UDC 637.12.046

DOI 10.29326/2304-196X-2019-1-28-29-33

MONITORING OF CALCIUM CONTENT OF RAW COW MILK

Ye. S. Kandinskaya[1], S. V. Redkin[2], G. V. Chebakova[3]

[1] Post-Graduate Student, FEI HE Moscow State Academy of Veterinary Medicine and Biotechnology – Moscow Academy of Veterinary Medicine named after K. I. Skriabin, Moscow, Russian Federation, *e-mail: kandinskaya@gmail.com*

[2] Associate Professor, Candidate of Science (Biology), FEI HE Moscow State Academy of Veterinary Medicine and Biotechnology – Moscow Academy of Veterinary Medicine named after K. I. Skriabin, Moscow, Russian Federation

[3] Associate Professor, Candidate of Science (Veterinary Medicine), FEI HE Moscow State Academy of Veterinary Medicine and Biotechnology – Moscow Academy of Veterinary Medicine named after K. I. Skriabin, Moscow, Russian Federation

SUMMARY

Milk is a natural food product that is unique in its nutritive value and significance for human organism. Its composition is balanced in major biochemical components as well as mineral components including calcium. Calcium is essential for many metabolic processes and is contained in milk in easily digestible and phosphorus-balanced form. Therefore, decrease in its content in milk creates prerequisites for insufficient meeting the body need in the said microelement and has an effect on human metabolism especially in children. Results of laboratory testing of 400 milk samples collected from clinically healthy Holstein and Black and White Spotted cows kept on 40 farms located in the Moscow Oblast in 2001–2017 are presented. The raw milk was examined for the following quality indicators: sensory, physical and chemical as well as microbiological parameters. It was found that calcium concentration in milk depended on the season. It was shown that the majority of tested milk samples did not comply with the veterinary and sanitary quality parameters despite of the tendency to increase in analyzed parameter content in autumn. The monitoring showed recent decrease in calcium content of cow milk and dairy products intended for infant food. Average calcium content of raw milk was found to be 900–950 mg; it varied from 700 up to 1,100 mg of calcium/litre of milk. Further testing scheme based on analysis of such factors as pure protein, diet, biologically active dietary supplements is proposed. Such testing will allow comprehensive assessment of exogenous factors influencing calcium content of milk as well as harmonization of Russian requirements for food quality and safety assessment with the European ones.

Key words: milk and dairy products, monitoring, veterinary and sanitary quality assessments, calcium content of milk.

INTRODUCTION

The state policy of the Russian Federation is aimed at preserving health and increasing life expectancy of the country's population [6]. Milk and dairy products that are traditionally considered highly important and balanced in terms of nutritional and biological value take a special place in human diet. In 2016 Russia held the fifth position in global milk production. The share of the Russian Federation is 6.2% of the world's cow milk production. Just in the last 4 years exports to China have increased by 42 times, while supplies to other countries have increased by 38%, which shows the great potential of the Russian dairy industry in the global market [8].

Federal Law No. 184-FZ "On Technical Regulation" of December 27, 2002 established uniform product requirements mandatory for implementation with regard to the objects of technical regulation. This indicates that the national standards and other normative documents were harmonized with the requirements of the World Trade Organization [5]. In the context of Russia's activities within the Eurasian Economic Community (EAEC), the quality and safety of raw milk and dairy products are determined by national and interstate standards and are governed by technical regulations of the Customs Union "On food safety" (TR CU 021/2011) and "On safety of milk and dairy products "(TR CU 033/2013) which are aimed at obtaining dairy products according to established criteria guaranteeing the quality and safety of products and governing conditions for their production, transportation, processing, storage and marketing. Within the Russian national standard the basic requirements for the quality of collected milk are specified in GOST P 52054-2003 (with modifications No. 1 and 2), as well as interstate GOST 31449-2013 [2, 3].

