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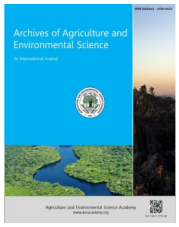

REVIEW ARTICLE

A review on toxicity of heavy metals due to intake of contaminated bovine milk

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ABSTRACT

Environmental pollution is a grievous problem that people on the earth encounter. Anthropogenic activities such as industrialization, urbanization and especially agricultural activities have made a substantial contribution causing the deteriorations of land resources, atmosphere and hydrosphere. Heavy metals being a noticeable pollutant in the environmental pollution have already caused direct and indirect toxicities to human beings. These heavy metals tend to accumulate through food chains and food webs in human and animal tissues leading them to suffer from variety of health problems. Milk and other dairy products have played a significant route of heavy metal exposure to humans since they are largely being consumed at present. This review provides a snapshot about the threats associated with ingestion of toxic heavy metals through milk and other dairy products as to be vigilant in order to ensure the food safety.

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INTRODUCTION

The term environment encompasses all of the natural resources that exert effects on human survival and existence. These natural resources are being utilized by humans for acquiring their necessities from the dawn of their civilization (Rai *et al.,* 2011; Alec *et al.,* 2015). Environmental pollution is a topic emerged with the beginning of the industrial revolution which is considered as a significant global change hence it changes the existence of the ecosystems (Hooke *et al.,* 2012). The health problems associated with environmental pollution have played much attention among people and have already been extensively studied (Beamish *et al*., 2011). Pollution is defined as accumulation of unsuitable material and energy in environments as a result of basically human activities. It can interfere with ambient air, soil/land resources and water resources making negative impacts on living beings. The contributors which are responsible for environmental pollution are called environmental pollutants.

A pollutant can be a physical, chemical or biological material which is released into the environment that can directly or indirectly damage humans and other living organisms on earth (Khan, 2013). Heavy metals, pesticides, organic chemicals, oils and tars, fertilizers are the common pollutants in soil. Particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide and nitrates are some of common air pollutants while phosphorous and animal manure make severe deteriorations of hydrosphere. Evidences have shown that long-term exposure to ubiquitous environmental toxicants can adversely affect humans starting from their early embryonic stage and continuing throughout the postnatal life (Cao *et al*., 2016). Environmental regulations and standards implemented by international and local regulatory bodies are very important as they intervene for minimizing the adverse environmental issues and help to secure human and animal health (Liu *et al*., 2015). Although the environmental pollution cannot be completely prevented, minimization is very much needed as it can obviously effect on economic, social and political development among societies (Bagul *et al*., 2015).

Heavy metal pollution: Heavy metals being a noticeable pollutant cause significant toxicological effects to human beings and ecological environments. Chromium (Cr), lead (Pb), cadmium (Cd) and mercury (Hg) have been prioritized since they occupy a larger portion out of the other metallic pollutants. The threat is that the food and drinking

water can be severely contaminated by such toxic heavy metals as they are abundantly present in various forms in the soil, natural water and ambient air. When they are ingested through food or drinking water, they can affect negatively on the metabolism of living cells once the concentration of such metals exceed their maximum tolerance levels (Ojedokun and Bello, 2016). The characteristic physical property of heavy metals is that they have relatively a high atomic weight compared to other metallic elements in the periodic table. Their toxicity depends on several factors including the dose ingested, route of exposure as well as the human factors such as age, genetics, gender and nutritional status of such exposed individuals (Tchounwou *et al*., 2010). Their wide distribution in the environment has been caused by numerous anthropogenic activities basically centralizing with rapidly expanding industrial areas. Domestic disposals and technological applications have also caused for their extensive distribution while the agricultural activities play a significant role for excessive spreads of such toxic heavy metals into soil and water raising worldwide concerns over their potential influences on human health and the environment (Wuana and Okieimen, 2011). The heavy metal contents in environments have been gradually increased due to the development of the global economy along with the advent of modern technologies. Their wide distribution, Strong latency, Irreversibility and remediation hardness are the matters arising when remediation techniques are supposed to be implemented (Su *et al*., 2014).

