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QUALITY AND SAFETY OF RAW COW'S MILK IN SLOVAKIA IN 2011

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ABSTRACT

The quality and safety of raw cow's milk is very important for dairy companies and consumers of milk products. Due to the methods of production, it is impossible to completely eliminate contamination of milk with microorganisms, therefore the microbial content of milk is a major feature in determining its quality. Other important factors to consider include somatic cells count, veterinary drug residues, milk composition and freezing point. Somatic cells represent the udder health and can be used for monitoring of subclinical mastitis. A high level of somatic cells can increase proteolysis in milk which affects technological processes. Veterinary drugs administered to cows may lead to residues in the milk which are harmful to humans. The content of fat, protein and solids-non-fat are the main indicators used by dairies for technological purposes. In this article we discuss the quality and safety of raw cow's milk in Slovakia during 2011. We found that 73.53% of samples tested for somatic cell count, and 84.54% of samples tested for total bacterial count, met the European Union legislation limits. We found the largest decrease in fat and protein content was during the summer period and the largest increase was in the winter period. We found that 92.14 %, 98.7% and 91.38% of samples met the limit presented in STN 570529:1999 for fat content, protein content and freezing point respectively. The percentage of drug positive samples was 0.087%.

Keywords: raw cow's milk, total bacterial count, somatic cell count, fat, protein, solids-not-fat, freezing point, drug residue

INTRODUCTION

Cow's milk has long been considered a highly nutritious and valuable human food and is consumed daily by millions, in a variety of different products. Due to the importance of milk in the human diet, it is essential to increase milk production and to improve its quality **(Dănuţ et al., 2011)**. Milk has been called nature's most complete food **(Ataro et al., 2008; Park, 2009)**. Milk is more than a source of nutrients for any mammalian neonate, as it is also important for the growth of children and nourishment of adults. Aside from the nutritional values of milk, milk borne biologically active compounds, such as casein and whey proteins, have been found to be increasingly important for physiological and biochemical functions that have crucial impacts on human metabolism and health **(Gobbetti et al., 2007; Korhonen and Pihlanto-Leppälä, 2004)**. Four major areas of bioactivity of milk components have been categorised: 1) gastrointestinal development, activity and function; 2) infant development; 3) immunological development and function; and 4) microbial activity, including antibiotic and probiotic action **(Gobbetti et al., 2007; Park, 2009)**.

Its nutrient composition makes milk an ideal medium for bacterial growth and therefore it can be considered one of the most perishable agricultural products because it can so easily be contaminated **(Bryan, 1983)**. Raw cow and sheep milk may contain microorganisms which can cause food borne diseases **(Adesiyun et al., 1995; Steele et al., 1997; Headrick et al., 1998, Dudriková et al., 2010, Fabianová et al., 2011, Poľáková et al., 2011, Zigo et al., 2011)**. Because of the specific methods of production, it is impossible to avoid contamination of milk with microorganisms. The microbial content of milk is a major feature in determining its quality **(HUI, 1993, Chandan, 2008; Tamine 2009)**. It has been stated that the number, and type, of microorganisms in milk immediately after milking, are affected by factors such as, animal and equipment cleanliness, the season, feed and animal health. Bacterial contamination of raw milk can originate from different sources: the air, milking equipment, feed, soil, faeces or grass **(Coorevits et al., 2008)**. The occurrence of mastitis in dairy farms depends on three biosystems: dairy cows, the environment and microorganisms. Application of antimastitis programs is very important **(Pukáčová et al., 2010)**.

Deficiency in the nutrition of dairy cows may influence many biochemical and physiological processes, as well as milk composition **(Filipejová et al., 2011)**.

Physicochemical and microbiological analyses are an important tool to monitor the quality of food products **(Hettinga et al., 2008)**. Monitoring the quality and safety of milk requires careful analysis of microbial and somatic cell loading **(Gunasekera et al., 2003)**. Biological monitoring of raw milk, which involves analysis of microbial and somatic cells, is essential for milk and dairy quality assurance. Milk microbiology impacts on issues such as the shelf life of dairy products, as well as on determination of the type of product for which raw milk is to be used **(Muir, 1996)**. A high biological count in raw milk alerts the dairy processor to possible problems with product safety **(Sørhaug and Stepaniak, 1997)**.

Poor milk hygiene, and more specifically high somatic cell counts (SCC), also have implications on the structure of milk, its processing value, shelf life and edible food loss **(Barbano et al., 2006)**, and indirectly on consumer concerns with regard to human health, bacterial

contamination and antimicrobial residues **(Ruegg and Tabone, 2000; Saville et al., 2000; Jayarao and Henning, 2001; Hogan, 2005; Straley et al., 2006)**.

Several studies have implicated high SCC as a causative factor in the reduced shelf life of fluid milk **(Ma et al., 2000)**, as well as reduced cheese yield and quality **(Kitchen, 1981; Munro et al., 1984; Barbano et al., 1991)**.

Herds with higher SCC exhibit an increased risk of antibiotic residue violation because of their increased antibiotic usage, owing to the greater prevalence of subclinical mastitis **(Ruegg and Tabone, 2000)**.

In addition, elevated SCC is associated with lower milk yields, resulting in potential losses in income. Hence, monitoring and control of SCC at a national level, as well as on an individual farm basis, is necessary to identify and monitor trends. It is also a fundamental resource for quality assurance programs **(Berry et al., 2006)**.

The European Union currently imposes a regulatory limit of 400,000 somatic cells/ml and 100,000 bacterial cells/ml **(Commission Regulation (EC) No 1662/2006 of 6 November 2006 amending Regulation (EC) No 853/2004)**.

