IJBPAS, July, 2015, 4(7): 5013-5020

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

STUDY ON THE LEAD AND CADMIUM CONCENTRATIONS IN MILK DAIRIES IN SANANDAJ AREA

AHSAN RAHIMI[1], AMIRPARVIZ REZAIESABER[2*]

1: Department of Veterinary Medicine, Tabriz Branch, Islamic Azad University, Tabriz, Iran

2: Department of Clinical Sciences, Tabriz Branch, Islamic Azad University, Tabriz, Iran

***Corresponding Author's: E Mail: Am_rezaei@iaut.ac.ir**

ABSTRACT

Milk as an excretion of the mammary gland can carry numerous xenobiotic substances, which constitute a technological risk factor for dairy products and, above all, for the health of the consumer. Determination of the residual concentrations of metals in milk could be an important. Therefore, the aim of this study was the measure the concentrations of toxic heavy metals in the milk of Holstein-Friesian cows of Sanandaj province.The research material comprised milk obtained from 100 dairy cows from 4 areas of Sanandaj province (North, South, West, East; 25 samples from each). Elements (Cd, Pb) were determined using inductively coupled plasma emission atomic spectrometry by means of an Optima 2000 DV instrument (PerkinElmer Inc.), after mineralization in a microwave system using the Anton Paar microwave oven. Measurements were made along the plasma in an axial direction. The present research showed that the milk of cows had higher levels of toxic heavy metals compared to the standard levels. Also, based on Pearson correlation index calculated in present study it shows that there is a reverse and significant correlation between lead amounts in milk and age of animals. As well as, there is a reverse and significant correlation between Cadmium amounts in milk and age of animals. So, authors suggest other researches in this field. The level of heavy metals in Sanandaj province is very high and must be taken measures in this filed.

Keywords: Cadmium, Lead, Milk, Cow

INTRODUCTION

Milk as an excretion of the mammary gland can carry numerous xenobiotic substances, which constitute a technological risk factor for dairy products and, above all, for the health of the consumer. Determination of the residual concentrations of metals in milk could be an important “direct indicator” of the hygienic status of the milk, as well as an “indirect indicator” of the degree of pollution of the environment in which the milk was produced (Licata et al. 2004; González-Montaña et al. 2012).

In the last few years, the contamination of milk is considered as one of the main dangerous aspects. Trace metals are a general collective term applying to the group of metals and metalloids with an atomic density greater than 6 g/cm. This term is widely recognized and usually applied to the elements such as cadmium (Cd), Cu, Fe, lead (Pb), and Zn which are commonly associated with pollution and toxicity problems (Malhat et al. 2012). One of the main problems with metals is their ability to bio-accumulate. Metal residues in milk are of particular concern because milk is largely consumed by infants and children (Tripathi et al. 1999).

The food chain is an important source of Cd and Pb accumulation, especially for plants grown on polluted soils. Significant amounts of Cd and Pb can be transferred from contaminated soil to plants and grass, causing accumulation of these potentially toxic metals in grazing ruminants, particularly in cattle (López Alonso et al. 2003; Miranda et al. 2005). Accumulation of Cd and Pb in ruminants causes toxic effects in cattle, but also in humans consuming meat and milk contaminated with toxic metals (González-Weller et al.2006; Vromman et al. 2008; Cai et al. 2009).

Cd and Pb are amongst the elements that have caused the most concern in terms of adverse effects on human health. This is because they are readily transferred through food chains and are not known to serve any essential biological function. Lead is a pervasive and widely distributed environmental pollutant with no beneficial biological roles. The poisoning is more common in farm ruminants, which are considered most susceptible to the toxic effects of lead (Swarup et al. 2005). For that reason, the concentration of Cd and Pb in cow's milk should be monitored to ensure the consumers' health (Jen et al. 1994).

In most studies, the concentrations of toxic heavy metals and trace elements were determined in the milk obtained most frequently from Holstein-Friesian cows. Therefore, the aim of this study was the measure the concentrations of toxic heavy metals in the milk of Holstein-Friesian cows of Sanandaj province.

MATERIALS AND METHODS

The research material comprised milk obtained from 100 dairy cows from 4 areas of Sanandaj province (North, South, West, East; 25 samples from each).

