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*Review*

# HEAVY METALS – ENVIRONMENTAL CONTAMINANTS AND THEIR OCCURRENCE IN DIFFERENT TYPES OF MILK

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## ABSTRACT

The aim of this review is to summarize the findings about heavy metals and their effects on animal organism and to describe a source of contamination and inputs of heavy metals into food chain. Furthermore, the comparison of the occurrence of selected heavy metals in different types of milk on the basis of previous studies has been made. Based on available information and according to level of contamination, we want to draw an attention to suitability of using milk for further processing in selected areas of the world.

**Key words:** heavy metals; toxic elements; contaminants; milk

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## INTRODUCTION

Industrial progress, industrialization, urbanization and agricultural production have become permanent resources of extraneous chemicals for living organisms. In recent years, food safety is regarded as a carrier theme for food industry. The increase in agricultural production efficiency causes using of large quantities of chemical products not even in animal feed production, but also on farms with milk production. Due to non-compliance with right technologies, these substances are becoming a part of agricultural products, including milk from cows, ewes or goats. These contaminants are not a natural part of milk, but they are secreted into the milk from animal body. Success in food production significantly depends on the abundance of quality materials and good manufacturing practice. Therefore, an attention should be paid to understanding the problems and ways of possible penetration of contaminants into the food chain.

### Heavy metals and trace elements

Heavy metals are widely dispersed in the environment. The toxicities induced by excessive levels of some of these elements, such as chromium (Cr), cadmium (Cd), lead (Pb) and mercury (Hg) are well known (Llobet *et al.*, 2003). Heavy metals like cadmium, lead, mercury and arsenic are the major toxic metals posing a threat to human health. Their concentrations in animal organisms and their milk concentrations may increase very fast, although their excretion through milk is very low (Miller, 1971; Houpert *et al.*, 1997). Their ecosystem accumulation (water-soil-plant-animal) makes them very toxic and leads to undesirable consequences for live organisms (Bogut *et al.*, 2000; Piskorova *et al.*, 2003). Free-living animals are important indicators of the environmental pollution with heavy metals (Kottferová and Koréneková, 1998). Sheep and cattle reared freely on pasture are also indicators of the environmental pollution (Gallo *et al.*, 1996). Increased concentrations of heavy metals in body

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of domestic animals result in low fitness of animals, reproduction problems, immunity decline and occurrence of cancerous and teratogenic diseases (Bires *et al.*, 1995).

In the local studies, cadmium, lead, copper, zinc, iron, chromium and manganese are found at toxic levels in soils and vegetables (Ghafoor and Rasool, 1999; Quadir *et al*., 2000). These studies guide to hypothesize that fodders grown on such soils will also accumulate these heavy metals, and animals reared on contaminated fodder will contain heavy metal residues in edible tissues, such as milk. The general public eating such contaminated edible products may accumulate toxic levels of heavy metals (Licata *et al*., 2004).

Pollution of the environment with metals, such as lead, is a world-wide problem. Lead alkyl additives into petrol are combusted and emitted into the atmosphere and can be responsible for high concentration of lead in some vegetation, roadside, soil, air, water and plants (Burguera and Randon, 1987).

Lead has been added to petrol (gasoline) as an anti-knocking agent since the 1920s in order to improve fuel performance and reduce wear on vehicle engines. Since this time, leaded petrol has been reported to cause more lead exposures than any other source worldwide (Landrigan, 2002). During the 1970s, health impacts associated with lead emissions from vehicles became a widely discussed issue. Many studies have reported that environmental lead emissions have resulted in significant health effects to the central nervous system, haem-synthesis, reproductive system, as well as psychological and neurobehavioral functions, and may even increase the risk of cancer (Bellinger, 2005; Fewtrell *et al*., 2004; Tong *et al*., 2000). It has been observed throughout the world that the lead content of various environmental components has been decreased after the replacement of leaded petrol (Bridbord and Hanson, 2009; Landrigan, 2002).