Milk composition varies considerably throughout the seasons, as shown in multiple studies **(Auldist et al., 1998; Lindmark-Månsson et al., 2003; Lock and Garnsworthy, 2003)**.

The composition of raw milk determines, to a large extent, the nutritional value and the technological properties of milk and dairy products. Therefore, the composition of milk is of great importance for the dairy industry and there is great interest in changing the composition of milk. The composition of milk varies due to the stage of lactation, feeding, health status of the cow and genetic factors **(Fox and McSweeney 1998)**.

The production of high quality milk, and keeping the herd in good health, are the main objectives in primary milk production **(Janštová et al., 2011)**.

MATERIAL AND METHODOLOGY

Raw cow's milk

Samples of raw cow's milk were collected from individual dairy farms in Slovakia by trained personnel of dairy companies, according to the standard ISO 707:2008 and stored until analysed in a fridge at 0 - 4 °C.

Samples were analysed in laboratories accredited according to ISO17025:2005 (general requirements for the competence of testing and calibration laboratories):

- EXAMINALA, Dairy Research Institute, Dlhá 95, 010 01 Žilina, Slovakia,
- Milex Progres a.s., Beňadická 13, 851 06, Bratislava, Slovakia,
- State Veterinary and Food Institute Bratislava, Detached testing Laboratory, Akademická 3, Nitra, National Reference Laboratory for Milk and Milk Products

Laboratory methods

Determination of milk composition

STN 57 0536 (1.4.1995) - Determination of milk composition with infrared absorption analyser.

Determination of somatic cells

ISO 13366-2:2006 Milk - Enumeration of somatic cells - Part 2: Guidance on the operation of fluoro-opto-electronic counters.

Determination of total bacterial counts

ISO 4833:2003 Microbiology of food and animal feeding stuffs - Horizontal method for the enumeration of microorganisms - Colony-count technique at 30 ˚C.

ISO 7218:2007 Microbiology of food and animal feeding stuffs - General requirements and guidance for microbiological examinations.

ISO 6887-1:1999 Microbiology of food and animal feeding stuffs - Preparation of test samples, initial suspension and decimal dilutions for microbiological examination - Part 1: General rules for the preparation of the initial suspension and decimal dilutions.

ISO 6887-5:2010 Microbiology of food and animal feeding stuffs - Preparation of test samples, initial suspension and decimal dilutions for microbiological examination - Part 5: Specific rules for the preparation of milk and milk products.

Determination of freezing point

ISO 5764:2009 Milk - Determination of freezing point - Thermistor cryoscope method (Reference method).

Determination of drug residues

STN 570531:2001 - Identification and determination of antibiotics and sulphonamides in raw milk and heat-treated milk.

Testing period

Samples were collected and analysed during the year 2011.

Number of samples

The total number of samples analysed during the testing period was different according to tested analyte. We analysed 19,830 samples for total bacterial counts, 24,457 samples for somatic cell count, 24,260 samples for milk composition, 15,453 samples for freezing point and 19,475 samples for drug residues.

Evaluation of the results

Evaluation of the results was performed according to the limits specified in European Union legislation and Slovak technical standards:

Commission Regulation (EC) No 1662/2006 of 6 November 2006 amending Regulation (EC) No 853/2004 of the European Parliament and of the Council laying down specific hygiene rules for food of animal origin.

STN 570529:1999 Raw cow's milk to dairy processing and treatment.

RESULTS AND DISCUSSION

The number of analysed samples and results of bulk cow's milk collected from dairy farms in Slovakia in 2011 are presented in the tables and figures. Results of the determination of total bacterial count (TBC), and somatic cell count (SCC), in bulk raw cow's milk are presented in Table 1, Figure 1 and Figure 2. Results of determination fat content, protein content, lactose content and solids-not-fat content in bulk raw cow's milk are presented in Table 2 and Figures 3 - 6. Results of determination of freezing point and drug residues in bulk raw cow's milk are

presented in Table 3 and Figures 7 - 8. Results of individual indicators of quality and safety, divided into categories according to legislation limits and requirements of standard are presented in Figures 9 - 14.

Table 1 Results of determination total bacterial count (TBC) and somatic cells count (SCC) in bulk raw cow's milk in Slovakia in 2011

Year 2011		TBC	TBC < 50,000 /ml	TBC 51,000 - 100,000 /ml	TBC CFU/ml (average)	SCC	SCC < 300,000 /ml	SCC 301,000 - 400,000 /ml	SCC/ml (average)
January	No. of samples	**1,641**	1,228	206	63,000	**1,977**	1,137	356	315,000
	%	-	74.8 %	12.6 %	-	-	57.5 %	18.0 %	-
February	No. of samples	**1,653**	1,249	215	58,500	**2,025**	1,127	432	324,000
	%	-	75.6 %	13.0 %	-	-	55.7 %	21,3 %	-
March	No. of samples	**1,692**	1,221	176	7,1000	**2,086**	1,048	476	343,000
	%	-	72.2 %	10.4 %	-	-	50.2 %	22.8 %	-
April	No. of samples	**1,674**	1,227	186	67,000	**2,022**	1,086	448	339,000
	%	-	73.3 %	11.1 %	-	-	53.7 %	22.2 %	-
May	No. of samples	**1,650**	1,134	273	77,500	**2,071**	1,137	441	312,000
	%	-	68.7 %	16.5 %	-	-	54.9 %	21.3 %	-
June	No. of samples	**1,679**	1,169	199	78,500	**2,072**	1,066	456	345,000
	%	-	69.6 %	11.9 %	-	-	51.4 %	22.0 %	-
July	No. of samples	**1,652**	1,052	236	84,000	**1,958**	916	384	365,000
	%	-	63.7 %	14.3 %	-	-	46.8 %	19.6 %	-
August	No. of samples	**1,653**	1,058	246	87,000	**2,087**	943	425	367,000
	%	-	64.0 %	14.9 %	-	-	45.2 %	20.4 %	-
September	No. of samples	**1,623**	1,190	177	66,500	**2,048**	1,065	405	334,000
	%	-	73.3 %	10.9 %	-	-	52.0 %	19.8 %	-
October	No. of samples	**1,647**	1,255	165	64,000	**2,114**	1,161	405	327,000
	%	-	76.2 %	10.0 %	-	-	54.9 %	19.2 %	-
November	No. of samples	**1,633**	1,283	170	54,500	**1,984**	1,229	340	297,000
	%	-	78.6 %	10.4 %	-	-	61.9 %	17.1 %	-
December	No. of samples	**1,633**	1,241	207	57,500	**2,013**	1,122	376	331,000
	%	-	76.0 %	12.7 %	-	-	55.7 %	18.7 %	-
Sum	No. of samples	**19,830**	**14,307**	**2,456**	-	**24,457**	**13,037**	**4,944**	-
	%	-	**72.15 %**	**12.39 %**	-	-	**53.3 %**	**20.2 %**	-

