, which process organic milk in Latvia, and the company is located at Ķeipenes rural district, Ogre’s district. The organic milk for this company is delivered by following farms: ”Lejasrembēni”, ”Jaunbiteni”, „Kalna Gauriņi”, “Alejas”. To take into consideration, that the amount of obtained organic milk is 100% from all organic milks, which are processed, the qualitative factor gives the possibility to consider about organic milk quality in Latvia, therefore the number of analysed milk samples to engage as general multitude.

The data was processed using SPSS software package SPSS 11.0. and MS EXCEL.

RESULTS AND DISCUSSION

1. The evaluation of chemical composition of organic milk

According to the literature's data, the feed composition and preparation in organic and conventional agriculture has differences, therefore the possibility exists, that chemical composition of organic milk is distinctive from conventional milk.

The content of lactose, protein and fat in organic milk is given in Table 3. The mean content of lactose in organic milk samples was 4.85±0.04%, the significantly higher content of lactose was found ($p<0.05$) in the milk obtained from organic farms. The results of research relate to *Olivo* cognition, that the content of lactose in organic milk is significantly higher. At the same time, research results disagree with *Byström's, Toledo – Alonzo's* research results, where the authors affirm, that the content of lactose in organic and conventional milk have no significant difference.

The little changes are observed in a content of lactose in milk. The higher content of lactose can be explained with the feed composition, the higher content of sugar, founded in organic farms' feed grasses The higher content of lactose can be explained with unsuccessful regulation of digestion.

The mean content of protein in organic milk was 3.30±0.04%, it was not significantly different from conventional milk ($p>0.05$).

The research results relate with *Haggar, Kristensen, Byström, Mogensen, Toledo-Alonzo* and *Ellis,* research results, the content of protein in organic and conventional milk samples have no significant difference. The research results disagree with *Olivo* cognition, that the content of protein is higher in conventional milk samples. The results relate with other research, where Latvian scientists found the lower content of protein – 7.74±0.07% in blood obtained from cows of organic agriculture. The research results are in contradiction with *Olivo* statement, that the content of protein is higher in conventional milk samples.

It is not strange, that different results have been reported regarding to the protein content of organic milk, since organic milk production varies in feeding regimes. The reason for lower content of protein can be less quantity of sugar juicy feed, which stimulates production of butyric acid, used for protein synthesis.

The mean content of fat was 4.98±0.08%; it was significantly higher than in conventional milk samples.

The research results disagree with *Kristensen, Mogensen, Toledo-Alonzo, Olivo* cognitions, that fat content is higher in conventional milk. *Haggar, Byström, Ellis* found no significant difference between organic and conventional milk samples.

The higher content of fat in organic milk can explain with differences in keeping and feeding conditions. The high quality feed well balanced and rich with cellulose, always was available in organic farms.

The content of urea is influenced by following factors: feed composition and dose, the weight of cows, milk yield, season, month and lactation. The content of urea in organic milk samples is shown in Figure 1.

The urea content in organic milk samples was ranged between 64.90 and 252.56 mg kg^{-1}. The mean content of urea was 167.43±9.64 mg kg^{-1}, which was fit in common limit with milk from 150 to 300 mg kg^{-1}. In 32% of organic milk samples the content of urea was for 29.6 mg kg^{-1} lower than 150 mg kg^{-1}. Only 8% of analysed organic milk samples do not incorporate in *Rajala – Schultz* data limit 103 mg kg^{-1} to 154 mg kg^{-1}.

The research results relate with *Toledo – Alonzo* results, where author determines significant difference in content of urea in milk from different agricultural systems. The difference between the urea content in organic and conventional milk samples can be explained with stricter rules regarding to the amount of concentrate allowed in organic farms.

The higher amount of concentrate allowed has a negative influence on spurekla function and milk production.

The lower production intensity in organic farms, what *Jemeljanovs*' research results affirm, should be a possible explanation of the low milk urea level in organic milk found in this study.

As livestock specialists suppose, the content of urea in milk should be till 150 mg kg^{-1}, if it is higher, it burdens inseminate. It means that from this point of view, the urea content in organic milk samples is normal.

The lowest content of urea in 32% of samples could explain with low content of soluble nitrogen in feed and with seasonal changes of milk. The lowest content of urea, according to *Godden's* data, is from April to June. The *Dursts's* research shows that the normal content of protein, what was found in organic milk – 3.18%, and low content of urea could explain with the low content of total protein in feed. At the same time, according research results, the total protein content in feed grasses getting from organic farms is higher – 3.26±0.21% in comparison with conventional – 2.99±0.30%.