The animals were kept in a loose barn with a free access to the stockyard located along the long walls of the building. Winter feeding of cows was based on the preserved feeds obtained from the farm (maize silage, wilted silage, ensilaged sugar beet pulp, hay, and concentrates), whereas during the summer feeding, cows additionally used the pasture.

Milk samples from a total of 100 cows (25 samples from each area) at the amount of 10 mL from one cow were taken. Animals consisted of cows of the similar milk yield (3,800–4,000 kg), similar age (3–7 years old), and similar lactation stage (100–150 day post-calving).

Elements (Cd, Pb) were determined using inductively coupled plasma emission atomic spectrometry by means of an Optima 2000 DV instrument (PerkinElmer Inc.), after mineralization in a microwave system using the Anton Paar microwave oven. Measurements were made along the plasma in an axial direction.

Statistical analysis of the data was performed using SPSS software (version 19.0). Prior to analyses, data were investigated to determine their distribution using the Shapiro–Wilk *W* test. Differences were considered significant at the level of $P < 0.05$. The relationships between the levels of individual elements in the milk of examined animals were calculated using Pearsoncorrelation index. Statistical significance of coefficients of correlation was tested at the levels of $P < 0.05$.

RESULTS

The mean value of lead and cadmium in milk is given in table 1 in term of ppm and ng/ml. Based on data presented, the mean value of pb and Cd is higher than standard level introduced by European Commission Regulation (2006). Also, based on Pearson correlation index calculated in present study it shows that there is a reverse and significant correlation between lead amounts in milk and age of animals. As well as, there is a reverse and significant correlation between Cadmium amounts in milk and age of animals (table 2).

Table 1: mean value of Pb and Cd in milk in term of ppm and ng/ml

Heavy metal	No. of samples	Mean		Standard deviation		p-value
		ppm	ng/ml	ppm	ng/ml	
Lead	100	0.87	17.60	0.37	7.46	0.001
Cadmium	100	0.009	10.25	0.002	2.10	0.212

Table 2: correlation between lead and cadmium levels in milk with age and lactation

Heavy metals	Age	Lactation
Lead	r (Pearson)= -0.055 n= 100	r (Pearson)= -0.198 n= 100
Cadmium	r (Pearson)= -0.176 n= 100	r (Pearson)= 0.038 n= 100

DISCUSSION AND CONCLUSION

Differences in trace mineral metabolism between breeds of cattle have been reported. Cd and Pb are environmental pollutants toxic to humans and animals (Cai et al. 2009). Cd and Pb are nonbiodegradable, and their accumulation in the environment raises agricultural and public health concerns (Olsson et al. 2005; De Vries et al. 2007). In our study, Pb and Cd concentrations in the milk of cows were significantly higher ($P < 0.05$) compared to standard levels. The Pb concentration in the milk of both breeds exceeded, however, permissible EU standards, amounting to 0.0412 μg/mL for Holstein-Friesian cows, respectively. In the study by Gabryszuk et al. (2010), the Pb concentration in the milk of cows from organic farms was much lower and ranged from 0.0041 to 0.0062 μg/mL.

Heavy metal contamination in milk has been reported also in different countries and regions (Simseket al.2000; Licata et al. 2004; Pavlovic et al. 2004). In the study by Bilandžić et al. (2011), mean lead concentrations exceeded the maximum residue levels in the north and the south regions of Croatia (0.0587 and 0.0362 μg/mL, respectively). Levels above 0.020 μg/mL were measured in 35.5 % of samples from the north and 28.3 % of samples from the south regions. In the study by Pavlovic et al. (2004), the Pb level ranged from 0.028 to 0.036 μg/mL, but that of Cd was between 0.005 and 0.006 μg/mL for a majority of 15 farms in Croatia. Sikrić et al. (2003) reported even higher Pb concentration in milk, which amounted to 0.023–0.070 μg/mL.

During lactation, Pb and Cd are thought to be transported from maternal plasma to mammary gland and secreted into milk along with Cu and Zn. However, the interaction between toxic heavy metals and trace elements (Ca, Mg, P, Cu, Fe, Mn, Se, Zn) has not been understood clearly, particularly in milk. There is a good level of understanding of the role of major nutritional elements like Ca, Mg, P, Na, and K in milk, but the effects of Pb and Cd on their metabolism have not been sufficiently investigated (Isaac et al. 2012).