The use of leaded petrol resulted in the emission of large quantities of led that are still present in the ambient environment, which may continue to cause concerns for health (Mielke *et al*., 2011). Although the United States were responsible for 80 % of all leaded petrol sold globally prior to 1970 (Kristensen, 2015), Australia was a substantial consumer of lead petrol products. The use of leaded petrol in Australia over a 70 years period, from 1932 to 2002 (Cook and Gale, 2005) was a major contributor to atmospheric lead levels (Kristensen, 2015). With the introduction of unleaded petrol in Australia in 1985 and the subsequent phase out of leaded petrol by 2002, ambient lead levels have fallen in metropolitan urban centers to levels less than 10 % of Australia's current guideline for lead in ambient air (0.5 $\mu g.m^{-3}$) (Abeeb *et al*., 2003).

Manufacturing processes, incineration of refuse and combustion of coal, are also the other sources which contribute to lead occurrence in the atmosphere; hence it is not surprising that lead levels are highest in area of intense industrialization (Burguera *et al*., 1988; Shakour *et al.*, 2006). Lead is toxic to the blood and the nervous, urinary, gastric and genital systems. Furthermore, it is also implicated in causing carcinogenesis, mutagenesis and teratogenesis in experimental animals (Pitot and Dragan, 1996; Baht and Moy, 1997). Accumulation of lead in the organism produces damaging effects in the hematopoetical, hematic, renal and gastrointestinal systems (Correia *et al*., 2000). On the other hand, cadmium is also easily volatilized at the operating temperatures of common industrial processes, much of the cadmium in the atmosphere results from incineration of ferrous scrap and metallurgy processes (Thomas *et al.*, 1972). Cadmium is considered to be one of the most toxic metals. In addition, it is implicated in high blood pressure (Perry *et al*., 1979), prostate cancer, mutations and fetal (embryonic) death (Pitot and Dragan, 1996). Chromium, nickel and cobalt are also toxic metals which are released to the environment. They originated from dumping industrial wastes in the rivers, as well as the application of phosphatic fertilizers (Venugopal and Luckey, 1978).

Toxicity of metal is closely related to age, sex, route of exposure, level of intake, solubility metal oxidation state, duration of exposure, frequency of intake, absorption rate and mechanisms/efficiency of extraction (Venugopal, 1978; Mertz, 1986).

Milk and milk products are the most diversified of the natural food stuffs in terms of composition and contain more than twenty different trace elements. Most of them are essential and very important, such as copper, zinc, manganese and iron (Schroeder, 1973; Somer, 1974). These metals are cofactors in many enzymes and play an important role in many physiological functions of man and animals. Lack of these metals causes disturbance and pathological conditions (Koh, 1986; Schuhmacher, 1991). The amount of metals in non-contaminated milk is admittedly minute, but their content may be significantly altered through manufacturing and packaging process. Also, metals that can contaminate different cattle feed and environment, such as lead, cadmium, chromium, nickel and cobalt, could be excreted into milk at various levels and cause serious problems (Abou-Arab, 1994, 1997).

**Table 1: Classification of elements according to toxicity (Toman *et al*., 2003)**

| Low toxicity | | | Very toxic, relatively accessible | | | Toxic, low solubility | | |
|---|---|---|---|---|---|---|---|---|
| Na | C | F | Be | As | Au | Ti | Ga | Hf |
| K | P | Li | Co | Se | Hg | La | Zr | Os |
| Mg | Fe | Rb | Ni | Te | Cu | W | Rh | Nb |
| Ca | S | Sr | Pd | Pb | Zn | Ir | Ta | Ru |
| H | Cl | Al | Ag | Sb | Sn | Re | Ba | |
| O | Br | Si | Cd | Bi | Pt | | | |

**The effect of toxic elements**

Cadmium and lead are heavy metals which have caused most concern in terms of adverse effects on human health. This is because they are readily transferred through the food chains and are not known to serve any essential biological function (Liu, 2003). Children have been shown to be more sensitive to cadmium and lead than adults and the effects are cumulative. As a result, the regular absorption of small amounts of certain elements, such as lead, may cause serious effects on the health of growing children, including retardation of metal development and deficiencies in concentration, adverse effects on kidney function, blood chemistry and the cardiovascular system, as well as hearing degradation (Ataro *et al*., 2008; Salma *et al*., 2000).