Hojman notifies that the content of urea in milk correlates with fat content in milk. To verify *Hojman*'s statement, that there was the correlation between content of fat and urea in milk, the regression analyse was used. The correlation coefficient was gotten 0.246, which showed, that there was weak connection. The factor - fat content in milk is not significant ($p>0.05$), it means that model is not statistically significant. Within the framework of this research, the correlation between urea and fat content was not found.

The content of calcium in milk is influenced by feed components, season and physiological factors of animal. The content of calcium in milk samples is shown in Table 4.

The content of calcium in organic milk samples was ranged between 20 and 25 mmol l^{-1}, the mean content of calcium was 21.9±0.22 mmol l^{-1}. However statistically significant difference in content of calcium between organic and conventional milk samples was not found. The mean content of calcium in milk from different agricultural systems was significantly lower compared with the data from literature 30 mmol l^{-1}.

Gorbatova mentions, that the content of calcium in milk obtained in summer period, when the milk samples were collected, is lower in comparison with milk samples obtained in winter. The lowest content of calcium can observe in mastitis cow milk, the content of calcium in mastitis cow's milk can be for 9% lower.

The content of calcium in milk increases in following order: from conventional to organic agriculture. The significant difference in content of calcium ($p>0.05$) in organic and conventional milk samples was not found. The cows kept in organic agriculture didn't get mineral additives, as result raising immunity of organic cows is possible only by natural methods. It means that it is possible to achieve the same results as in conventional agriculture, by using organic methods. In conventional agriculture animals are treated with antibiotics and other medicaments, but disease is not prevented.

Bluzmanis notes, that in blood serum from organic cows the relation between calcium and phosphorus (2:1) is better, then in conventional (2.27:1).

Within the framework of research the content of thiamin (Table 5) and riboflavin were determined in milk.

The content of thiamin in organic milk samples was for 34.1% lower compared with conventional milk and it was significantly lower ($p<0.05$) in comparison with the data from literature and conventional milk. The content of thiamin in conventional milk was 0.41±0.01 mg l^{-1}, it agrees with the data from literature.

The parameters of content of riboflavin in milk are given in Table 6. The content of riboflavin in organic milk ranged from 1.28 to 2.96 mg l^{-1}. Still the mean content of riboflavin in organic milk was 1.70±0.10 mg l^{-1} and it was for 35.8% lower than in conventional milk, statistically significant difference between organic and conventional milk samples ($p<0.05$) was found. The significant difference was not established, mean content of riboflavin in organic milk was compared with data from literature.

Many authors were accent that the content of thiamin and riboflavin is not varying in different seasons and the cow's feed has no significant influence on it. However there is still a possibility that feed can influence the content of thiamin and riboflavin in milk, especially if the cow's feed is reach with grain and flour. The lower amount of concentrate allowed, used in organic farms, can negatively influence the content of thiamine and riboflavin in organic milk. During the decreasing amount of concentrate allowed in organic farms was established the lower concentration of thiamine and riboflavin in milk. Light contributes to decrease of the concentration of riboflavin in milk, therefore milking and pretreatment organization in organic farms is one of the most significant factors, which impact the concentration of these vitamins.

The research results do not allow to say, that organic milk is better than milk obtained from other agricultural systems. Very often organic farmers accent the wholesomeness and higher concentration of vitamins in organic products, but research results don't verify it. It is very important, thence EU Regulation about food wholesomeness was enforced in Latvia. Any pronounced statement about the higher concentration of vitamins and other substances should be confirmed with research results. It is important for organic farmers too. When research results will be inquired, it will help to make the accent and to popularise friendly to the environment and nature products production.

Within the framework of research, it was verified the correlation between concentration of thiamine and riboflavin. The correlation between the concentration of thiamine and riboflavin is shown in Figure 2.

The correlation coefficient $r>0.5$ (0.68) testifies, that there is a linear correlation between concentration of thiamine and riboflavin. The p - value<0.05, it means, that if the concentration of thiamine increases, the concentration of riboflavin increases too and vice versa. At the same time, this model can not be used for forecasting concentration of vitamins, because the determination coefficient is low ($R^2=0.47$).