Violation of veterinary and sanitary rules and infringement of technology of collecting, processing and storing milk and dairy products can cause food toxicosis, bacterial food poisoning and outbreaks of zooanthroponotic diseases etc. [1]. In this regard milk raw materials and dairy products entering the Russian market shall meet certain requirements based on criteria for quality and safety assessment in compliance with veterinary legislation and

sanitary rules [7, 9, 10]. Therefore, a continuous objective assessment of milk quality and safety is needed to update the current requirements for milk quality.

Milk quality depends on a number of exogenous and endogenous factors such as the animal species and breed, age, lactation stage, feeding and keeping conditions, health and others. The main parameters of naturalness and quality of raw milk are the content of protein and fat, casein, the amount of whey protein, acidity, density, the freezing point of milk, etc.

At present the calcium content of milk and products thereof is an important criterion for consumers of dairy products, especially infant food. Calcium is essential in a great number of constructive metabolic processes and is found in an easily digestible and phosphorus-balanced form in milk. Therefore, its content reduction in milk creates the preconditions for the organism's deficiency of this element and affects human metabolism, especially in children. It is therefore very urgent to optimize calcium content in raw milk, as well as by means of modern technological methods aimed at targeted metabolism change in the animal, e. g. using biologically active feed additives.

Specialists in different scientific and practical spheres have been engaged in the problem of raw milk quality in recent years. The research works of such scientists as V. M. Kartashova, L. D. Demidova, G. A. Talanov, G. A. Larionov et al. are devoted to improvement of animal health safety and technological quality of milk. Due to the fact that the feeding factor is considered one of the most significant ones in the system providing a high quality product of animal origin, the use of new biologically active components is reviewed by many scientists, such as M. M. Andreev, V. Karpov, V. Kasalapov, V. A. Medvedsky et al.

By implementing intensive technology of milk production the measures aimed at normalizing metabolic processes in livestock are becoming more and more significant. In order to increase milk productivity, milk fat content, its saturation with vitamins, microelements and other nutrients some researchers, such as A. V. Vostroilov, S. N. Semyonov, M. A. Kustov, V. I. Trukhachyov et al. designed highly digestible feed and feed additives of natural origin.

At present, however, an insignificant number of papers on reduction of calcium content in milk from healthy animals influenced by various factors are available. There are no scientifically substantiated and experimentally proven effects of lack of calcium in raw milk for the human body. In connection with the foregoing, a more detailed study of calcium reduction taking into account factors that affect the veterinary and sanitary cow milk quality determines the relevance of the study.

The objective of this study is to monitor the calcium content of cow milk under endogenous and exogenous factors.

MATERIALS AND METHODS

The studies were conducted at the Department of Parasitology and Veterinary and Sanitary Examination and Microbiology of the FEI HE Moscow State Academy of Veterinary Medicine and Biotechnology – Moscow Academy of Veterinary Medicine named after K. I. Skriabin as well as external accredited laboratories and centers.

The object of the study was raw milk from clinically healthy Holstein and Black and White Spotted cows.

Laboratory testing of 400 raw milk samples obtained from 40 breeding farms of the Moscow Oblast in 2001–2017 was carried out. The raw milk was examined for the following quality indicators: sensory, physical and chemical as well as microbiological parameters.

Milk quality and safety indicators were determined in accordance with the technical regulations of the Customs Union "On safety of milk and dairy products" (TR CU 033/2013) and "On food safety" (TR CU 021/2011) [9, 10].

Milk was examined for physical and chemical parameters according to GOST P 52054-2003 [3]. Determination of calcium salts in the milk was carried out according to GOST P 55331-2012 [4].

