HEAVY METALS CAUSING TOXICITY IN HUMANS, ANIMALS AND ENVIRONMENT

D.Linga Rao,
Department of Physics, R.V.V.N College , Dharanikota.
***Corresponding author: Email: bssbdegcollege@gmail.com**

ABSTRACT

The heavy metals chiefly include Pb, Hg, Cd, Cr, Cu , Zn, Mn, Ni, Ag, etc. The heavy metals, viz., As, Cd, Pb and Hg are considered most toxic to humans, animals, fishes an d environment. Excessive concentrations of heavy metals are detrimental. They destabilize ecosystems because of their bioaccumulation in organisms, and toxic effects on biota and even death in most living beings. All heavy metals, in spite some of them are essential micronutrients, have their toxic effects on living organisms via metabolic interference and mutagenesis s. The bioaccumulation of toxic metals can occur in the body and food chain. So, the toxic metals generally exhibit chron ic toxicity. The heavy metals like Pb and Hg have significant toxic effects. The heavy metals are important pollutants for fishes, because these are not eliminated from aquatic sy stems by natural methods, such as organic pollutants, and are enrich ed in mineral organic substances. Occurrence of heavy metals differs in fishes, depending on their age, development and other physiological factors. Among animal species, the fishes are inhabitants which can be highly affected by these toxic pollutants. Heavy metals can have toxic effect s on different organs. They can enter into water via drainage, atmosphere, soil erosion and all human activities by different ways. As the heavy metals concentrated more in the environment, they enter biogeochemical cycle, leading to toxicity.

Key words: heavy metals, biogeochemical cycle,

INTRODUCTION

The metal which has a relatively high density and toxic at low quantity is referred as 'heavy metal' , e.g., arsenic (As), lead (Pb), mercury (Hg), cadmium (Cd), chromium (Cr), thallium (Tl), etc. Some 'trace elements' are also known as heavy metals, e.g., copper (Cu), selenium (Se) and zinc (Zn). They are essential to maintain the body metabolism, but they are toxic at higher concentrations. The heavy metals can enter the bodies to a small extent via food, drinking water and air . The heavy metals concerned with the environmental science chiefly include Pb, Hg, Cd, Cr, Cu, Zn, manganese (Mn), nic kel (Ni), silver (Ag), etc. . Further, the heavy metals are metallic elements which have a relatively high density, and they are poisonous at low quantity. The excess quantities of heavy metals are detrimental as these destabilize the ecosystems because of their bioaccumulation in organisms, and elicit toxic effects on biota and even death in most living organisms. Due to formation of toxic soluble compounds, certain heavy metals become toxic. However, some metals are without any biological role or they are not needed by the body and they become poisonous only in specific forms. However, any amount of Pb can result to detrimental effect. The 'lighter metals', e.g., beryllium can also be toxic in certain circumstances. Some 'essential elements/metals', e.g., iron (Fe) may also be toxic. Sometimes, the action of essential elements can be changed by the toxic metals, resulting into toxicity by interfering with the metabolic process. Therefore, most of the heavy metals are poisonous, while some metals are less toxic, e.g. bismuth (Bi). Metalloids like As and polonium may also be toxic. Beside, both radiological and chemical toxicities can be induced by the radioactive metals. Similarly, the metals with abnormal oxidation phase can also be poisonous, e.g., Cr(III) is an essential trace element, while but Cr(VI) exhibit the carcinogenic effect. The bioaccumulation of toxic metals can occur in the body and food chain. So, the toxic metals generally exhibit chronic toxicity. For example, the radioactive heavy metals like radium can imitate calcium (Ca) to be incorporated into the bone, but the similar health hazards can also be due to Pb or Hg.However, barium (Ba) and aluminium (Al) are exceptions as they can be quickly excreted by the kidneys. Industrialization has spoiled the environment by putting more and more concentrations of several metals. The heavy metals like Pb and Hg cause severe toxicity, as there are some historic.