After evaluation of chemical composition of organic milk, is determined, that the content of lactose and fat has significant difference compared with conventional milk. The concentration of calcium in milk samples, obtained from different agricultural systems, compared with data from literature, was significantly lower. The concentration of thiamine and riboflavin in organic milk was significantly lower, in comparison with conventional agriculture. Research results show, if the agricultural system converts from conventional to organic, the concentration of separate nutrients will convert too.

2. The evaluation of concentration of antibodies in organic milk

The concentration of immunoglobulins in milk is influenced by a variety of factors, including age, health status and stage of lactation.

The concentration of **IgA** varies from 0.42 to 2.32 $g\ l^{-1}$ and it has significant differences ($p<0.05$) in milks, obtained from different agricultural systems. The higher concentration of IgA was observed in conventional milk – 1.12±0.05 g l^{-1}. The widest range of concentration of IgA was determined in milk, obtained from transitional period.

The concentration of IgA decreases in order: conventional→transitional period→organic agriculture (Figure 3). The mean concentration of IgA in organic milk was 5.5 times higher, in comparison with the data from literature (0.13 g l^{-1}). The concentration of IgA in milk obtained from transitional period and conventional agriculture was 6.9 and 8.6 times higher, relatively it could testify the mastitis problems in farms, where milk samples were obtained. For once, the high concentration of IgA in conventional milk can relate with cows' vaccination, what is used in this agricultural system. The increased concentration of IgA was not relate with mastitis, because milk samples were selected in such way, to eliminate the possibility to analyse milk samples obtained from mastitis cows. The conductivity of milk was detected and conductivities parameters was used for selecting milk samples for analyses.

The dispersion analysis was used for comparing IgA concentration in milk samples, obtained from different agricultural systems. The significant difference was determined in concentration of IgA in milk samples obtained from organic and conventional milk.

The concentration of **IgG** in milk increases in order: conventional to transitional period and organic agriculture (Figure 4). The concentration of IgG (g l^{-1}) in milk samples obtained from agricultural systems was according to the data from literature – 0.15-0.8 g l^{-1}.

The mean concentration of **IgM** in organic milk was the highest - 1.65±0.07 g l^{-1} and comparing with milk obtained from transitional period and conventional agriculture did not have the wide range results. The concentration of IgM increases in order: conventional→transitional period→ organic agriculture (Figure 5). The concentration of IgM was significantly higher in organic milk. The concentration of IgM in milk samples from different agricultural systems had significantly higher in comparison with the data from literature 0.04 – 1.00 g l^{-1}.

Repeatedly increases IgM concentration in cows' blood explained as reaction of inflammation. The concentration of IgM in blood and in milk is not proportional, therefore increased concentration of IgM is not react of pathogen.

Increased concentration of immunoglobulins in milk could evaluate as positive, because recently the interest for cows' immunization with aim to maximize antibodies concentration in milk increase.

The concentration of **lactoferrin** was from 0.03 to 0.071 g l^{-1}. The concentration of lactoferrin increases in order: conventional→ transitional period→organic agriculture (Figure 6.). There has significant difference in the concentration of lactoferrin in milk from different agricultural systems. The concentration of lactoferrin in organic milk samples (0.03 g l^{-1}) was 1.5 times higher in comparison with conventional milk samples (0.02 g l^{-1}).

The concentration of lactoferrin in milk obtained from different agricultural systems was according to the literature's data from 0.02 to 0.350 g l^{-1}. For once the high concentration of lactoferrin in organic milk was not related with mastitis and there are other factors: cows keeping conditions, cow's natural immunity fortification and others. Lactoferrin inhibits microorganisms, such as coliforms and others. For existence and multiplying of microorganisms the high concentration of iron ion is required. The high concentration of lactoferrin in organic milk indicates the role of potential antimicrobiological agent in raw material.

The concentration of **lysozyme** in milk samples obtained from different agricultural systems was in a wide range from 0.02 to 0.77 mg l^{-1}.

The concentration of lysozyme is important parameter of milk quality; it impacts milk storage duration and milk processing. Lysozyme is termostable, 75% from lysozyme activity preserves after milk heating up to 75°C 15 min or 80°C 15 s. It means that in pasteurised milk the concentration of enzyme is sufficient for limiting development of microorganisms and for preserving milk quality. Although there was not found significant difference between organic and conventional milk samples, but there was marked tendency, the concentration of lysozyme increases in order: conventional→ transitional period→organic agriculture (Figure 7). The research results show, that the concentration of lysozyme in organic milk is considerable, as antibody providing milk quality in due time.