Cadmium is ubiquitous environmental contaminant arising primarily from electroplating, plastics manufacturing, mining, paint pigments, alloy preparation, and batteries. Food is the most important source of cadmium in the non-smoking, non-occupationally exposed population (Järup, 2003). Cadmium causes tissue damage in humans and animals and many toxicological studies have found the functional and structural changes in the kidneys, liver, lungs, bones, ovaries and fetal effects (Kukner *et al*., 2007; Massányi *et al*., 2007). Cadmium can induce both carcinogenic and non-carcinogenic effects on various organs including the lung, liver, kidney, bone and vascular system (Waalkes, 2003). At the cellular level, cadmium induces oxidative stress, cell proliferation and apoptosis (Tremellen, 2008; Turner and Lysiak, 2008). Cadmium is a known endocrine disruptor and reproductive toxicant (Henson and Chedrese, 2004; Cheng *et al*., 2011) which affects male fertility through altered function of hypothalamic-pituitary-testicular axis (Lafente, 2013) and/or through direct gonadotoxic and spermiotoxic effects (Thompson and Bannigan, 2008). The disruption of functional structures within the blood-testis (Wong *et al*., 2004; Siu *et al*., 2009) and blood-epididymis barrier (Toman *et al*., 2002; Dubé and Cyr, 2013) results in impaired spermatogenesis and sperm maturation processes associated with infertility (Cheng and Mruk, 2012). Cadmium has been suggested to have some of its toxic effects by disturbing metabolism of essential metals, such as selenium. Zinc and selenium are believed to be the antagonists of cadmium toxic effects (Toman *et al*., 2009).

Selenium is known due to its antioxidant role in living systems and, therefore, it is considered to be an essential element for humans and animals. However, routine selenium supplementation is not recommended,

**Table 2: Mean ± SE values (mg.L$^{-1}$) of Cd, Cr, Ni and Pb in the milk of cattle and goats collected from two areas of Pakistan during the period of November, 2006- April, 2007 (Ijaz *et al*., 2009)**

| Metal | Cattle milk | Goat milk |
|---|---|---|
| Cd | 0.076 ± 0.014* | 0.084 ± 0.003 |
| Cr | 1.066 ± 0.074$^{NS}$ | 1.152 ± 0.045 |
| Ni | 22.395 ± 0.988* | 19.522 ± 0.011 |
| Pb | 18.870 ± 2.912* | 42.687 ± 0.051 |

$^{NS}$Non-significantly ($p > 0.05$) different from the respective value.
*Significantly ($p < 0.05$) different from the respective value.

if the Se intake is equal to 80 µg per day or greater (Burk, 2002). The best way of adequate selenium intake is via food and increase of its content in plants by soil or foliar applications is under investigation during the last decade (Ducsay and Ložek, 2006; Zhao and McGrath, 2009). The treatment with Se during Cd exposure has been demonstrated to have beneficial effects on Cd-induced toxicity (Kimáková *et al.*, 2006; El-Sharaky *et al*., 2007). However, the co-effect of the trace elements on the toxicity caused by Cd is not yet well studied. Xiao *et al*. (2002) assessed the protective effect of Se and Zn on Cd-induced oxidative stress only in the kidney of the rat, besides, Cd was administrated using the intraperitoneal route.