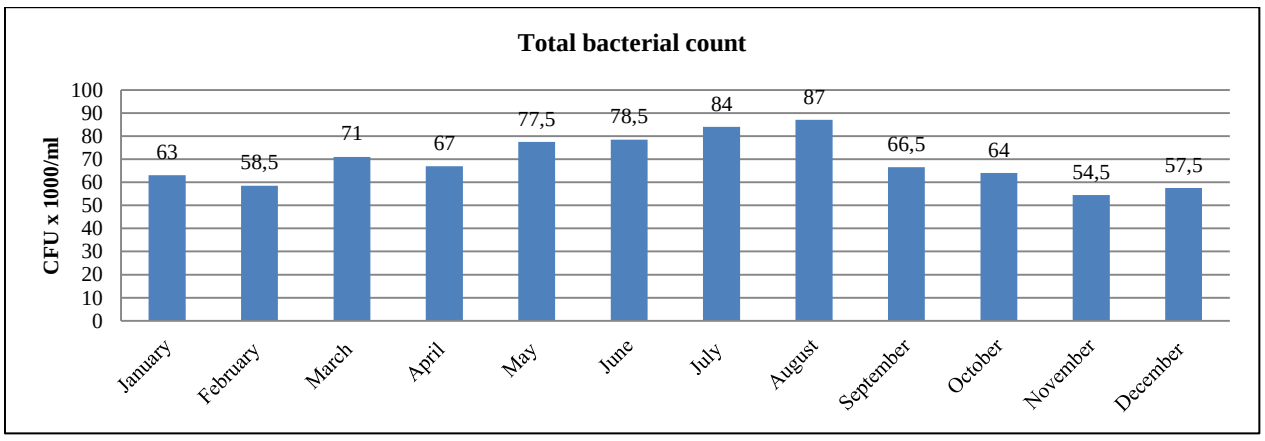

Fig. 1 Average results of determination of total bacterial count (TBC) in bulk raw cow's milk in Slovakia in 2011

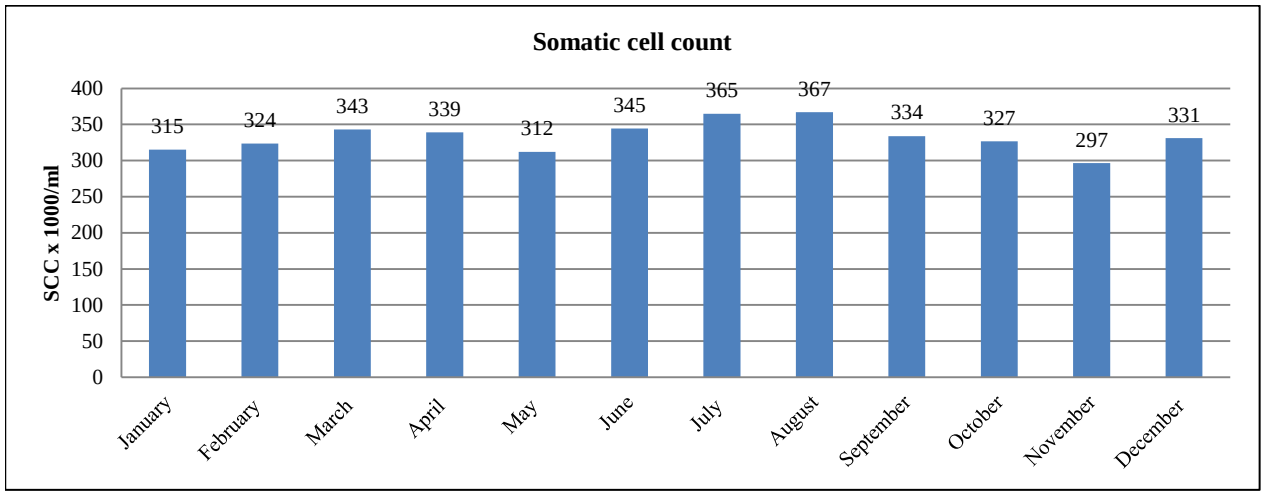

Fig. 2 Average results of determination of somatic cell count (SCC) in bulk raw cow's milk in Slovakia in 2011

Table 2 Results of determination of fat content, protein content, lactose content and solids-not-fat (SNF) content in bulk raw cow's milk in Slovakia in 2011