Obtained results we could clarify with different agricultural systems, where farmers used different methods for cow's immunization. The cow's vaccination is used in conventional agriculture, but organic system is based on cow's natural immunity fortification without using medicaments. As result, the concentration of antibodies in milk was different.

3. The evaluation of microbiological and chemical contamination of organic milk

The somatic cell count, total plate count, the concentration of cadmium, lead, copper, iron, zinc and the level of aflatoxin M_1 were determined in this research.

Somatic cell count (SCC). Antibiotics and other medicine are forbidden in regular feedstuffs at organic farms, including antibiotic usage for mastitis treatment, disinfection agent usage is restricted too. All this measures can cause the decrease of somatic cell count and wide spectrum of mastitis agents in milk. The dispersion of somatic cell count in organic milk is presented in Figure 8.

47.8% of organic milk samples were according the limits of Regulation (EC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for the hygiene of foodstuffs. However 52.2% of milk samples somatic cell count were more than 400 000 ml^{-1}, including 25% SCC – more than 1 000 000 ml^{-1}.

The somatic cell count in organic milk had ranged between 4 000 to 1 413 000 ml^{-1}, the mean SCC was 351 123±40 057 ml^{-1}, it was lower than in conventional milk samples at the same time period – 391 000 ml^{-1}.

Norman and *Schaik* consider, that somatic cell count in milk obtained from healthy cows is not more than 200 000 ml^{-1}, *Konošonoka* mentions in the research, that healthy cow's milk SCC is 300 000 ml^{-1}. Somatic cell count is a measure for the prevalence of mastitis in a dairy herd and used by regulatory agencies as an indicator of the wholesomeness, safety and suitability of raw milk for human consumption.

The main factor, which influences somatic cell count, is the state of cow's health. In organic agriculture the use of antibiotics for mastitis treatment is restricted. The restriction on antibiotics may lead positively to a more intensive health promotion and disease prevention effort, and to consequent and early intervention in the case of disease. In this way it is possible to decrease number of antibiotic resistant bacteria in udder and in milk.

Furthermore, the cows' vaccination, using different vaccines, for example *Staphylococcus aureus* and others, increases. As result some cause of mastitis is eliminated, but other multiply easy. Today there is not prevalent vaccine for mastitis prevention and in the near future will not be. In the nature nothing disappears and changes. Always the role of some microorganisms causing mastitis will replace and take other, therefore for mastitis treatment and prevention is necessary to look other ways, and resignation from antibiotic use is not considered as anomaly. Moreover, if this method will help to limit potential mastitis pathogens, it will be only positive.

On the other hand the restrictions on antibiotic use may negatively lead to a non-treatment policy, where animals requiring treatment will not be treated, as result the somatic cells count is higher than in this case.

The staphylococci percentage of distribution in organic milk samples is shown in Figure 9.

From obtained results is possible to conclude, that milk samples with increased number of staphylococci (above 2 000 cfu ml^{-1}) can testify about cow's mastitis. Some of coagulase negative staphylococci (CNS) strains were identified for clarifying main cause of mastitis in organic farms.

For isolates percentage, *Staphylococcus aureus* was isolated in 34% and CNS – 63% of analysed organic milk samples. From organic milk samples

Staphylococcus strains were not isolated in 5 cases. Some of CNS strains were identified (Table 7).

Results have shown that coagulase negative staphylococci and *Staphylococcus aureus* have the leading part for initiate of mastitis in organic milk, what is related with *Smolder's* research results, where the main microorganisms prevail in organic and conventional milk samples were CNS, respectively, 46.0 % and 40.9%, *Staphyloccocus aureus,* respectively, 15.8% and 18.6%.

Somatic cell count in milk is influenced by many factors, *Bluzmanis* considers, that the increasing somatic cell count has correlation with the amount of staphylococci.

The correlation coefficient $r<0.5$ (0.204) testifies about weak linear correlation between somatic cell count and staphilococci count. B_0 coeficient's p – value (0.051) is higher than 0.05, therefore coefficient is equal zero. It means that in this research correlation between SCC and the number of staphylococci was not found.

Not always the amount of staphylococci influences the increase of amount of somatic cell count in milk. SCC depends on the nature of mastitis causes, aggression and other factors. The other authors' researches verify that it is the correlation between *Staphylococcus aureus* and somatic cell count in milk. At the same time many CNS can cause clinical mastitis, without the rapid increase of somatic cell count. Therefore, for getting objective research results, it was necessary to look correlation between pathogens and SCC.