Bovine milk: Milk is a white colored liquid secreted by the mammary glands of mammals and it acts as the primary source of nutrients for the newly born mammals. The composition of milk differs in different mammalian species such as goat, sheep, camel and cattle during the evolution to fulfill the nutritional requirements of their offspring. Bovine milk contains nutrients such as lipids, proteins, amino acids, vitamins and minerals needed for growth and development of individuals. Since the milk composition has a dynamic nature, the composition varies with stage of lactation, breed, age, nutrition, and energy balance and health status of the animal. Other than the nutrition some specific milk proteins take part in the early development of immune response and non-immunological defense (Haug *et al*., 2007). Since recent years the consumption of milk and milk products such as cheese, yoghurt and milk powder has increased as it plays a vital role in human nutrition (Khalil and Seliem, 2013). Regular daily milk consumption has been widely recommended as the bovine milk contains variety of most essential nutrients which are critical to maintain healthy life of each individual including humans (Arianejad *et al*., 2015). Although dairy products occupy a significant part in a healthy diet, the safety of such dairy products decreases when it is contaminated with toxic environmental pollutants (Rezaei *et al*., 2014).

Heavy metals in bovine milk: Food safety is a worldwide concern and it has already received much attention among people. Dairy products being an important food product in human diet are highly vulnerable to contaminations, and thus strict quality standards have to be implemented to ensure the industry wellbeing (Qian *et al*., 2011).Toxic elements in dairy products have created adverse health problems at any age limit of mankind including infants, school children and old people since they consume large amount of such dairy products frequently. Different agricultural activities such as irrigation with toxic metal containing water, use of drugs, pesticides and fertilizers have caused in toxic metal contamination in milk and other dairy products substantially (Siddiki *et al*., 2012). From nutritional point of view, the metal elements in the milk and other dairy products are classified into essential metals and in non-essential metals. Fe, Cr, Mn, Zn, Cu, and Co is mainly classified as essential metals while non-essential metals mainly represented by Hg, Cd and Pb etc. When these both heavy metal categories exceed their concentrations above the maximum permissible limits, they can make extremely serious toxic effects on consumers and lead variety of health disorders (Gogoasa *et al.,* 2006). Heavy metals can accumulate in human and animal tissues deriving especially from food and water. When foodstuffs are grown on contaminated soil or irrigated with deteriorated water, these toxic heavy metals can be spread (Aslam *et al*., 2010). Farm animals are highly susceptible to the environmental pollution from heavy metals since they are often reared for milk and meat products. Recent evidences frequently emphasizes that heavy metal residues are distinctly present in milk to an extent that exceed the maximum permissible concentrations established by international authorities (Javed *et al*., 2013). Grazing lands can be contaminated with Pb and Cd due to numerous anthropogenic activities such as continuous application of large amounts of fertilizer, disposal of industrial wastes and traffic emissions. In addition to that, packaging and other technological processes can also increase the total concentration of heavy metals significantly in milk (De castro *et al*., 2010). Powdered milk is a most popular dairy product which contains both basic and additional nutrients needed for consumers. This can also be a good source of heavy metals that ultimately causes detrimental effects to humans. Confirmation of the presence of these toxic heavy metals in milk and their corresponding quantities are necessary to be quantified since the safety of consumers has to be ensured (Solidum *et al*., 2012)

Conclusions

In view of present investigations, heavy metal residues in dairy products have been drastically increased causing direct and indirect toxicities to humans. Since livestock species are being reared on lands contaminated with such toxic heavy metals, they can possibly get accumulated within living tissues of humans causing the safety of consumers at a higher risk. Therefore, strict rules and regulations must be assured by local and international authorities to ensure the health and safety of consumers.

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