Cd and Pb mainly distribute in the liver and kidney, where Cd is bound to metallothionein (MT), a small, cysteine-rich metal-binding protein (Klaassen et al. 1999).

Several studies have suggested that interactions between Cd orPb in the organism result in a high degree from an affinity of both metals to MT and their ability to induce its synthesis. They can induce MT synthesis in various tissues, especially in the intestine, liver, and kidney (Cai *et al*. 2009). Metallothionein, which is synthesized in response to cadmium, lead, zinc, copper, or mercury exposure (MT inducers), contributes to the accumulation of metals by eliminating them from metabolism. Olsson *et al*. (2010) found a significant relationship between kidney levels of Cd and metallothionein. Another way of eliminating metals from metabolism is through the formation of neutral complexes (e.g., Se–Cd and Se–Pb) by selenium, which are then bound by proteins similar to metallothionein. This is possible because of the high affinity of selenium for these elements (Tomza-Marciniak *et al*. 2011). The interaction between Zn and Cu has been extensively reported (Bremner and Beattie 1995) and is a consequence of the ability of these metals to induce synthesis of metallothioneins and of their competition for metallothionein-binding sites.

Interaction between toxic heavy metals (Pb and Cd) and major nutritional and trace elements was also found in humans, most frequently in blood and serum (Bárány et al. 2002) and in the milk of nursing mothers (Krachler et al. 1998; Stawarz et al. 2007). Wang *et al*. (2012) reported correlations among the toxic (Cd, Pb) and nutritionally essential (Zn, Cu, Fe, Mn, Se) elements in the blood, also urine and feces in the male. In the case of the toxic metals, a significant positive correlation was found for Cd–Pb in blood and a moderate correlation in urine. Cd was positively correlated with most of the essential elements in both urinary and fecal excretion. Moreover, significant direct correlations were found between Cd and either Zn or Se concentration in both urine and feces, whereas a significant negative correlation was found between Cd and Se in blood.

The present research showed that the milk of cows had higher levels of toxic heavy metals compared to the standard levels. Also, based on Pearson correlation index calculated in present study it shows that there is a reverse and significant correlation between lead amounts in milk and age of animals. As well as, there is a reverse and significant correlation between Cadmium amounts in milk and age of animals. So, authors suggest other researches in this field. The level of heavy metals in Sanandaj province is very high and must be taken measures in this filed.

REFERENCES

[1] Bárány E, Bergdahl IA, Bratteby LE, Lundh T, Samuelson G, Schütz A, et al. Relationships between trace element concentrations in human blood and serum. Toxicology Letters. 2002;134(1–3):177–184.

[2] Bilandžić N, Dokić M, Sedak M, Božica S, Varenina I, Knežević Z, et al. Trace element levels in raw milk from northern and southern regions of Croatia. Food Chemistry. 2011;127(1):63–66.

[3] Bremner I, Beattie JH. Copper and zinc metabolism in health and disease: speciation and interactions. Proceedings of the Nutrition Society. 1995;54(2):489–499.

[4] Cai Q, Long ML, Zhu M, Zhou QZ, Zhang L, Liu J. Food chain transfer of cadmium and lead to cattle in a lead–zinc smelter in Guizhou, China. Environmental Pollution. 2009;157(11):3078–3082.

[5] deVries W, Römkens PF, Schütze G. Critical soil concentrations of cadmium, lead, and mercury in view of health effects on humans and animals. Reviews of Environmental Contamination and Toxicology. 2007;191:91–130.

[6] EC Commission regulation (EC) no. 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. Official Journal of the European Union. 2006;L364:5–24.

[7] Gabryszuk M, Słoniewski K, Metera E, Sakowski T. Content of mineral elements in milk and hair of cows from organic farms. Journal of Elementology. 2010;15(2):259–267.

[8] González-Montaña JR, Senís E, Gutiérrez A, Prieto F. Cadmium and lead in bovine milk in the mining area of the Caudal River (Spain) Environmental Monitoring and Assessment.2012;184(7):4029–4034.

[9] González-Weller D, Karlsson L, Caballero A, Hernández F, Gutiérrez A, González-Iglesias T, et al. Lead and cadmium in meat and meat products consumed by the population in Tenerife Island, Spain. Food Additives and Contaminants. 2006;23(8):757–763.