Year 2011		**Composition**	**Fat > 3.3 g/100g**	**Fat > 3.6 g/100g**	**Fat g/100g (average)**	**Protein > 2.8 g/100g**	**Protein > 3.2 g/100g**	**Protein g/100g (average)**	**Lactose g/100g (average)**	**SNF ≥ 8.5 g/100g**	**SNF g/100g (average)**
January	No. of samples	**1,978**	1,875	1,667	3.875	1,970	1,739	3.405	4.805	1,751	8.810
	%	-	94.8 %	84.3 %	-	99.6 %	87.9 %	-	-	88.5 %	-
February	No. of samples	**2,013**	1,898	1,689	3.680	1,806	1,758	3.405	4.830	1,776	8.830
	%	-	94.3 %	83.9 %	-	89.7 %	87.3 %	-	-	88.2 %	-
March	No. of samples	**2,074**	1,989	1,731	3.830	2,060	1,619	3.415	4.855	1,819	8.720
	%	-	95.9 %	83.5 %	-	99.3 %	78.1 %	-	-	87.7 %	-
April	No. of samples	**2,010**	1,890	1,627	3.795	1,989	1,319	3.255	4.860	1,583	8.660
	%	-	94.0 %	80.9 %	-	99.0 %	65.6 %	-	-	78.8 %	-
May	No. of samples	**2,059**	1,826	1,356	3.685	2,051	1,431	3.265	4.875	1,648	8.690
	%	-	88.7 %	65.9 %	-	99.6 %	69.5 %	-	-	80.0 %	-
June	No. of samples	**2,072**	1,797	1,182	3.610	2,061	1,366	3.255	4.820	1,689	8.640
	%	-	86.7 %	57.0 %	-	99.5 %	65.9 %	-	-	81.5 %	-
July	No. of samples	**2,038**	1,751	1,104	3.605	2,029	1,212	3.235	4.810	1,490	8.565
	%	-	85.9 %	54.2 %	-	99.6 %	59.5 %	-	-	73.1 %	-
August	No. of samples	**2,074**	1,879	1,312	3.690	2,069	1,473	3.260	4.790	1,582	8.60
	%	-	90.6 %	63.3 %	-	99.8 %	71.0 %	-	-	76.3 %	-
September	No. of samples	**2,036**	1,866	1,443	3.735	2,018	1,738	3.325	4.815	1,798	8.695
	%	-	91.7 %	70.9 %	-	99.1 %	85.4 %	-	-	88.3 %	-
October	No. of samples	**2,118**	1,944	1,725	3.915	2,117	2,027	3.450	4.770	1,995	8.820
	%	-	91.8 %	81.4 %	-	100.0 %	95.7 %	-	-	94.2 %	-
November	No. of samples	**1,987**	1,932	1,852	4.055	1,985	1,941	3.520	4.805	1,846	8.885
	%	-	97.2 %	93.2 %	-	99.9 %	97.7 %	-	-	92.9 %	-
December	No. of samples	**2,001**	1,890	1,760	3.940	1,987	1,922	3.490	4.790	1,870	8.850
	%	-	94.5 %	88.0 %	-	99.3 %	96.1 %	-	-	93.5 %	-
Sum	No. of samples	**24,460**	**22,537**	**18,448**	**-**	**24,142**	**19,545**	**-**	**-**	**20,847**	**-**
	%	-	**92.1 %**	**75.4 %**	**-**	**98.7 %**	**79.9 %**	**-**	**-**	**85.2 %**	**-**

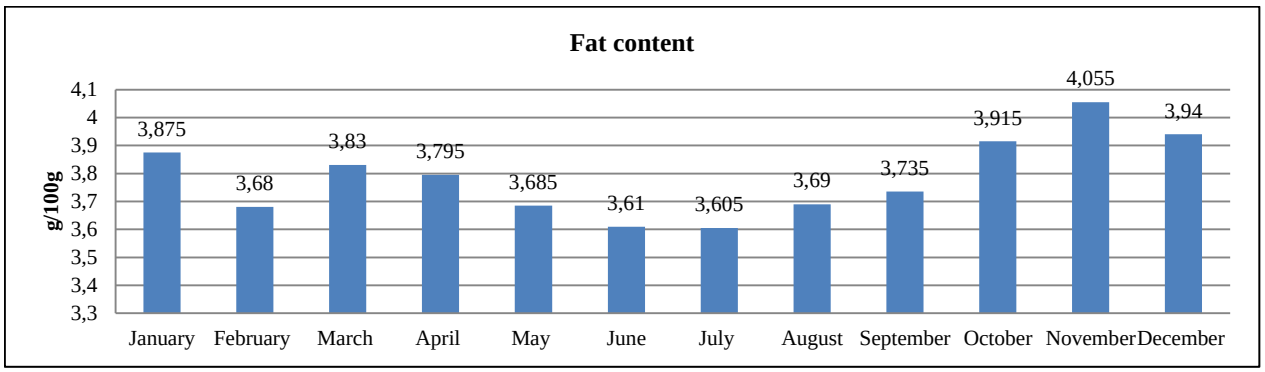

Fig. 3 Average results of determination of fat content in bulk raw cow's milk in Slovakia in 2011

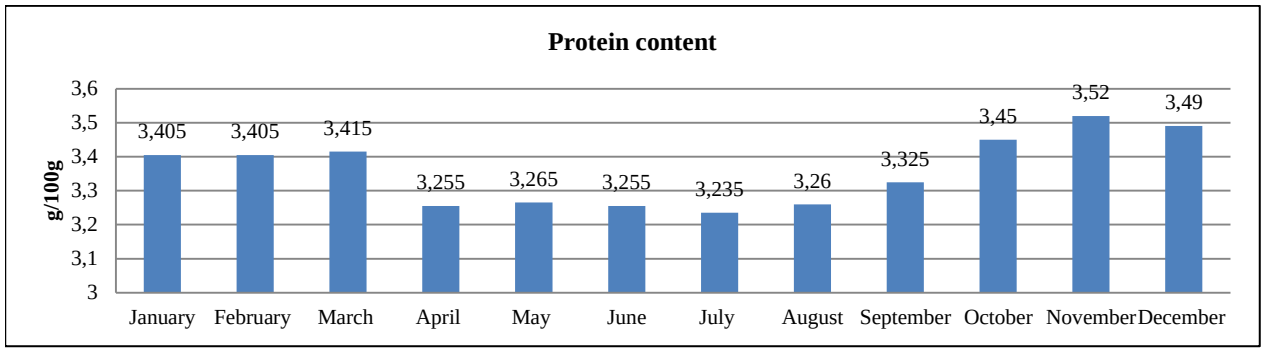

Fig. 4 Average results of determination of protein content in bulk raw cow's milk in Slovakia in 2011