The correlation between somatic cell count and *Staphylococcus* species is shown in Figure 10. The correlation coefficient $r<0.5$ (0.296) testifies about weak linear correlation between SCC and *Staphylococcus* species. The determination coefficient (R^2) is 0.088. It means that in 8.8% cases the changes of somatic cell count can explain with the changes of amount of staphylococci. In this case it is not possible to find for correlation, but it is possible to describe the tendency. P – value of coefficients (b_0 and b_1) was less than 0.05. With probability 95% it can affirm, that b_0 and b_1 coefficients value is not zero, therefore tendency between SCC and staphylococcus species exists.

With probability 99% somatic cell count is significantlly different in organic milk samples, where CNS and CNS and *Staphylococcus aureus* were isolated.

The higher increase of somatic cell count was in organic milk samples in which the *S.aureus* and CNS was isolated. The highest count of staphylococci in organic milk, independent from staphylococci species, doesn't cause the significant increase of SCC. It is weak linear correlation between isolated microorganisms and SCC in milk.

The total plate count is parameter, which helps to consider about hygienic conditions in the farms. The total plate count in organic milk samples is given in Figure 11.

Despite the high microbiological quality of organic milk, 27% of organic milk total plate count was not according to the limits of Regulation (EC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for the hygiene of foodstuffs – 100 000 cfu ml^{-1}.

In addition, for insuring high quality milk, it is not enough to cool milk till +4+6°C for a short period of time (20 – 30 min). The initial quality of milk is depended on: noticing sanitary – hygienic rules in milking time, cleanness of equipment and consideration of personal hygienic rules. Only honest job and cleanness can make organic milk better than milk obtained from other agricultural systems.

Aflatoxin M_1. Of course, if organic agriculture is restricted usage of the preservatives for preparation of feed, the risks linked to aflatoxins contamination could be higher in organic production than in conventional production. It appears that there are both advantages and disadvantages, regarding to the aflatoxins problem in organic agriculture. Among the advantages included the use of less nitrogen in organic agriculture, and also the use of organic nitrogen. The disadvantages are that, since no herbicides are used in organic farming, there are more weeds, as well as the presence of *Pyralidae*. However, in organic agriculture it is possible to reduce the presence of weeds and *Pyralidae*, by using crop rotations and other agronomic practices.

The level of alflatoxin M_1 in organic and conventional milk samples is given in Table 8.

Obtained results have shown that no AFM_1 values were exceeded permissible level - 0.05 µg kg^{-1} in organic and conventional milk. The study relating to AFM_1 in milk samples found no significant differences between organic and conventional milk. The research results relate with *Wyss's* statement, that the level of alfatoxin M_1 has no significant difference in organic and conventional agriculture obtained milks. *Martini* established that 92% of organic and conventional milk samples were contaminated with aflatoxin M_1. *Ghidini* affirms that the contamination of organic milk with aflatoxin M_1 is significantly higher in comparison with conventional milk.

The research results show, it is possible to get silage with level of aflatoxin M_1, which don't exceed Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs, maximally decreasing usage of preservatives for feed preparation in organic agriculture.

For producing safe milk for human consumption, the adopting preventive measures, as good agricultural, processing and storage practice, is necessary.

Heavy metals and trace elements. Organic methods are used to minimize pollution of air, soil and water, although they cannot ensure that products are completely free of residues, because of general environmental pollution, including acid rain, ozone whole and other. There are many of chemical hazards associated with foods. Those chemical contaminants are coming from general environmental pollution. Contaminants in animal feeds, such as agricultural and industrial chemicals, heavy metals and other, can give rise to safety's hazards in food of animal origin. However, as pointed above, organic agriculture does not reduce level of persistent environmental pollutants in organically grown products. These may therefore be present in organic feedstuffs and hence in organic food of animal origin.

The concentration of lead and cadmium in milk samples, obtained from different agricultural systems is given in Figure 12.

Means of ***lead*** concentration in organic and conventional milk samples were 0.025±0.020 mg kg^{-1} wet weight and 0.033±0.001 mg kg^{-1} wet weight. In both cases maximum permissible level for such product (0.020 mg kg^{-1} wet weight) determined by Regulation (EC) No 466/2001 setting maximum levels for certain contaminants in foodstuffs was exceed. The concentration of lead in organic and conventional milk have significant difference ($p<0.10$). The research results are in conflict with *Ghidini* conclusions, that there is no significant difference in the concentration of lead in organic and conventional milk.

