The content of heavy metals in cows of different breeds

T V Zaznobina¹, O V Ivanova¹

¹ Krasnoyarsk Research Institute of Animal Husbandry FRC KSC SB RAS, 66, Mira ave., Krasnoyarsk, 660049
E-mail: krasnptig75@yandex.ru

Abstract. Nowadays, one of the environmental problems is the pollution of the environment with heavy metals, the release of which leads to accumulation in the body of animals. The aim of the research was to study the content of heavy metals in the body of cows of different breeds in a separated agricultural enterprise. Researches were held in LLC ”EIF Solyanskoe” of Krasnoyarsk region. The objects of research were the blood, urine and milk of cows Red-Motley breed and Black-Motley breed at the age of the second lactation. The result of research determined that concentration of Cu, Zn and Pb in milk and blood serum of Red-Motley cows was more than in Black-Motley cows; on the contrary, in urine the concentration of the studied metals was higher in Black-Motley cows. In general, the content of heavy metals in milk, blood serum and urine of cows of both breeds did not exceed the maximum permissible concentrations, with the exception of Pb in milk, the existence of which was slightly higher than the hygienic norm by 0.02–0.03 mg/kg.

1. Introduction

One of the main directions of the economic policy of the Russian Federation in the sphere of food security is the production of safe food and consumer protection [1]. Food products that do not pose a danger to the human body and do not have harmful effects on the health of present and future generations are considered safe [2].

However, there are a number of threats to food safety, one of which is the pollution of the environment with heavy metals [3, 4, 5].

As a result of anthropogenic activities, territories contaminated with various toxic elements appear thus, it becomes difficult to obtain environmentally safe products [6].

The ingress of salts of heavy metals in natural ecosystems occurs mainly because of emissions of road transport, emissions, sewage and waste from industrial enterprises, the use of chemical agents in agricultural work.

The release of heavy metals into the environment leads to their accumulation through biological and trophic chains in animal’s organism.

The toxicants migrate from animal’s organism into livestock products, including milk [7].

A negative consequence of the impact of heavy metals such as copper, zinc, cadmium, lead on the animal’s body is a violation of metabolic processes, the occurrence of pathological diseases [8].

Being in milk and dairy products, toxic substances can cause food poisoning and cause a carcinogenic and mutagenic effect on the human body [8, 9, 10].

The main measures to prevent poisoning by heavy metals are monitoring of their content in the products and control their concentrations in animal’s organism.
In this regard, researches of toxic elements contained in milk, blood and urine of cows are relevant and important in the production of environmentally safe products.

The aim of the research is to study the content of heavy metals in the organism of different breeds cows in a separated agricultural enterprise.

2. Materials and methods
Research was conducted in LLC "EIF Solyanskoе" Rybinsk district of the Krasnoyarsk region according to the scheme of research (Fig. 1).

The objects of survey were the blood, urine and milk of Red-Motley and Black-Motley breeds cows at the age of the second lactation. Method of keeping cows on the farm – tied housing, feeding of animals according to the rations balanced for all major nutrients and energy.

Milk sampling was carried out in accordance with GOST 26809.1-2014 [11], blood and urine samples were taken from 3 animals from each group before morning feeding, while blood was taken from the subcutaneous vein using a vacuum sampling system of venous blood PUTH Vacumine 3, urine – in a disposable container in the amount of 10 ml.

The study of milk samples of cows for the content of heavy metals was carried out by atomic absorption method in the certified testing center of RSI "Regional veterinary laboratory" on the atomic absorption spectrophotometer "Solar series S". Blood serum was obtained by settling whole blood and retraction of the blood clot, followed by centrifugation using a laboratory centrifuge "ULAB UC-1412D" at 2000 rpm for 10-15 minutes. The investigation of the obtained blood serum and urine was carried out by mass spectrometry in the laboratory of Institute of Chemistry of FRC KSC SB RAS on a quadrupole mass analyzer "Agilent 7900 ICP-MS" with inductively coupled plasma.

Environmental safety of milk was determined in accordance with SanPiN 42-123-4089-86 "Maximum allowable concentration of heavy metals and arsenic in food raw materials and food products" [12].

Biometric processing of experimental data was performed on a personal computer using Microsoft Excel.
3. Results

As a result of the research, it was determined that the concentration of Cd in the milk of tested cows was at the same level. In the milk Red-Motley cows the amount of Cu was more by 0.13 mg/kg, Zn – by 0.62, Pb – by 0.01 mg/kg than in the milk Black-Motley cows (Fig. 2).

![Figure 2. Heavy metals content in the milk cows (M±m), mg/kg](image)

It was noted the detected concentrations of Pb in the milk of cows of both breeds slightly exceeded the hygienic norm by 0.02–0.03 mg/kg; the concentration of other metals was within the norm.