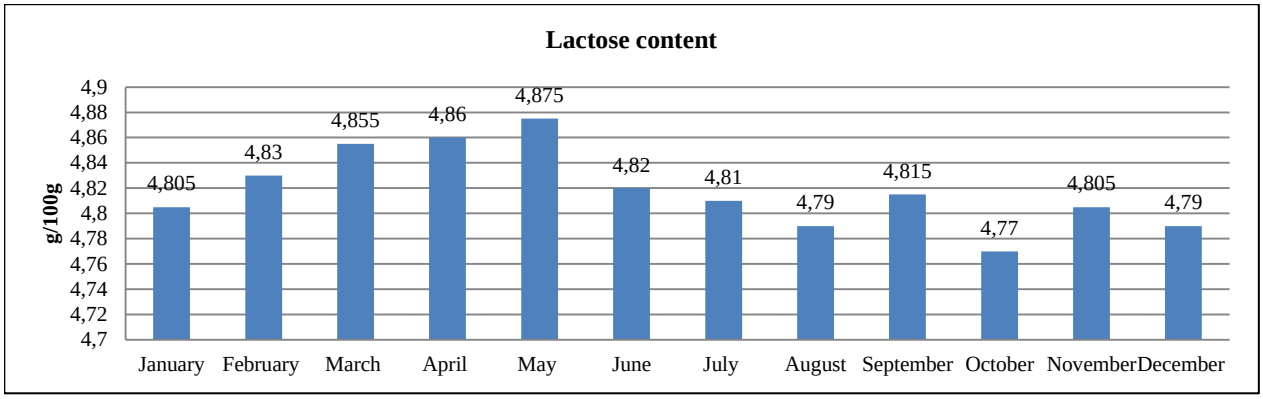

Fig. 5 Average results of determination of lactose content in bulk raw cow's milk in Slovakia in 2011

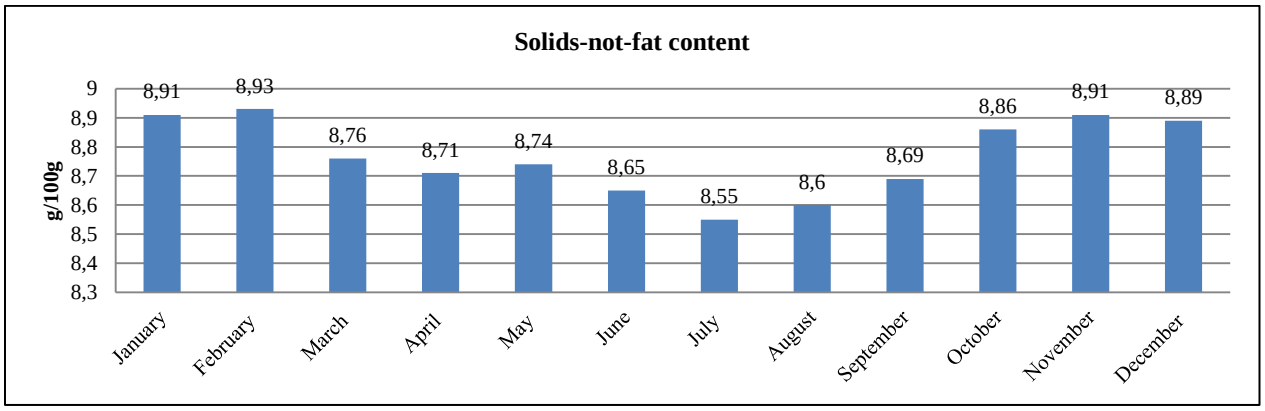

Fig. 6 Average results of determination of solids-not-fat content in bulk raw cow's milk in Slovakia in 2011

Table 3 Results of determination of freezing point and drug residues in bulk raw cow's milk in Slovakia in 2011

