

Mercury Contamination of Fish, Cattle and its Public Health Impacts: A Review

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Abstract

Mercury is a toxic element and its type, dose and rate of exposure determines the level of toxicity. Bacteria can transform mercury into methylmercury, a highly toxic form of mercury. Contamination of water, soil, foods, and environment by mercury is matter for both animals and humans. Contaminated fodder and water with mercury is the main source of mercury in animal products. Humans acquire the mercury poison mainly through intake of fish and animal source foods contaminated with mercury. Animals poisoned by mercury exhibits abnormalities of central nervous system, coordination of movement and visual aberration. Generally, accumulation of mercury not only has pernicious effect on the cattle but also on the population who is consuming contaminated milk and meat with mercury.

Keywords: Cattle • Ethiopia • Gold mining • Mercury • Fish

Introduction

Environmental contamination from mercury is ubiquitous on our planet. Mercury is a highly toxic element, and is released into the environment as metallic Hg. Up to ~80% is derived from human activities, such as burning fossil fuels, mining, smelting, and burning waste; with the remainder primarily from volcanoes and forest fires [1]. A 2013 report from the United Nations Environment Programme (UNEP) estimated the total, annual emission of mercury to be in the range of 5,000 to 8,000 metric tons per year. Emissions include anthropogenic sources (such as coal-burning power plants and gold mining), natural geological sources (such as volcanoes) and re-emission or exposure of mercury due to disturbance of soils and sediments containing mercury.

Once in the environment, mercury can be transformed by bacteria into methylmercury, methylmercury then bioaccumulates in fish and shellfish. *Pseudomonas* mercury-resistant bacteria strains have the capacity to volatilize inorganic and organic mercury to elemental mercury. The fish accumulate substantial concentrations of Hg (mercury) in their tissues, and thus the fish are the single largest sources of Hg for humans through fish eating.

Contaminated fodder and water are the main sources of mercury in animal products. There are three paths for mercury to enter the body: through the digestive system, through inhalation and through skin [2]. Human toxicity varies with the form of mercury, the dose and the rate of exposure. The target organ for inhaled mercury vapor is

primarily the brain. Mercurous and mercuric salts chiefly damage the gut lining and kidney, while methyl mercury is widely distributed throughout the body. Excretion of mercuric mercury is largely through urine and stool, although significant amounts are shed through sweat, tears, breast milk, and saliva.

Literature Review

Toxicity of Mercury

Toxicity is the amount to which a chemical matter or a mixture of material can harm an organism. Mercury is believed to interfere with DNA transcription and protein synthesis, including protein synthesis in the developing brain, with destruction of endoplasmic reticulum and disappearance of ribosomes. The toxicity of mercury depends on its chemical form methyl mercury being the most hazardous metal and stable form of mercury that has been attributed to the suffering of most avian and mammalian predators at the top of contaminated tropics.

There are three main types of mercury such as elemental mercury, Organic mercury and Inorganic mercury. Methylmercury compounds are the most dangerous ones to humans, since they cause central nervous system damage. The organic Hg readily crosses the blood brain barrier (BBB) and also crosses the placenta. The fetal blood Hg levels are equal to or higher than maternal levels [3]. The methyl Hg also appears in human milk. The organic Hg compounds are most toxic in the CNS, and may also affect the kidneys and immune

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system. The methyl Hg is toxic to the cerebral and cerebellar cortex in the developing brain and is a known teratogen and the organic forms of Hg (e.g., methyl Hg) are more toxic than the inorganic forms due to ease of absorption into the human system.

The mothers, who were exposed to high amounts of Hg but were asymptomatic, gave the birth to severely affected infants. The infants often appeared normal at birth but developed psychomotor retardation, blindness, deafness and seizures over time. Since the foetus is susceptible to neurotoxic effects of methyl Hg, several studies have focused on subclinical effects among children whose mothers were exposed to high levels of methyl Hg.