The main sources of lead pollution in the environment are: industrial production processes and their emissions, road traffic with leaded petrol, the smoke and dust emissions of gas-fired power stations, the laying of lead sheets by roofers as well as the use of paints and anti-rush agents. The lead contamination in organic and conventional milk samples could happen due to feeding the cows with collected from along the road sides' fodder. The cow acts as a very effective biological filter diverting lead from her feed to her bones rather than to her milk.

The mean concentration of ***cadmium*** in organic and conventional milk samples was 0.007±0.001 mg kg^{-1} and 0.009±0.001 mg kg^{-1} wet weight. The cadmium content in organic and conventional milk samples was very low and fairly constant in all types of milk. Cadmium, like lead, is a cumulative poison, i.e., the danger lies primarily in the regular consumption of foodstuffs with low contamination. However, in contrast with lead, the definition of an exact toxicity limit is not possible for cadmium. The decisive point is whether absorption of the existing cadmium actually takes place. This is, firstly, dependent upon the composition of the diet as a whole and, secondly, on the bio-availability of the cadmium compound present. Again, as with lead, the cow acts as an effective biological filter and the proportion of ingested cadmium finding access to milk is extremely small.

The concentration of iron, cooper and zinc in milk samples, obtained from different agricultural systems is given in Figure 13. The concentration of ***iron*** in organic and conventional milk samples was 1.26±0.02 mg kg^{-1} wet weight, what is for 0.04 mg kg^{-1} wet weight higher in comparison with conventional milk – 1.22±0.03 mg kg^{-1} wet weight.

The mean concentration of ***cooper*** in organic milk was 0.201±0.005 mg kg^{-1} wet weight, in conventional milk – 0.27±0.007 mg kg^{-1} wet weight. The significant difference between organic and conventional milk samples was established ($p<0.05$). The research results relate *Bluzmanis* results, where author found in blood serum, obtained from organic cows, in comparison with conventional, higher concentration of iron – 38.20 mg%, however lower concentration of copper – 0.06 mg%.

There is not found significant difference between the concentration of ***zinc*** in organic and conventional milk, but the concentration of zinc in organic milk for 0.05 mg kg^{-1} wet weight was higher compared with conventional milk samples. The research results relate to *Bluzmanis* research results, author have determined the higher concentration of zinc in organic milk 0.32mg%, in comparison with conventional - 0.19mg%.

Some heavy metals (the so-called trace elements) are essential in very small concentrations for the survival of all life forms, for example, copper, iron, zinc and others. Despite this fact, it is often forgotten that in some circumstances, in higher concentrations, these can also be quite toxic, for example, when they are present in an organic compound.

The legally accepted upper limits for different heavy metals except lead though are not exceeded by any analysed milk sample, not even from conventional bulk milk.

The obtained results verify that separate parameters of milk chemical composition (lactose, fat, IgM and lactofferin content) and quality is higher in organic milk samples, at the same time the content of thiamin, riboflavin and IgA is higher in conventional milk. This does not allow to highlight or to slight the quality of milk obtained from one or other agricultural system.

CONCLUSIONS

9. The concentration of separate nutrients in organic milk compared with conventional milk is different.
10. Statistically significant differences between organic and conventional milk were found in content of important milk component: fat and lactose.
11. The mean content of urea in organic milk was 167.4±9.6 mg kg^{-1}. In the 32% of organic milk samples the urea content was significant lower

according to the data from literature - 150 mg kg^{-1}. It is explained with restrictions regarding the amount of concentrate allowed and lower milk yields in organic farms.

12. The concentration of thiamin and riboflavin was for 34.1% and 35.8% lower in comparison with conventional milk. It is explained with organisation of milking and storage process and with low concentration of silage used in organic herds.
13. The environment, as significant pollution parameter, influence the concentration of lead in organic and conventional milks, but copper, iron, cadmium and zinc concentrations have not exceeded permissible level.
14. *Staphylococcus aureus* (33%) and CNS (62%) prevail in organic milk. It have significant influence on the somatic cell count. Somatic cell count exceed 400 000 ml^{-1} more than 50% of analysed milk samples.
15. The mean total plate count exceeds 100 000 cfu ml^{-1}, cooling milk till +4+6°C. In general, the hygienic conditions on the farms are the main cause for the high total plate count in milk.
16. The different concentrations of lactoferrin, IgM and lysocyme in organic and conventional milk are demonstrated significant cow's immunity fortification influence in organic agriculture.