Year 2011		Freezing point	Freezing point > -0.515	Freezing point < -0.515 - > -0.520	Freezing point < -0.520	Freezing point (°C) (average)	Drug residues	Drug residues (positive samples)
January	No. of samples	**1,394**	136	281	977	-0.524	**1,618**	1
	%	-	9.8 %	20.2 %	70.1 %	-	-	0.062 %
February	No. of samples	**1,341**	140	214	987	-0.525	**1,628**	3
	%	-	10.4 %	16.0 %	73.6 %	-	-	0.184 %
March	No. of samples	**1,270**	89	180	1,001	-0.525	**1,662**	0
	%	-	7.0 %	14.2 %	78.8 %	-	-	0.000 %
April	No. of samples	**1,380**	133	201	1,046	-0.527	**1,642**	2
	%	-	9.6 %	14.6 %	75.8 %	-	-	0.122 %
May	No. of samples	**1,300**	91	197	1,012	-0.527	**1,622**	2
	%	-	7.0 %	15.2 %	77.8 %	-	-	0.123 %
June	No. of samples	**1,286**	119	195	972	-0.525	**1,644**	1
	%	-	9.3 %	15.2 %	75.6 %	-	-	0.061 %
July	No. of samples	**1,244**	116	197	931	-0.524	**1,612**	0
	%	-	9.3 %	15.8 %	74.8 %	-	-	0.000 %
August	No. of samples	**1,243**	106	214	923	-0.525	**1,609**	3
	%	-	8.5 %	17.2 %	74.3 %	-	-	0.186 %
September	No. of samples	**1,127**	91	204	832	-0.524	**1,591**	1
	%	-	8.1 %	18.1 %	73.8 %	-	-	0.063 %
October	No. of samples	**1,334**	120	204	1,010	-0.524	**1,641**	0
	%	-	9.0 %	15.3 %	75.7 %	-	-	0.000 %
November	No. of samples	**1,362**	95	177	1,090	-0.525	**1,629**	0
	%	-	7.0 %	13.0 %	80.0 %	-	-	0.000 %
December	No. of samples	**1,172**	95	144	933	-0.525	**1,577**	4
	%	-	8.1 %	12.3 %	79.6 %	-	-	0.254 %
Sum	No. of samples	**15,453**	**1,331**	**2,408**	**11,714**	-	**19,475**	**17**
	%	-	**8.6 %**	**15.6 %**	**75.8 %**	-	-	**0.087 %**

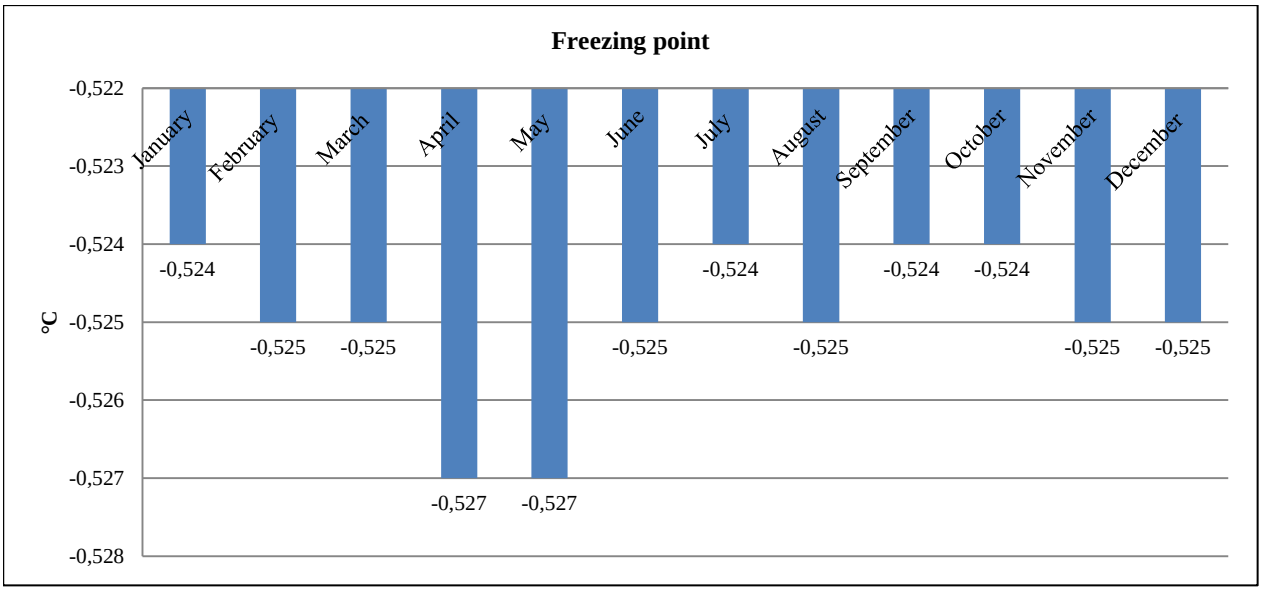

Fig. 7 Average results of determination of freezing point in bulk raw cow's milk in Slovakia in 2011

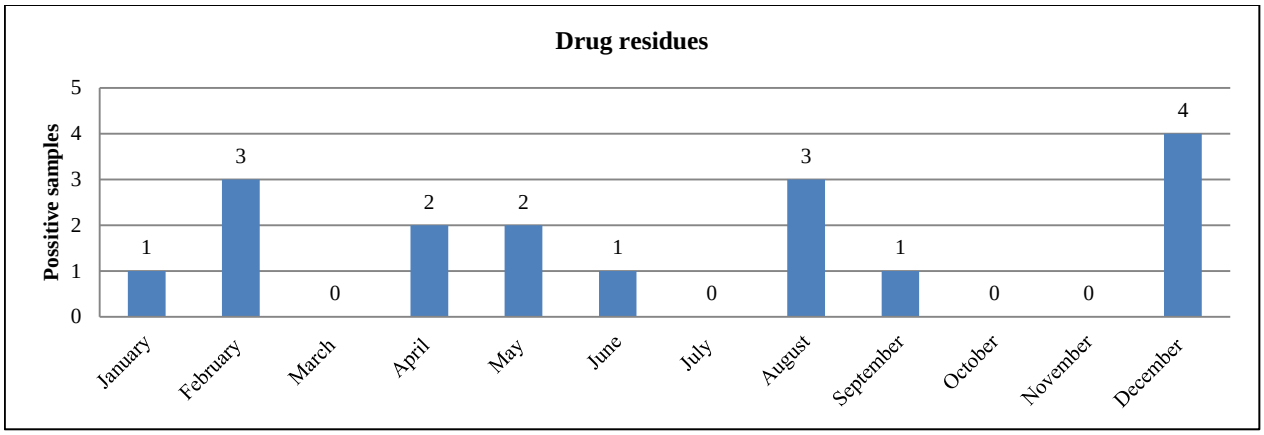

Fig. 8 Results of determination of drug residues in bulk raw cow's milk in Slovakia in 2011