[10] Isaac CP, Sivakumar A, Kumar CR. Lead levels in breast milk, blood plasma and intelligence quotient: a health hazard for women and infants. Bulletin of Environmental Contamination and Toxicology. 2012;88(2):145–149.

[11] Jen SL, Lee SJ, Lin SY. Determination of cadmium and lead in raw milk by graphite furnace atomic absorption spectrophotometer. Journal of Dairy Science. 1994;77(4):945–949.

[12] Klaassen CD, Liu J, Choudhuri S. Metallothionein: an intracellular protein to protect against cadmium toxicity. Annual Review of

Pharmacology. 1999;39(1):267–294.

[13] Krachler M, Li FS, Rossipal E, Irgolic KJ.Changes in the concentrations of trace elements in human milk during lactation. Journal of Trace Elements in Medicine and Biology. 1998;12(3):159–176.

[14] Licata P, Trombetta D, Cristani M, Giofrè F, Martino D, Calò M, et al. Levels of “toxic” and “essential” metals in samples of bovine milk from various dairy farms in Calabria, Italy.Environment International. 2004;30(1):1–6.

[15] López Alonso M, Prieto Montaña F, Miranda M, Castillo C, Hernández J, Benedito JL. Cadmium and lead accumulation in cattle in NW Spain. Veterinary and Human Toxicology. 2003;45(3):128–130.

[16] Malhat F, Hagag M, Saber A, Fayz AE. Contamination of cows milk by heavy metal in Egypt.Bulletin of Environmental Contamination and Toxicology. 2012;88(4):611–613.

[17] Miranda M, López Alonso M, Castillo C, Hernández J, Benedito JL. Effects of moderate pollution on toxic and trace metal levels in calves from a polluted area of northern Spain. Environment International. 2005;31(4):543–548.

[18] Olsson IM, Eriksson J, Oborn I, Skerfving S, Oskarsson A. Cadmium in food production systems: a health risk for sensitive population groups. Ambio. 2005;34(4–5):344–351.

[19] Olsson IM, Jonsson S, Oskarsson A. Cadmium and zinc in kidney, liver, muscle and mammary tissue from dairy cows in conventional and organic farming. Journal of Environmental Monitoring.2010;3(5):531–538.

[20] Pavlovic I, Sikiric M, Havranek JL, Plavljanic N, Brajenovic N. Lead and cadmium levels in raw cow's milk from an industrialised Croatian region determined by electrothermal atomic absorption spectrometry. Czech Journal of Animal Science. 2004;49(4):164–168.

[21] Sikirić M, Brajenović N, Pavlović I, Havranek JL, Plavljanić N. Determination of metals in cow's milk by flame atomic absorption spectrophotometry. Czech Journal of Animal Science.2003;48(11):481–486.

[22] Simsek O, Gültekin R, Öksüz O, Kurultay S. The effect of environmental pollution on the heavy metal content of raw milk. Nahrung. 2000;44(5):360–363.

[23] Stawarz R, Formicki G, Massányi P. Daily fluctuations and distribution of xenobiotics, nutritional and biogenic elements in human milk in Southern Poland. Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances & Environmental Engineering. 2007;42(8):1169–1175.

[24] Swarup D, Patra RC, Naresh R, Kumar P, Shekhar P. Blood lead levels in lactating cows reared around polluted localities; transfer of lead into milk. Science of the Total Environment. 2005;347(1–3):106–110.

[25] Tomza-Marciniak A, Pilarczyk B, Bąkowska M, Pilarczyk R, Wójcik J, Marciniak A, et al. Relationship between selenium and selected heavy metals concentration in serum of cattle from a non-polluted area. Biological Trace Element Research. 2011;144(1–3):517–524.

[26] Tripathi RM, Raghunath R, Sastry VN, Krishnamoorthy TM. Daily intake of heavy metals by infants through milk and milk products. Science of the Total Environment. 1999;227(2–3):229–235.

[27] Vromman V, Saegerman C, Pussemier L, Huyghebaert A, De Temmerman L, Pizzolon JC, et al. Cadmium in the food chain near non-ferrous metal production sites. Food Additives and Contaminants: Part A. 2008;25(3):293–301.

[28] Wang Y, Ou YL, Liu YQ, Xie Q, Liu QF, Wu Q, et al. Correlations of trace element levels in the diet, blood, urine, and feces in the Chinese male. Biological Trace Element Research.2012;145(2):127–135.