Thus, the allocation of heavy metals in the milk of cows of the two breeds was arranged in descending order in the following sequence: Zn > Cu > Pb > Cd.

The analysis of blood serum of cows (Fig. 3) was indicated that cows of Red-Motley breed have content of Cu higher by 0.019 mg/kg, Zn – by 0.006, Pb – by 0.001 mg/kg in comparison with Black-Motley breed. The concentration of Cd in the blood serum of both breeds was the same.

![Figure 3. Heavy metals content in the blood serum of cows (M±m), mg/kg](image)
The content of heavy metals in the blood serum of the analyzed breeds of cows did not exceed the values of hygienic norms.

The concentration of chemical elements in the blood serum of Red-Motley breed decreased in a number of Cu > Zn > Pb > Cd, cows of Black-Motley breed – in a number of Zn > Cu > Pb = Cd.

As a result of the analysis of the content of heavy metals in urine (Fig. 4), it was found that cows of Black-Motley breed in comparison with Red-Motley breed contained more Cu and Zn on 0.002 mg/kg, Pb on 0.020 mg/kg. The concentration of Cd in urine of cows of both breeds was the same.

![Figure 4](image_url). Heavy metals content in urine of cows (M±m), mg/kg

The content of heavy metals in the urine of cows of Red-Motley and Black-Motley breed did not exceed the MAC values. In cows of Red-Motley breed concentration of toxic metals decreased in a number of Zn > Cu > Pb = Cd, in cows of Black-Motley breed – in a number of Zn > Pb > Cu > Cd.

4. Conclusion

Thus, the analysis of the content of heavy metals in milk, blood serum and urine of cows breeding in LLC "EIF Solyanskoe" Krasnoyarsk region, indicates that in milk and serum of red-motley breed cows is accumulated more Cu, Zn and Pb in comparison with Black-motley breed. In the urine concentration of these metals was higher in cows of Black-Motley breed. At the same time, the identified amounts of toxic elements were within acceptable values, with the exception of Pb in milk (the excess was 0.02–0.03 mg/kg).

References

[1] Medvedskaya T V, Subbotin A M and Matsinovich M C 2009 Environmental safety in the production of livestock products (Vitebsk)

[2] Federal Law N 29 2000 About quality and food safety (Moscow: AO «Kodeks») pp 34

[3] Batmanov A V 2017 Accumulation of heavy metals introduced varieties of strawberries in the conditions of the steppe zone of the Samara Zavolzhye: synopsis of thesis. ... Cand. of Agr. (Ust-Kinel'sky)

[4] Rahman M A, Rahman M M, Reichman S M, Lim R P and Naidu R 2014 Heavy metals in Australian grown and imported rice and vegetables on sale in Australia: Health hazard Ecotoxicology and Environmental Safety 100(1) 53–60
[5] Nazir R, Khan M, Masab M, Rehman H U, Rauf N U, Shahab S, Ameer N, Sajed M, Ullah M, Rafeeq M and Shaheen Z 2015 Accumulation of heavy metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physico-chemical parameters of soil and water collected from Tanda Dam kohat J. Pharm. Sci. & Res. 7(3) 89–97

[6] Mamenko А M and Portyannik S V 2010 Migration of heavy metals in milk of cows in conditions of environmental pollution. pollutants and xenobiotics Vestnik UGSHA 2(12) 85–91

[7] Fedorovich V V, Siratsky I Z, Boiko E V and Stadnitskaya O I 2013 Microelements in milk and blood of cows of Ukrainian black-and-white dairy breed Actual problems of intensive development of animal husbandry 16(2) 54–60

[8] Darwish W S, Hussein M A, El-Desoky K I, Ikenaka Y, Nakayama S, Mizukawa H and Ishizuka M 2015 Incidence and public health risk assessment of toxic metal residues (cadmium and lead) in Egyptian cattle and sheep meats Int. Food Res. J. 22 4 1719–26

[9] Suldina T I 2016 The content of heavy metals in food and their impact on the body Nutrition. dietary supplements and biostimulants 1 136–40

[10] Lobkov V J, Yarlykov N G and Eremeeva A N 2017 Evaluation of cow milk safety indicators in the farms of the Yaroslavl region Bull. of AI of Verkhnevolzhya 2(38) 27–32

[11] GOST 26809.1-2014 2015 Milk and dairy products. Acceptance rules. sampling methods and preparation of samples for analysis. Introduct. 2016-01-01 (Moscow: Standartiform)

[12] SanPiN 42-123-4089-86 1986 Maximum allowable concentrations of heavy metals and arsenic in food raw materials and food products. Introduct. 1986-03-31 (Moscow: Izd-vo standartov)