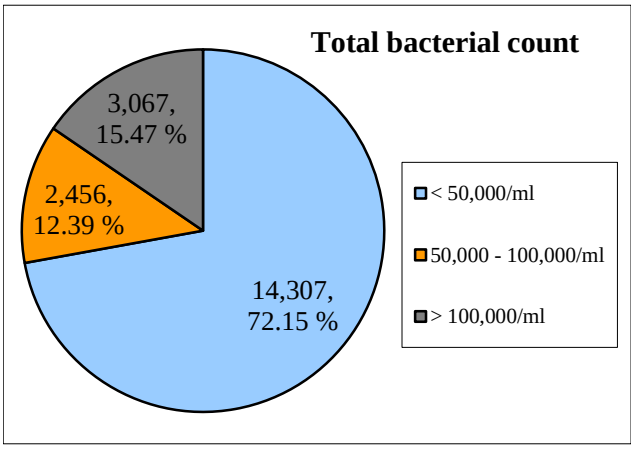

Fig. 9 Results of total bacterial count in raw cow`s milk divided into three categories

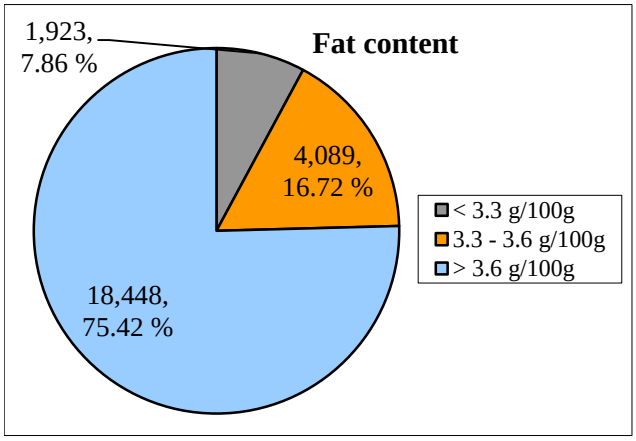

Fig. 11 Results of determination of fat content in raw cow's milk divided into three categories

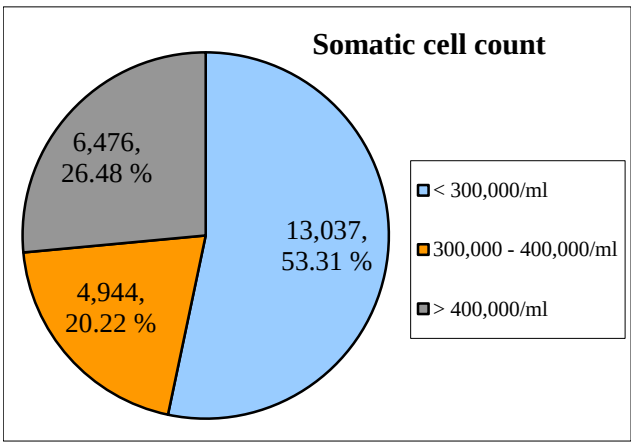

Fig. 10 Results of determination of somatic cell count in raw cow's milk divided into three categories

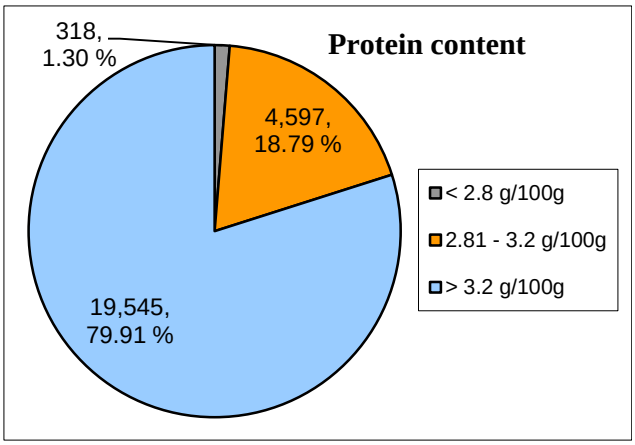

Fig. 12 Results of determination of protein content in raw cow's milk divided into three categories

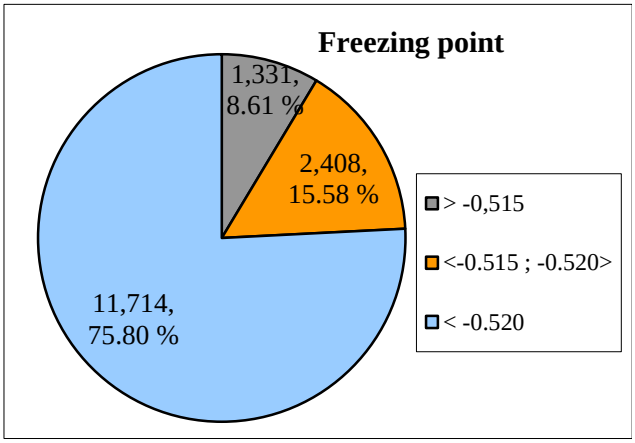

Fig. 13 Results of freezing point in raw cow's milk divided into three categories