Nickel is an essential trace element. Its industrial application has a broad spectrum and primarily it is used in alloys (Das *et al*., 2008). Nickel is also an essential trace metal that is vital for growth enhancement in very low doses for birds and mammals (Lukáč *et al*., 2009). High quantity of nickel is known to be injurious for animal and human health. Its effects on various aspects of reproduction have been previously described. Animal studies demonstrate that nickel has negative effects on the structure and function of the testis, seminal vesicles and prostate gland; there is similar report on adverse effect on spermatozoa (Pandey *et al*., 2000; Forgacs *et al*., 2001). Lukáč *et al*. (2014) reported about negative effect of nickel on spermatogenesis. The decrease in the relative volume of germinal epithelium indicates on alterations of the spermatozoa production.

Accelerated industrial and agricultural development considerably affects environmental emissions of selected toxic elements: cadmium, lead, mercury and arsenic (Lopez *et al.*, 2002). Their concentrations in animal organisms and their milk concentrations may increase very fast, although their excretion through milk is very low (Houpert *et al*., 1997). Their ecosystem accumulation (water-soil-plant-animal) makes them very toxic and leads to undesirable consequences for live organisms (Bogut *et al*., 2000 Piskorova *et al*., 2003). Free-living animals are important indicators of the environmental pollution with heavy metals (Kottferová and Koréneková, 1998). Sheep and cattle reared freely on pasture are also indicators of the environmental pollution (Gallo *et al*., 1996). It is also known that metal (Cd, Pb and Hg) excretion is significantly lower in the offspring (Oskarsson *et al*., 1995).

**The content of heavy metals in different types of milk**

Concentrations of heavy metals in milk were mainly described in cows (Cerkvenik *et al.*, 2000; Pilsbacher and Grubhofer, 2002; Sikirič *et al*., 2003). Ijaz *et al*. (2009) compared the content of heavy metals (Cd, Cr, Ni, Pb) in cattle and goat milk in Pakistan. They found difference in concentrations of these metals, which are listed in Table 1. The goat milk was found strongly ($p < 0.05$) contaminated with Cd than cattle milk, 0.084 vs. 0.076 mg.L$^{-1}$, respectively.

Licata *et al*. (2004) and Triphathi *et al*. (1999) reported the levels of Cd in the milk of cattle 0.0228 and 0.00007 mg.L$^{-1}$ in area of Calabria-Italy and India. Baldini *et al*. (1990) (Rome-Italy), Cerutti (1999) (Milano-Italy) and Martino *et al*. (2001) (Spain) found Cd concentration in cattle milk in the range between 0.0002 and 0.03 mg.L$^{-1}$, which is quite lower than the measured values in the study of Ijaz *et al.* (2009). Ijaz *et al.* (2009) states in his study, that the higher values of Cd residues in the milk of goats (0.084 mg.L$^{-1}$), than in the cattle milk (0.076 mg.L$^{-1}$) are also in accordance with the values determined by Coni *et al*. (1996) in the milk of goat

**Table 3: Metal content (mg.kg$^{-1}$) in buffalo‘s and cow‘s raw milk samples from area of Giza-Egypt (Enb *et al*., 2009)**

| Metals | Buffalo‘s milk | | Cow‘s milk | |
|---|---|---|---|---|
| | Mean ± SD | Range | Mean ± SD | Range |
| Iron | 0.980 ± 0.442 | 0.786-1.242 | 0.682 ± 0.406 | 0.607-0.794 |
| Copper | 0.212 ± 0.102 | 0.188-0.542 | 0.142 ± 0.116 | 0.108-0.194 |
| Manganese | 0.076 ± 0.044 | 0.051-0.916 | 0.056 ± 0.038 | 0.048-0.084 |
| Zinc | 4.366 ± 0.814 | 3.966-6.814 | 3.146 ± 1.081 | 3.001-3.940 |
| Lead | 0.084 ± 0.042 | 0.044-1.088 | 0.066 ± 0.056 | 0.040-0.960 |
| Cadmium | 0.118 ± 0.086 | 0.094-0.142 | 0.086 ± 0.062 | 0.070-0.112 |
| Chromium | 0.042 ± 0.022 | 0.036-0.058 | 0.034 ± 0.014 | 0.028-0.066 |
| Nickel | 0.006 ± 0.010 | 0.003-0.009 | 0.004 ± 0.002 | 0.002-0.009 |
| Cobalt | 0.008 ± 0.010 | 0.003-0.014 | 0.004 ± 0.001 | 0.003-0.006 |
| Tin | 0.006 ± 0.010 | 0.004-0.010 | 0.003 ± 0.006 | 0.002-0.005 |