Environmental and Health Risks by Lead:

Exposure of Pb can cause many effects depending on level and duration of Pb. The developing foetus and infant are more sensitive than the adult. Mostly, the bulk of Pb is received from food ; however, other sources may be more important like water in areas with Pb piping and plumb solvent water, air near point of source emissions, soil, dust and paint flakes in old houses or contaminated land. In air, the Pb levels are brought in food through deposition of dust and rain containing metal on crops and soil. Eight broad categories of Pb use are: batteries; petrol additives; rolled and extruded products; alloys; pi
gments and compounds; cable sheathing; shot; and ammunition. In environment, the Pb comes from both natural and anthropogenic sources. The Pb exposure can be through drinking water, food, air, soil and dust from old paint. The Pb is among the most recycled non-ferrous metals, so its secondary production has grown steadily. The high levels of Pb may result in
toxic effects in humans which in turn cause problems in the synthesis of haemoglobin (Hb), effects on kidneys, gastrointestinal tract (GIT), joints and reproductive system, and acute orchronic damage to nervous system.

Environmental and Health Risks by Mercury:

The Hg is not present naturally in living organisms. It is a toxic substance with no known function in biochemistry or physiology. It has complex and unusual chemical and physical properties. Degassing of earth's crust, emissions from volcanoes

and evaporation from natural bodies of water are the major natural sources of Hg. World-wide mining of metal leads to indirect discharges into atmosphere. The Hg is widely used in industrial processes and in different products (e.g., batteries, lamps and thermometers). It is also used in dentistry as an amalgam for fillings and in pharmaceutical industry. The Hg is mostly present in a relatively unreactive form as a gaseous element. The methylated forms of Hg are bioaccumulated over a million-fold and concentrated in living beings, especially fish. These forms of Hg (monomethyl Hg and dimethyl Hg) are highly toxic, causing neurotoxicological disorders. Inorganic Hg toxicity is associated with tremors, gingivitis and/or minor psychological changes, together with spontaneous abortion and congenital malformation in humans. Monomethyl Hg causes damage to brain and CNS, while foetal and postnatal exposures have given rise to abortion, congenital malformation and development changes in young children.

Environmental and Health Risks by Cadmium:

The Cd derives its toxicological properties from its chemical similarity to Zn (an essential micronutrient for plants, animals and humans). The Cd once absorbed by an organism, present for many years (over decades for humans), though it is eventually excreted. It is produced as an inevitable by-product of Zn (or occasionally Pb) refining, since these metals occurnaturally within the raw ore. But once collected, the Cd is relatively easy to recycle. The Cd is mostly used in Ni/Cd batteries, rechargeable or secondary power sources exhibiting high output, long life, low maintenance and high tolerance to physical and electrical stress. The coatings of Cd provide good corrosion resistance, particularly in high stress environments like marine and aerospace applications where high safety or reliability is required; the coating is preferentially corroded ifdamaged. It is also used as pigment, stabilizer for PVC, in alloysand electronic compounds. As an impurity, it is present in several products, including phosphate fertilizers, detergents and refined petroleum products. Average daily intake of Cd for humans is 0.15 μg from air and 1 μg from water. The Cd if exposed for long time may cause kidney dysfunction. Its high exposure may cause obstructive pulmonary disease and lung cancer. Bonedefects (osteomalacia, osteoporosis) have also been reported in humans and animals. Besides, it can also cause increased blood pressure and myocardial disease in animals.

Environmental and Health Risks by Selenium:

The Se is needed in small amounts by humans and other animals but in larger quantity, it can damage to nervous system, and cause fatigue and irritability. It accumulates in living tissue, and its high contents in fish and other animals can cause serious health problems in humans over a lifetime of overexposure. There may be hair and fingernail loss, damage to kidney and liver tissue, damage to circulatory tissue, and more severe damage to nervous system.

Environmental and Health Risks by Antimony:

The antimony (Sb) is used in compound, antimony trioxide (a flame retardant). It is also found in batteries, pigments, and ceramics and glass. Its high exposure for short duration cancans nausea, vomiting and diarrhea. The long-term exposure of Sb can cause cancer in humans.