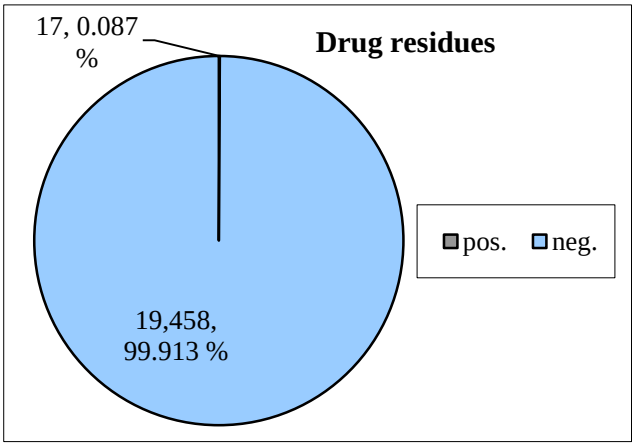

Fig. 14 Results of drug residues in raw cow's milk divided into two categories

The results from bulk cow's milk collected from dairy farms in Slovakia in 2011 show that 15.47 % of samples did not met the legislation limit of a maximum of 100 x10^3 CFU.ml^{-1} total bacterial count. We found that the highest increase in the average total bacterial count, 84 x 10^3 CFU.ml^{-1} and 87 x 10^3 CFU.ml^{-1}, were in summer period in July and August respectively. The lowest average total bacterial count, 55 x 10^3 CFU/ml and 58 x 10^3 CFU.ml^{-1}, were detected in November and December respectively.

The lowest average somatic cell count (97 x 10^3 SC.ml^{-1}) was detected in November, and the highest increase in the average somatic cell count (367 x 10^3 SC.ml^{-1}) was seen in August. We found that 26.48 % of samples did not met the legislation limit of 400 000 SC.ml^{-1} in 2011.

The percentage of unsatisfactory results did not mean that farmers had to be immediately penalised, because in Slovakia a rolling geometric mean is used, according to the Commission Regulation EC No. 1662/2006. However, there is a large potential to improve the quality and safety of raw cow's milk, as well as economic losses in dairy farms in Slovakia.

Other indicators of quality and safety were tested. We found that the minimum average fat content was 3.605 g/100g in July and maximum average fat content was 4.055 g/100g in November and 7.86 % of samples did not meet the limit presented in STN 570529:1999, 16.72% of samples had a fat content between 3.3 - 3.6 g/100g and 75.42% of samples had a fat content >3.6 g/100g. This means that 92.14% of samples meet the limit presented in STN 570529:1999. **Bujko et al. (2011)** evaluated milk performance indicators in dairy cows of the Holstein breed. They found a fat content 3.87 g/100g. **Heck et al. (2009)** found a fat content of 4.38 g/100g. **Tamime (2009)** indicate a fat content 3.70 g/100g. **Chandan et al., (2008)** indicate a fat content 3.80 g/100g. According to **Hui (2009)** milk has to contain not less than 3.25 g/100g of milk fat. The fat content of milk for various breeds differs. The Holstein breed contains 3.54 g/100g, Ayshire 3.95 g/100g, Jersey 5.13 g/100g and Brown Swiss 3.99 g/100g **(Hui, 2009)**.

We found that the highest increase in average fat content was over the winter period. The lowest average fat content was detected during the summer period.

The minimum average protein content was 3.235 g/100g in July and maximum average protein content was 3.520 g/100g in November, and 1.30 % of samples did not meet the limit presented in STN 570529:1999, 18.79% of samples had a protein content between 2.81 - 3.2 g/100g and 79.91% of samples had a protein content >3.2 g/100g. This means that 98.7% of samples meet the limit presented in STN 570529:1999.

Bujko et al. (2011) found an average protein content of 3.36 g/100g. **Heck et al. (2009)** found a protein content of 3.48 g/100g. According to **Tamime (2009) and Chandan et al., (2008)** the protein content in raw cow's milk is 3.4 g/100g. We found that the highest increase in the average protein content was in the autumn and winter periods. The lowest average protein content was detected in the summer period. According to **Hui (2009)**, the protein content of milk of the Holstein breed is 3.29 g/100g, Ayshire 3.48 g/100g, Jersey 3.98 g/100g and Brown Swiss 3.64 g/100g **(Hui, 2009)**.

We found that the highest increase in the average lactose content (4.875 g/100g) was in May. **Heck et al. (2009)** found a lactose content of 4.51 g/100g. According to **Tamime (2009) and Chandan et al., (2008)** the lactose content is 4.8 g/100g, and **Bujko et al. (2011)** found a lactose content of 4.96 g/100g.

The lowest average solids-not-fat content was 8.565 g/100g in July. We found that the highest increase in the average solids-not-fat content (8.93 g/100g) in February. According to **Hui (2009),** milk has to contain not less than 8.25 g/100g of solids-not-fat.

Based on our results we agree with the results published by **Hui (2009)**, regarding seasonal variations in protein and fat content in raw cow's milk. We found the largest decrease in the fat and protein content was during the summer period and the largest increase in the winter period. This seasonal variation can lead to significant economic consequences.

The lowest average freezing point was -0.524 °C and 8.61% of samples did not meet the limit of STN 570529:1999, 15.58% of samples had freezing point in interval <-0.515 ; -0.520> and 75.80% of samples had freezing point <-0.520 °C. This means that 91.38% of samples meet the limit presented in STN 570529:1999.

Heck et al. (2009), found a freezing point of -0.519 °C.

We found that the highest average freezing point was -0.527 °C, detected in the spring period in April and May.

We have found 17 drug positive samples representing 0.087% of all samples.

CONCLUSION

The quality and safety of raw cow's milk in Slovakia in 2011 was satisfactory. However, there is a large potential to improve farm management to eliminate economic losses in dairy farms. We found that 73.53 % of samples tested for somatic cells count, and 84.54 % samples tested for total bacterial count, met the legislation limits. We found the largest decrease in the fat and protein content was during the summer period and the largest increase in the winter period. We found that 92.14 %, 98.7 % and 91.38 % of samples met the limit presented in STN 570529:1999 for fat content, protein content and freezing point respectively. The percentage of drug positive samples was 0.087 %.

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