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Assessment of Health Challenges Associated with Man and Plants Exposed to High Doses of Heavy Metals

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Abstract- Heavy metal is a term that is usually applied to common transition metals such as lead (Pb), zinc (Zn) copper (Cu) etc. Some of these metals are beneficial to both plants and animals in lower concentrations as trace elements and could be harmful to their health when the permissible levels are exceeded. Hence this modest attempt was to consider the health challenges that are associated with man and plants exposure to higher concentration of these metals. Some of the documented health challenges in man are: inflammation of the brain, skin discoloration, vomiting, dehydration, respiratory disorder, necrotic changes in the liver and kidney etc while in plants toxic metals may have negative effect on germination, leaf formation, root growth, flowering and fruiting etc. From the foregoing, it is therefore necessary to guide against the exposure of both man and plants to high doses of these metals so that all can live a healthy life.

Keyword: Concentrations, Exposure, Healthy life, Heavy metals, Trace Elements.

1.0 Introduction

The American heritage dictionary (2009) defines heavy metal as metal with a specific gravity greater than about 5.0, especially one that is poisonous, such as lead or mercury, a metallic element with a high relative atomic mass (Chemistry Dictionary, 2008). The term is usually applied to common transition metals, such as copper, lead and zinc. These metals are a cause of environmental pollution (heavy metal pollution) from a number of sources, including lead in petrol, industrial effluents, and leaching of metal ions from the soil into lakes and rivers by acid rain. Examples of heavy metals include chromium, arsenic, cadmium, lead, mercury and manganese. Generally, heavy metals have densities above $5gcm^3$ (Ademoroti 1996 and Encyclopedia of Public Health, 2002).

2.0 Sources of Heavy Metals to Both Plants and Animals

There are quite a number of ways by which heavy metals get into the atmosphere, the plant and ultimately man and animal through the consumption of food substances contaminated by these metals. These sources are non-point source and point source. Non-point source is defined as natural or anthropogenic. Heavy metals normally occur in nature and are essential to life but can become toxic through accumulation in organisms. Arsenic, cadmium, chromium, copper, nickel, lead and mercury are the most common heavy metals, which can pollute the environment. Mercury, lead and cadmium are of greatest concern because of their ability to travel long distances in the atmosphere (http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xOTE3NSY2P WVuJjMzPSomMzc9a29z, assessed on the 15 August, 2016). Example of natural source are chemical and physical weathering of rock (Igneous and Metamorphic) through which heavy metals get into the atmosphere. Other contributions include the decomposition of animal and plants debris, precipitation or atmospheric deposition of air-borne particles from volcanic activity, wind, plant exudates and oceanic spray (Kennish, 1992). Anthropogenic source (Human related activities) has long been established as a possible route for toxic heavy metals. Anthropogenic activities such as industrial processing and use of metals, alloys and metallic compounds disperse them into the environment thereby elevating their levels (Dara and Chand, 2005).

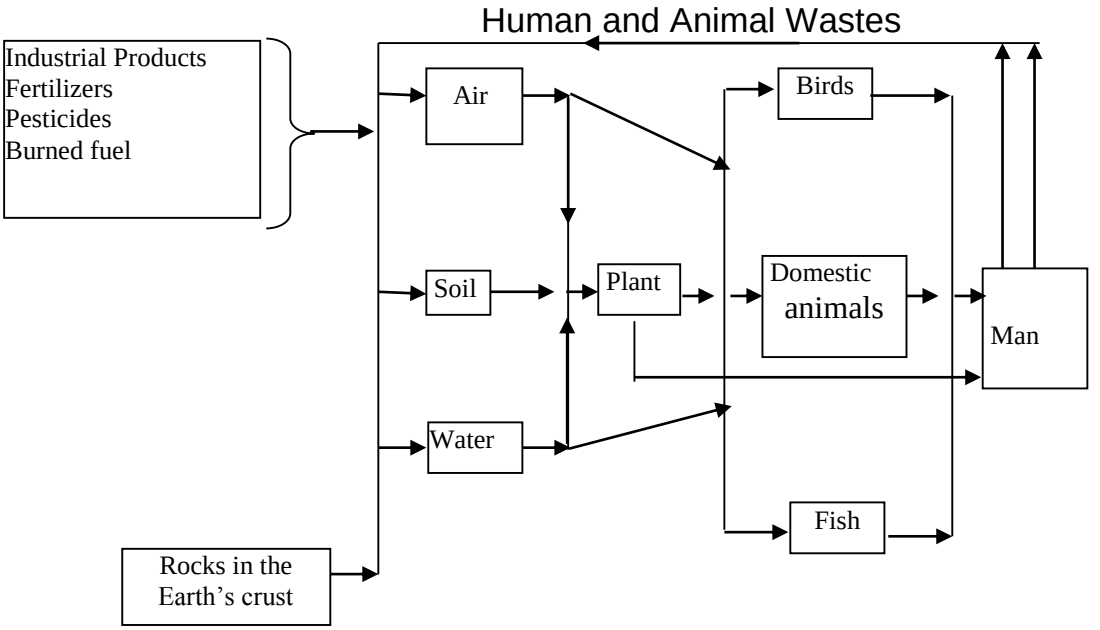

Fig 1**:** Sources of heavy metals and their cycling in the soil – water – air – organism ecosystem (Brady, 1974).

Point source on the other hand are traceable sources of heavy metals and they include domestic wastewater effluent contains metals from metabolic waste, consumer products, generator fumes, automobile exhaust and corrosion of water pipes. Whatever the sources of toxic metals once they are released, they find their ways into the soil and become part of the life cycle of soil – plant – animal – man (fig 2.1) as reported by Brady (1974). Sadly, enough, the moment they become part of this cycle, they tend to bio-accumulate in the body tissue of both man and animals even up to hazardous points or levels.