Environmental and Health Risks by Copper:

In humans, the Cu is essentially needed but in high doses, anaemia , liver and kidney damage, and stomach and intestinal irritation may occur. During Wilson's disease, it affects greatly. It is normally found in drinking water from Cu pipes and additives designed to control the algae growth.

Environmental and Health Risks by Chromium:

The Cr has been reported to be used in metal alloys and pigments for paints,
cement, paper, rubber and other materials. The low level Cr can irritate skin and can produce ulcer. Its chronic exposure can produce kidney and liver damage. The Cr can also damage to circulatory and nerve tissues. In aquatic animals, it is normally accumulated and can cause toxicity to eating fish.

Environmental and Health Risks by Nickel:

The Ni is needed in small amounts to produce red blood cells (RBCs),but it
becomes slightly toxic in excess quantity. Its chronic exposure can cause decrease in body weight, heart and liver damage, and skin irritation. In aquatic animals, the Ni is accumulated but its presence is not magnified along the food chains

Most Toxic Heavy Metals

In cooperation with the U.S. "Environmental Protection Agency" (EPA), the 'Agency for Toxic Substances and Disease Registry' (ATSDR) in Atlanta, Georgia (a part of the U.S. Department of Health and Human Services) reported that in a 'Priority List for 2001' called the 'Top 20 Hazardous Substances', As, Pb and Hg are at the 1st, 2nd and 3rd position, respectively in the list; while Cd is at the 7thplace. Therefore, the "elements/heavy metals", viz., As, Cd, Pb and Hg are considered most toxic to the humans, animals and environment.

Accumulation and Action of Heavy Metals

'Poison'is defined as any substance, which when absorbed into the body, will cause adverse or deleterious effects. Several metals and their compounds have been stated to be toxic to animals. The As, Cu, Pb, Hg and Cd have been reported to be the most toxic heavy metals. It is believed that many toxic metals exert their bad effects by distressing the enzyme systems of animals. Many of them bind to specific enzymes and proteins necessary for cellular function and thus compete with other substances essential for maintenance and the continued function of cells. Thus, the poisons can also have the effect of inducing

mineral deficiencies. Additionally, many toxic appear to assist in the formation of the paramagnetic anion, superoxide which itself is toxic and seems widely responsible for the spontaneous cell death.

The heavy metals can have toxic effects on different organs. They can enter into water via drainage, atmosphere, soil erosion and all human activities by different ways. With increasing heavy metals in the environment, these elements enter the biogeochemical cycle. The heavy metals can enter from contaminated water into fish body by different routes and accumulate in organisms. These metals can be concentrated at different contents in organs of fish body. The Cu and Zn have been measured in sediments near aquaculture sites at concentrations in excess of sediment quality guidelines. These elements could be lethal to aquatic biota and persist in sediments. In the body, the heavy metals enter through respiration, skin and intestinal absorption. The heavy metals of elemental forms are not completely absorbed, while organometallic forms are lipophillic and can soon enter through membranes, and even cross blood-brain barrier (BBB,the defense system of nervous system). The heavy metals after absorption into body can be widely distributed in different organs, including glands and CNS. Some of the heavy metals are called 'bone seekers' and they deposit into teeth and skeletal systems. The heavy metals then become toxic to enzyme system, and enhance the 'free radical' production and compete with essential elements which form the metallo-enzyme complexes to compete with nutritional minerals absorption10. Generally, all heavy metals cause toxicity to cells. After competing with the nutritional minerals, they render them unavailable to body, leading to ill-health.

Conclusion

The heavy metals, viz., As, Cd, Pb and Hg are most toxic to all human beings, animals, fishes and environment. The excess levels of heavy metals cause severe toxicity. Though some heavy metals are essential for animals, plants and several other organisms, all heavy metals exhibit their toxic effects via metabolic interference and mutagenesis. The Pb and Hg cause severe toxicity in all. Fishes are not the exception and they may also be highly polluted with heavy metals, leading to serious problems and ill-effects. The heavy metals can havetoxic effects on different organs. They can enter into water via drainage, atmosphere, soil erosion and all human activities by different ways. With increasing heavy metals in the environment, these elements enter the biogeochemical cycle leading to toxicity in animals, including fishes.

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