(0.15 mg.L$^{-1}$) and by Licata *et al.* (2004) in cattle milk (0.0228 mg.L$^{-1}$). However, 0.05 mg.L$^{-1}$ of Cd in the milk of goat has been reported by Caggiano *et al*. (2005) in the region of southern Italy.

Ijaz *et al*. (2009) indicated in his work, that the higher milk concentration of heavy metals can be attributed to the use of sewerage water for agricultural purposes. It has also been observed that the animals have direct access to this sewerage water for drinking. The uptake of heavy metals in the soil, vegetables, fodder and other herbage produced in the investigated areas of Faisabalad city the main sewerage drains may have a definite role in the contamination of the milk composition.

Enb *et al.* (2009) stated, that higher levels of heavy metals in buffalo's and cow‘s milk (Table 3) in his study may be attributed to the high contamination of animal feed and water by such pollutants. Abou-Arab (1994; 1997) indicated that these pollutants could be excreted into the milk at various levels and also could reach milk through handling procedures. In this respect, several studies have been carried out to assess metal contents in milk from different areas. Tripathi and Raghunath (1999) reported that metals (Zn, Cu, Pb and Cd) were detected in cow's and buffalo‘s milk samples at following levels: Zn 3.177-3.697 mg.L$^{-1}$, Cu 0.043-0.195 mg.L$^{-1}$, Pb 1.70-3.35 µg.L$^{-1}$ and Cd 0.07-0.10 µg.L$^{-1}$. However, Onianwa *et al*. (1999) determined levels of Zn 0.39-2.75, Cu 0.07-0.67, Fe 1.68-15.1, Cr 0.005-0.030, Pb 0.03-0.18, Cd 0.004-0.009, Co 0.03-0.12 and Ni 0.04-0.09 mg.L$^{-1}$ in cow's milk in Nigeria. Regarding to the investigation of Lante *et al*. (2004), they reported that Zn (4.631 mg.L$^{-1}$), Cu (0.0518 mg.L$^{-1}$), Fe (0.290 mg.L$^{-1}$), Mn (0.0291 mg.L$^{-1}$), Cr (0.004 mg.L$^{-1}$), Pb (5.23 µg.L$^{-1}$) and Cd (0.40 µg.L$^{-1}$) were detected at various levels in Italy. On the other hand, Caggiano *et al*. (2005) reported that metals in cow's milk were detected in southern Italy at the following levels: Mn: 0.13, Cr: 0.20, Pb: 0.20 and Cd: 0.06 mg.kg$^{-1}$. The average lead concentration 7.9 ng.L$^{-1}$ in raw milk samples collected from milk tanker in Iran was recorded by Tajkarimi *et al*. (2008) and they ranged from 1 to 46 ng.L$^{-1}$.

In our study we found the levels of copper, mercury, nickel and lead in sheep and cow milk from selected area of Slovakia below the limit of quantification (LOQ) (Cu: < 0.50; Hg: < 0.002; Ni: < 0.10; Pb: < 0.010 mg.kg$^{-1}$) in spring and autumn season. We analyzed contents of some trace elements in sheep milk: Fe 0.67 mg.kg$^{-1}$ in spring season; 0.69 mg.kg$^{-1}$ in autumn season, Mg 153 mg.kg$^{-1}$ in spring; 176 mg.kg$^{-1}$ in autumn and Zn 4.4 mg.kg$^{-1}$ in spring season; 3.8 mg.kg$^{-1}$ in autumn season. In cow milk we found content of Fe below the LOQ (< 0.50 mg.kg$^{-1}$) in both seasons, Mg 80 mg.kg$^{-1}$ in spring season; 103 mg.kg$^{-1}$ in autumn season and Zn 3.4 mg.kg$^{-1}$ in spring season; 4.1 mg.kg$^{-1}$ in autumn season (unpublished data).