Fig. Calcium content monitoring in raw cow milk

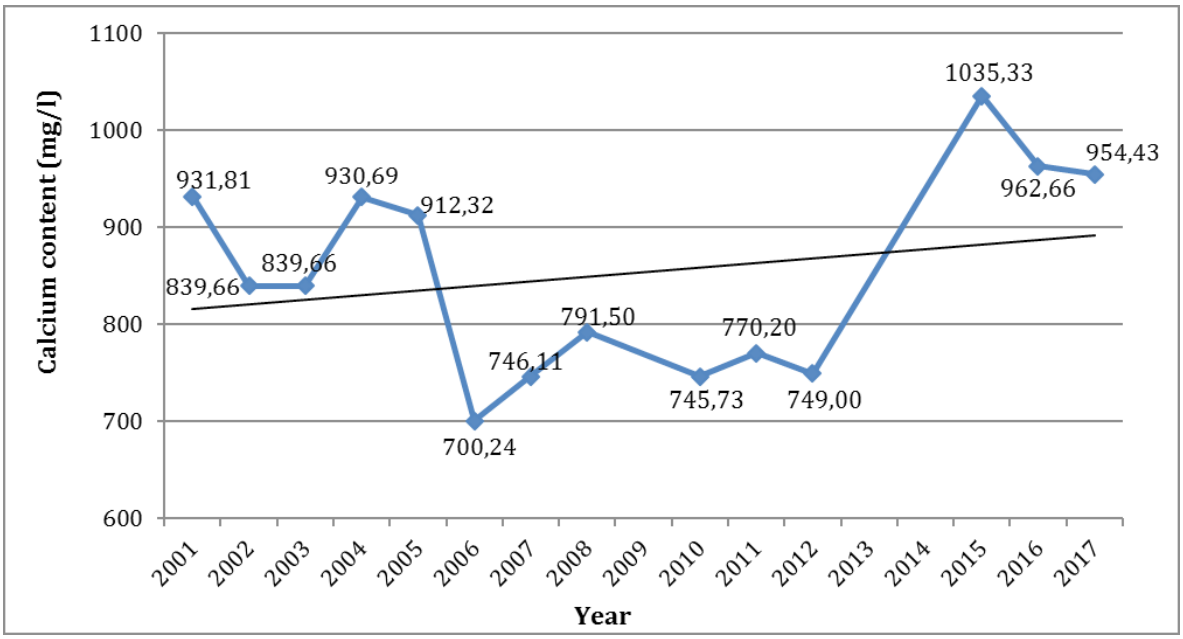

Table 1
Calcium content in raw cow milk

Year	Ca (mg/l)		
	mean value	min	max
2001	931.81 (±86.69)	462.9	1208.2
2002	839.66 (±96.68)	645.6	1067.0
2003	839.66 (±163.47)	466.0	1083.8
2004	930.69 (±88.54)	681.2	1134.0
2005	912.32 (±68.81)	702.0	1102.0
2006	700.24 (±64.68)	572.0	806.0
2007	746.11 (±97.03)	564.0	1044.0
2008	791.50 (±58.89)	678.0	870.0
2010	745.73 (±34.33)	618.0	840.0
2011	770.20 (±79.77)	558.0	866.0
2012	749.00 (±26.87)	730.0	768.0
2015	1035.33 (±14.62)	1016.0	1050.0
2016	962.66 (±58.51)	829.9	1048.7
2017	954.43 (±43.51)	760.0	1160.0

Analysis of data obtained within this study was conducted based on descriptive statistics where the arithmetic mean, error of the mean, standard deviation were determined. Variability of the studied characteristics was described with minimum and maximum values and the ratio of the standard deviation to the arithmetic mean value in percentage (variation coefficient (V, %).

RESULTS AND DISCUSSION

The advantage of the physiological value of milk in human nutrition is its balanced composition of not only main biochemical components but also minerals including calcium. The role of calcium in the body is enormous: it is essential for heart activity and is a blood component; it participates in constructive metabolic processes and in the formation of bone tissue; it is part of the cell structure; it participates in regulating acid-base balance of the internal environment of the body and normal functioning of many vital systems. It stabilizes the protective mechanisms that increase the body's resistance to diseases and external adverse factors.

The monitoring conducted in 2001–2017 shows that in recent years there has been a tendency to reduce the calcium content of cow's milk, particularly in dairy products intended for infant food. The mean calcium content, as well as its minimum and maximum concentrations in raw milk for the analyzed period are presented in Table 1.