Heavy metal absorption by plants is governed by soil characteristics such as pH and organic matter content (Csintalan and Tuba, (1992). It has also been reported that individual plant types greatly differ in their uptake of heavy metals (Intawongse and Dean, 2006). Primarily, roots of plants are saddled with the responsibility of absorbing water and mineral elements but to compliment this, absorption of elements do take place through the leaves i.e. foliar absorption. In fact, foliar route is said to be of equal importance to the soil-root pathway The primary source of heavy metals in the aerial parts of a plant is generally thought to be via aerial deposition (Alfani et al., 1996). Direct uptake of heavy metals through the leaf after deposition is an important route especially for lead, according to (Breckle and Kahle, 1992). The deposited particles may be washed by rain into the soil, re-suspended or retained on leaves (Harrison and Chirgawi, 1989).

3.0 Health Challenges

According to Alloway (1995), rise in the levels above certain limits of both essential and non-essential metals will always lead to phytotoxicity in plants. Also, Kabata-Pendias and Pendias (1984) suggested the following possible causal mechanism and the metals that are commonly involved as follows:

a. Changes in the permeability of the cell membrane; Ag, Au, Br, Pb, Cd, Cu, F, I and Hg.
b. Competition for sites with essential metabolites; As, F, Se, Sb, Te and W.
c. Reactions of Sulphydryl (-SH) groups with cations: Pb, Hg, Ag.

d. Affinity for reacting with phosphate groups and active groups of ADP or ATP; Al, Y, Zr, Be, Lanthanides and possibly, all heavy metals.

e. Occupation of sites for essential groups such as phosphate and nitrate; arsenate, selenate, borate, fluorate, tellurate.

f. Replacement of essential ions (mainly major cations); Cs, Li, Sr and Se.

Toxic heavy metals may affect germination, young or old trees, stem growth, leaf formation, root growth, flowering/fruiting, plant growth rate and biomass, photosynthesis, mineral nutrition, changes in chloroplasts numbers and volume transpiration and secondary metabolism (Breckle and Kahle, 1992; Csintalan and Tuba, 1992 and Turcsanyi, 1992). The metals could be found in water, air and soil. The mode of its transportation is of no essence, as it will definitely impact directly or indirectly on man. Heavy metals have been found in food crops and possess a potential health hazard to man through ingestion (Ferner et al., 2001; Ma et al., 2006). According to World Health Organization (WHO, 1984), the toxic effect of these metals ranges from severe mucosal irritation to possible necrotic changes in the liver and kidney in the case of copper while zinc and Iron could lead to vomiting, dehydration, electrolyte imbalance and lack of muscular co-ordination.

Ademoroti (1992) has reported the pathogenic effect of lead (Pb) poisoning to include encephalitis, inflammation of the brain, inattention, Intelligent Quotient (IQ) deficit and reduced nerve conduction. Mercury on the other hand has been reported to be the causes of brain damage, brain tumours and is also implicated in reduced neuropsychological function (Zielhuis, 1979). According to the American Chemical Society (1971), Copper could cause liver damage with prolonged exposure, Silver causes discoloration of skin and Zinc has possible lung effects. It has also been reported that bioaccumulation of small doses of lead overtime can constitute a serious health hazard (Mogo, 2002). Kimani (2007) and Casarett and Doull (1996) have revealed the damaging effects to man and animals exposed to toxic metal such as lead, mercury, zinc, cadmium, oxides of sulphur and nitrogen, carbon (ll) oxide (CO) to include: various diseases such as rheumatoid, arthritis, diseases of kidney, nervous and circulatory systems, inflammation of the liver, cancer of skin, liver and lung, gastrointestinal and respiratory tract irritations. A summary of the various heavy metals associated diseases is presented in Table 1.

Table 1: Effects of Heavy Metals Constituents of Particulate Matter on Human Health

Heavy Metal	**Sources of Environmental Sources**	**Minimum Risk Level**	**Chronic Exposure Toxicity Effects**
Lead	Industrial and vehicular emissions, paints and burning of Plastics, paper etc	Blood lead levels below 10 micrograms per deciliter of blood	Impairment of neurological development, Suppression of the haematological system (anemia), kidney failure, immunosuppression etc
Mercury	Electronic and Plastic waste, pesticides, pharmaceutical and dental waste.	Below 10 microgram per deciliter of blood; oral Rfd 4 mg/kg/day	Gastrointestinal and respiratory tract irritation, renal failure and neurotoxic.
Cadmium	Electronic, Plastics, batteries-diet and water.	Below 1 microgram per deciliter of blood	Local irritation of the lungs and gastrointestinal tract, kidney damage and abnormities of skeletal system.
Arsenic	Herbicides and Pesticides, electronic, burning of waste containing the element, contaminated water.	Oral exposure of 0.0003 mg/kg/day	Inflammation of the liver, peripheral nerve damage-neuropathy, cancer of liver, skin and lungs, irritation of the upper respiratory system pharyngitis, laryngitis, rhinitis, anemia, cardiovascular diseases.

Source: Kimani (2007)

CONCLUSION

Planting of crops in polluted areas or their exposure to sources of these metals will affect their yield or output and this will have hampered the attainment of the millennium development goals of eradicating hunger and poverty. It can also lead to loss of man power due to ailments that are associated with man exposure to this metals. In order to guide against these problems of exposure, plants or crops should not be planted in polluted areas and man must also do everything possible to avoid going near the sources of these metals.

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