According to Anutovič *et al*. (2005), concentrations of selected toxic elements in ewe‘s milk from the area of Slavonian region in Croatia can be different depending on lactation stage. In colostrum (2nd lactation day), Cd and Pb (0.011 and 0.035 mg.kg$^{-1}$, respectively) concentrations were significantly higher ($P < 0.01$), whereas As (0.011 mg.kg$^{-1}$) concentrations were lower in comparison with milk on the 10th (Cd: 0.004; Pb: 0.022; As: 0.025 mg.kg$^{-1}$), 30th (Cd: 0.005 Pb: 0.024; As: 0.028 mg.kg$^{-1}$) and 60th (Cd: 0.006; Pb: 0.026; As: 0.025 mg.kg$^{-1}$) lactation day.

Rodriguéz *et al*. (1999) determined concentrations of Pb and Cd in samples of human, cow (raw and pasteurized) and goat milk and powdered infant formula. The following mean Cd concentrations were recorded: in human milk - 2.70 µg.L$^{-1}$, in raw cow‘s milk - 4.88 µg.L$^{-1}$, in pasteurized cow‘s milk - 4.30 µg.L$^{-1}$, in goat‘s milk - 7.81 µg.L$^{-1}$ and in powdered infant formula - 3.81 µg.L$^{-1}$.

**Table 4: Toxic heavy metals and trace elements in milk from lactating cows reared in different environments of India (Patra *et al*., 2008)**

| | Toxic and trace elements in milk | | | | | |
|---|---|---|---|---|---|---|
| | Lead | Cadmium | Copper | Cobalt | Zinc | Iron |
| Unpolluted area (n = 52) | 0.25± 0.03 | 0.033 ± 0.02 | 0.101 ± 0.006 | 0.18 ± 0.009 | 3.95 ± 0.40 | 5.10 ± 1.06 |
| Closed lead cum zinc smeleter (n = 14) | 0.26 ± 0.047 | 0.052 ± 0.005 | 0.14 ± 0.007 | 0.23 ± 0.037 | 12.50 ± 0.73 | 8.68 ± 1.60 |
| Phospate fertilizer and mining areas (n = 21) | 0.28 ± 0.039 | 0.037 ± 0.005 | 0.08 ± 0.006 | 0.25 ± 0.010 | 6.34 ± 0.63 | 4.11 ± 1.15 |
| Coal minig areas (n = 46) | 0.35 ± 0.024 | 0.057 ± 0.003 | 0.08 ± 0.004 | 0.21 ± 0.008 | 4.79 ± 0.31 | 2.19 ± 0.33 |
| Steel manufacturing plant (n = 46) | 0.50 ± 0.04 | 0.256 ± 0.02 | 0.09 ± 0.006 | 0.26 ± 0.020 | 3.68 ± 0.25 | 2.78 ± 0.42 |
| Aluminium processing plant (n = 25) | 0.65 ± 0.020 | 0.87 ± 0.003 | 0.05 ± 0.006 | 0.12 ± 0.014 | 3.04 ± 0.25 | 2.46 ± 0.13 |
| Lead zinc smelter (n = 21) | 0.85 ± 0.114 | 0.78 ± 0.014 | 0.08 ± 0.009 | 0.17 ± 0.013 | 6.18 ± 0.55 | 3.62 ± 0.95 |

Respective milk samples were colected from 201 lacting cows and allowed to graze around industrial units; $P < 0.05$.