It was determined that the mean calcium content in raw milk was at the level of 900–950 mg and a fluctuation range was from 700 to 1,100 mg of calcium per 1 liter of milk. Despite the fact that the trend line shown in the figure reflects a tendency for increase in the levels of the mean values of the analyzed indicator, it should be concluded that the calcium content of the raw milk does not comply with CU TR 021/2011 and CU TR 033/2013 [9, 10].

In this regard the studies have been conducted to identify the causes and factors affecting the variation in the calcium content of milk raw materials. One of the stages of the research was to study the influence of the season on the calcium content of milk raw materials. The data received for the analyzed period are presented in Table 2.

Despite the fact that during the analyzed period there is a significant variation in the standard deviation of the mean value, there was a tendency for increase in the milk calcium concentration in autumn. The dependence of the calcium content on the season is confirmed by laboratory tests conducted by a number of external accredited testing centers. However, the mean value of this indicator is at the level of 850–900 mg/l.

At present the department is carrying out comprehensive studies to identify the causes and factors affecting the decrease in calcium concentration below the physiological norm.

One of research directions is the identification of the calcium dependence on the true protein, based on the fact that about 22% of the total amount of calcium is closely connected with casein, the rest is in the form of calcium phosphates and citrates. Another area of research involves analysis of calcium content in milk, depending on food, feed and industrial crops, as well as dietary supplements used for animal feed. Analysis of endogenous and exogenous factors will allow in the future to establish cause-and-effect relationships that influence the change of the calcium content, and conduct a comprehensive assessment of the quality of milk.

It should be noted that development of new approaches aimed at improving milk quality is quite a relevant and promising challenge in modern-day conditions. One of the approaches to optimize the calcium content in dairy products is obtaining products containing calcium-enriched organic and inorganic additives.

Table 2
Calcium content in raw milk depending on the season

Year	Ca (mg/l)			
	Spring	Summer	Autumn	Winter
2001	1030.05 (±66.47)	969.65 (±66.75)	566.11 (±101.49)	992.87 (±86.69)
2002	963.38 (±68.64)	–	860.60 (±67.47)	779.08 (±77.24)
2003	695.91 (±47.78)	628.94 (±81.14)	932.24 (±82.87)	916.23 (±145.89)
2004	769.08 (±54.65)	939.21 (±83.46)	948.22 (±77.51)	945.20 (±54.55)
2005	914.91 (±65.57)	–	955.00 (±131.14)	805.00 (±69.16)
2006	693.75 (±68.88)	715.33 (±62.25)	–	713.33 (±49.57)
2007	698.88 (±53.06)	–	–	761.26 (±103.15)
2008	–	–	–	791.50 (±58.89)
2010	840.00 (0)	703.71 (±19.34)	–	693.50 (±52.67)
2011	732.70 (±82.99)	–	808.91 (±59.74)	769.00 (±15.56)
2012	749.00 (±26.87)	–	–	–
2015	–	–	–	1035.33 (±4.62)
2016	–	961.05 (±56.72)	964.28 (±61.41)	–
2017	913.30 (±38.6)	940.00 (±42.70)	1010.00 (±34.9)	–
The mean	818.27 (120.01)	836.84 (147.14)	874.42 (141.91)	836.57 (115.89)

CONCLUSION

Analysis of monitoring results showed that the samples received from the milk producers of livestock farms in the Moscow Oblast showed the tendency for decrease of calcium content in milk, particularly in dairy products intended for infant food. The mean calcium content in raw milk during the analyzed period was at a level of 900–950 mg/l, a fluctuation range was from 700 to 1,100 mg of calcium/1 litre of milk. Despite the trend for increase, especially in autumn, the calcium content in milk did not meet the requirements based on criteria for quality and safety assessment in accordance with the veterinary legislation and sanitary rules.

Conflict of interest. The authors declare no conflict of interest.

REFERENCES

1. Borovkov M. F., Frolov V. P., Serko S. A. Veterinary and sanitary examination and basic animal product technology and standardization principles [Veterinarno-sanitarnaya ehkspertiza s osnovami tekhnologii i standartizacii produktov zhivotnovodstva]. ed. by Prof. M. V. Borovkova. 3rd revised and updated edition. SPb.: Lan', 2010 (in Russian).