Symptoms of Mercury poisoning

Mercury is very noticeable due to its neurological effects. Animals poisoned by organic mercury exhibit CNS stimulation and locomotor abnormalities after a lengthy latent period (weeks). The symptoms of toxicosis in most species of animals include incoordination of movement, visual aberration and decline in awareness. Signs may include blindness, excitation, abnormal behavior and chewing, incoordination, and convulsions. Mercury is also a mutagen, teratogen, and a carcinogen, and is embryocidal. And its neurologic signs may be irreversible once they develop.

Discussion

Mercury poisoning in food safety

Fish is an excellent low-fat food and a great source of protein, vitamins, and minerals. Cattles also provide a good nutrients from their products (i.e., milk, meat etc.) as a diet for humans. However, some fish and food from animal source may be contaminated with high levels of a form of mercury, called methyl mercury that can be harmful to pregnant women, women of childbearing age and children's.

Exposure to mercury and mercury compounds is harmful for human health, especially for fetuses and children at early stages of development. Contamination of food from natural sources and human activities, dental amalgam and occupational exposure in agriculture and manufacturing sectors are possible routes of exposure to mercury [4]. Dietary intake is the main source of human exposure to mercury. In food, mercury can exist in inorganic form and the more toxic organic forms such as MeHg in fish. Methylmercury in the human diet is rapidly and almost completely absorbed from the gastrointestinal tract.

The animals that are at the top of the food web present higher concentrations than those in lower trophic levels, due to MeHg which is more bioavailable than other forms and is quickly absorbed and slowly excreted. Humans are the top predators of the food chain, so it is easy for them to bioaccumulate mercury, especially for individuals living in the Mediterranean who consume larger quantities of seafood and fish; humans can also bioaccumulate mercury from animal products contaminated by mercury such as milk, milk products and meat. Fishes containing more than 0.4 ppm Hg are unfit human consumption.

Status of Mercury contamination in Ethiopia

Ethiopia has abundant natural resources. Mining is one of the main contributors for economic growth of Ethiopia. Gold is one of the mining mineral in the country. In mines, mercury is used to recover minute pieces of gold that is mixed in soil and sediments. If there is no strong legislation to manage the sector, the implications of mercury is high both on humans, animals and environment. Serious deficiencies in mine management in the country's mining site, Cyanide, arsenic and mercury have left dangerous levels of the soil and water contamination. According to the report of Humanitarian (2020), in the villages around Shakiso, childrens have been born with deformities, and women have had so many miscarriages they believe they are cursed; the bones of cattle have snapped like twigs, and men's bodies have crumpled and collapsed without warning.

Public health impacts

People may be exposed to mercury in any forms under different circumstances. However, exposure mainly occurs through consumption of fish and shellfish contaminated with methylmercury and through worker inhalation of elemental mercury vapours during industrial processes. Health problems caused by mercury are most severe for the developing fetus and for young children [5]. Pregnant women who eat fish contaminated with large amounts of methyl mercury run the risk that their babies will have unhealthful changes in their heart or blood vessels. Nervous system changes can affect the baby's ability to learn. In adults, methyl mercury can lead to problems of the central nervous system and possible adverse effects on the cardiovascular system.

Bioaccumulation of toxic heavy metals, like mercury, in milk and milk products is a matter of great concern. These products, milk and milk products are important parts of human diet. Such accumulation of mercury, not only have pernicious effect on the cattle, but also on the population who is consuming such contaminated milk and meat. Cooking does not eliminate mercury.

Conclusion

Mercury is a toxic element that can be released into environment due to natural and anthropogenic process. Once mercury released into environment, it can contaminate fish and animals that serve as a source of food for humans. Bioaccumulation of mercury in fish and animal products such as milk and meat is main route for human contamination by mercury. An individual affected by mercury may develop irreversible neurological disorders, blindness, deafness, and cancer since mercury is carcinogenic. Mercury is mutagen, teratogen, and embryocidal.

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