**Table 5: Concentrations of trace elements in raw cow´s milk samples from the southern and northern Croatia (Bilandžič *et al.*, 2011)**

| Element | Region | Number of samples | Mean ($\mu g.L^{-1}$) | Range (min.-max.) ($\mu g.L^{-1}$) | SD |
|---|---|---|---|---|---|
| As | Southern | 90 | 18.5 | 1.0283.0 | 38.9 |
| | Northern | 67 | 43.5 | 1.0-1019.0 | 131.6 |
| Cd | Southern | 90 | 1.76* | 1.0-11.0 | 1.94 |
| | Northern | 67 | 3.40* | 1.0-20.0 | 3.89 |
| Cu | Southern | 90 | 931.9 | 2.0-17.077 | 2448.0 |
| | Northern | 67 | 848.4 | 1.0-377.0 | 1190.1 |
| Hg | Southern | 90 | 1.59* | 1.0-.0 | 1.45 |
| | Northern | 67 | 7.10* | 1.0-90.0 | 16.6 |
| Pb | Southern | 90 | 58.7 | 1.0-370.0 | 82.9 |
| | Northern | 67 | 36.2 | 1.0-476.0 | 72.3 |

*Significant difference between two regions: $p < 0.001$.

The concentrations of Pb were following: in human milk - 8.34 $\mu g.L^{-1}$, in raw cow‘s milk - 14.82 $\mu g.L^{-1}$, in pasteurized cow‘s milk - 10.82 $\mu g.L^{-1}$, in goat‘s milk - 11.86 $\mu g.L^{-1}$, and in powdered infant formula - 8.30 $\mu g.L^{-1}$. Data from this study were within the normal ranges for each kind of milk. The Cd and Pb concentrations in goat‘s milk were significantly higher than the concentrations observed in the other kinds of milk, whereas human milk and powdered infant formula presented the lowest Cd and Pb concentrations. A considerable decrease in the concentration of Cd within the stage of lactation was observed. The concentrations of Cd and Pb in human, cow‘s and goat‘s milk also varied according to the time of year. The concentrations of Pb and Cd in different kinds of milk did not represent any risk to human health (infants or adults).

Tunegová *et al.* (2016) compared the content of selected toxic and trace elements in sheep and cow milk during two seasons (spring and autumn) in Slovakia. They reported that the content of Cd in cow milk was less than 0.0040 $mg.kg^{-1}$ in spring season and less than 0.0040 $mg.kg^{-1}$ in autumn season. The content of arsenic was below 0.030 $mg.kg^{-1}$ in both seasons. In sheep milk they recorded content of Cd below 0.0040 $mg.kg^{-1}$ and As below 0.030 $mg.kg^{-1}$ in both seasons. The content of Se was below 0.030 $mg.kg^{-1}$ in sheep and cow milks. In cow milk, value of calcium was 915 $mg.kg^{-1}$ in spring season and 1210 $mg.kg^{-1}$ in autumn season. Content of calcium in sheep milk was 1770 $mg.kg^{-1}$ in spring and 2170 $mg.kg^{-1}$ in autumn.

Weglarzy (2010) reported that cows are susceptible to contamination of the environment with the lead, which deposits in meat and liver, especially at the beginning of the growing season. He found that there is more lead in the cow’s cheese than in milk with the difference being the highest in April and with decreasing during the growing season. In May, the amount of cadmium in milk was lower. Cadmium and lead were depositing mostly in liver, and their amount in this organ was higher in autumn than in spring. Furthermore, the content of cadmium in meat was much higher than the acceptable level.

## CONCLUSION

The aim of this review was to document and compare the results of previous studies about prevalence of heavy metals in different types of milk and from different parts of the world. We pointed out effects of heavy metals on animal organism and their accumulation in human and animal organism. Majority of the literature sources shows that industry and agriculture are the most common sources of contaminants that are entering the food chain. Therefore, it is important to monitor the areas where milk is produced in order to avoid negative effects of these substances on animal and human organism and to improve the quality of milk, which is the raw material for further food processing.

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