2. GOST 31449-2013. Raw cow's milk. Specifications: international standard [Moloko korov'e syroe. Tekhnicheskie usloviya: mezhgosudarstvennyj standart]. M.: Standartinform, 2013 (in Russian).

3. GOST R 52054-2003. Raw cow's milk. Specifications (amended No. 1, 2): approved by the Order of the Federal Agency for Technical Regulation and Metrology No. 885-st of August 11, 2017 [Moloko korov'e syroe. Tekhnicheskie usloviya (s izmeneniyami № 1, 2): utv. Prikazom Federal'nogo agentstva po tekhnicheskomu regulirovaniyu i metrologii ot 11.08.2017 № 885-st]. Enacted on January 1, 2004. URL: http://docs.cntd.ru/document/1200032024 (in Russian).

4. GOST R 55331-2012. Milk and dairy products. Titrimetric method of calcium content determination: approved by the Federal Agency for Technical Regulation and Metrology: approved by the Order of the Federal Agency for Technical Regulation and Metrology No. 1653-st. of November 29, 2012 [Moloko i molochnye produkty. Titrimetricheskij metod opredeleniya soderzhaniya kal'ciya: utv. Prikazom Federal'nogo agentstva po tekhnicheskomu regulirovaniyu i metrologii ot 29.11.2012 № 1653-st]. Enacted on January 1, 2014. URL: http://docs.cntd.ru/document/1200097842 (in Russian).

5. On Technical Regulation. RF Federal Law No. 184-FZ of December 12, 2002 [O tekhnicheskom regulirovanii: Federal'nyj zakon RF ot 27.12.2002 № 184-FZ] (as amended on July 29, 2017). *Rossiyskaya gazeta*. 2002; 245 (December 31) (in Russian).

6. RF President Address to the Federal Assembly [Poslanie Prezidenta Federal'nomu Sobraniyu]. URL: http://www.kremlin.ru/events/president/news/53379 (access date: 11.12.17) (in Russian).

7. SanPiN 2.3.2.1078-01. Hygiene requirements for safety and nutrition value of foodstuff (as amended on July 6, 2011): approved by Chief Medical Officer of the Russian Federation on November 6, 2001 [SanPiN 2.3.2.1078-01. Gigienicheskie trebovaniya bezopasnosti i pishchevoj cennosti pishchevyh produktov (s izmeneniyami na 6 iyulya 2011 g.): utv. Glavnym gosudarstvennym sanitarnym vrachom RF 06.11.2001]. URL: http://docs.cntd.ru/document/901806306 (access date: 05.10.17) (in Russian).

8. National Dairy Producers Union (Soyzmoloko) made a presentation at Dairy Production Conference within the World Food-2017 [Soyuzmoloko vystupil s dokladom na molochnoj konferencii World Food-2017]. URL: http://www.souzmoloko.ru/news/news_4085.html (access date: 05.12.17) (in Russian).

9. Technical Regulation of the Customs Union TR CU 021/2011 on food product safety: approved by the Customs Union Commission Decision No. 880 of December 9, 2011 [Tekhnicheskij reglament Tamozhennogo soyuza TR TS 021/2011. O bezopasnosti pishchevoj produkcii: utv. resheniem Komissii Tamozhennogo soyuza ot 09.12.2011 № 880]. URL: http://docs.cntd.ru/document/902320560 (in Russian).

10. Technical Regulation of the Customs Union TR CU 033/2013 on safety of milk and dairy products: approved by the Eurasian Economic Commission Board Decision No. 67 of October 9, 2013 [Tekhnicheskij reglament Tamozhennogo soyuza TR TS 033/2013. O bezopasnosti moloka i molochnoj produkcii: utv. resheniem Soveta Evrazijskoj ehkonomicheskoj komissii ot 09.10.2013 № 67]. URL: http://docs.cntd.ru/document/499050562 (in Russian).

Submitted on 24.09.18
Accepted for publication on 20.12.18