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HAZARDS OF HEAVY METALS IN CONTAMINATED SOILS AND FOOD CROPS IRRIGATED WITH WASTEWATER IN SATNA REGION

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ABSTRACT

Consumption of food crops contaminated with heavy metals is a major food chain route for human exposure. The main threats to human health from heavy metals are associated with exposure to lead, cadmium, mercury and arsenic. These metals have been extensively studied and their effects on human health regularly reviewed by international bodies such as the WHO. Heavy metals have been used by humans for thousands of years.
Although several adverse health effects of heavy metals have been known for a long time, exposure to heavy metals continues, and is even increasing in same parts of the world, in particular in less developed countries, though emissions have declined in most developed countries over the last 100 years. Furthermore, this study highlights that both adults and children consuming food crops grown in wastewater irrigated soils ingest a significant amount of the metals studied.

Keywords: *Health risks, heavy metals, soil contamination, wastewater-irrigation.*

I. INTRODUCTION

Heavy metals are ubiquitous in the environment, as a result of both natural and anthropogenic activities, and humans are exposed to them through various pathways.[1] Wastewater-irrigation, solid waste disposal, sludge applicants, vehicular exhaust and industrial activities are the major sources of soil contamination with heavy metals, and an increased metal uptake by food crops grown on such contaminated soils is often observed. In general, wastewater contain substantial amount of beneficial nutrients and toxic heavy metals, which are creating opportunities and problems for agricultural production.[2]

There has long been concerns about heavy metals and metalloids pollution because of their stability and non-biodegradability in environmental media as well as their toxicity to plants, animals, and humans.[3]
Soils is the primary reservoir for heavy metals in the atmosphere, hydrosphere, and biota, and thus plays a fundamental role in the overall metal cycle in nature.[4]

Heavy metals in soil pose potential threats to the environment and can cause human health problems through various absorption pathways such as inhalation, absorption through dermal pores, or ingestion(diet through the soil- food chain) .[5]

Over the last four decades there has been increasing global concern over the public health impact attributed to environmental pollution. The world health organization (WHO) estimate that about a quarter of disease facing mankind today, occurs due to prolonged exposure to environmental pollution. Most of these environmental related diseases however not easily detected and may be acquired during childhood and manifested latter in adult hood. The deep penetration of the hazardous waste and disposals which contain toxic metals affecting the health of all species and corrupting the natural habitat into the soils, water and air.[6]

Heavy metals are elements with a specific gravity that is at least 5 times the specific gravity of i.e As (5.7), Cd (8.65), Fe (7.9), Pb (11.34), and Hg (13.55). Metals play a vital role in the metabolic processes of the biota. Some of the heavy metals are essential and are required by the organisms as micro nutrients (Co, Cr, Ni, Fe, Mn, and Zn etc.) and are known as 'trace elements.[7] They are involved in redox processes, in order to stabilize molecules through electrostatic interactions, as catalysts in enzymatic reactions, and regulating the osmotic balance.[8-9] Some heavy metals have no biological role and are detrimental to the organisms even at very low concentration (Cd, Hg, Pb etc.). However, at high levels both of the essential and non essential metals become toxic to the organisms.

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These heavy metals influence the microbial population by affecting their growth, morphology, biochemical activities and ultimately resulting in decreased biomass and diversity.[10] Heavy metals can damage the cell membranes, alter enzymes specificity, disrupt cellular functions and damage the structure of the DNA. Toxicity of these heavy metals occurs through the displacement of essential metals from their native binding sites or through ligand interactions.[7] Also, toxicity can occur as a result of alterations in the conformational structure of the nucleic acids and proteins and interference with oxidative phosphorylation and osmotic balance.[11],[7] The city of Satna is known as commercial capital of Baghelkhand. The city is amongst the few most promising cities of Madhya Pradesh because of the several new industries planned by some of the reputed industrial houses in the country.

Satna district comprises of variety of minerals including bauxite shale, laterite, conglomerate, cuartzite, sandstone, coal seams and granite etc. Soils derived from sandstone are generally nonpermeable and have no water contents. The water table in sandstone is deeper in general shalis show little percolation of ground water hence has limited retaining and explanation of it. Limestone allows movement of ground water due to the presence of such geology the ground water of study area is highly affected in its quality.[12]

Assessing the problems caused by contaminated soils typically involves soils chemistry as well as laboratory and field studies to fully assess the extent and significance of any adverse environment effects.[13] Metals are necessary for proper functioning of biological systems, their deficiency or excess can lead to a number of disorders.[14]

The problem of environmental pollution due to toxic metals is of major concern in most major metropolitan cities. Heavy metals occur naturally in the soil environment from the pedogenetic processes of weathering of parent materials at levels that are regarded as trace and rarely toxic.[15-16] Due to the disturbance and acceleration of nature's slowly occurring geochemical cycle of metals by man, most soils of rural and urban environments may accumulate one or more of the heavy metals above defined background values high enough to cause risks to human health, plants, animals, ecosystems, or other media.[17]

The present distribution of metals in the soil can serve as an indication of time, history, and extent of pollutants discharged in the area. A number of studies had been done to assess heavy metal concentration in soil and their impacts. The continuous disposal of industrial effluents on land leads to percolation of pollutants to the ground water through seapage and leaching causing contaminations.

Cement withdraws an attention as a pollutant. The raw materials of the cement have mainly the following constituents: 75% limestone ($CaCO_3$); 20% - 25% clay ($Al_2O_3 + Fe_2O_3$); 5% sand (SiO_2) and 2% Ferric oxide (Fe_2O_3). In fact cements are mineral materials, basically hydrated silicate and portlandite [$Ca(OH)_2$] for the ordinary Portland cement.[18] Cement adversely affects the populations of microorganisms.

As cement has high carbonate content, the dust tends to be highly alkaline. Therefore, it is likely that soil contaminated by cement will have high pH. The biological, physical and chemical properties of soil, such as water content, electrical conductivity, and pH, were all found to be affected when treated by raw materials of cement.[19]
Present work focuses on the level of concentration of heavy metal on human health and environment at Satna district. Heavy metal contamination in the environment has become a serious problem due to the increase in the addition of these metals to the environment. Natural sources as well as the anthropogenic sources account for this contamination, which has become a threat to public health. Cd, Cu, and Zn are among those heavy metals that are being released to the environment.[20]

Heavy metals may enter the human body through food, water, air or absorption through the skin when they come in contact with dust, fumes vapors or materials in the workplace. Heavy metals are used for the manufacture of pesticides, batteries, alloys, electroplated metal parts, textile dyes, steel and so forth. Its presence become toxic when they are not metabolized by the body and accumulate in the soft tissues.

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A growing number of publications are currently focused on the union of two processes ; phytoremediation and production of biofuel crops. [21-22] Small amounts of these elements are common in our environment, found naturally in food stuff and nutritionally essential for good health. Large amounts of them may cause acute or chronic toxicity (poisoning), damaged or reduced mental and central nervous function, lower energy levels and damage to blood composition, lungs, kidneys, liver and other vital organs. Long-term exposure may result muscular and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, multiple sclerosis and may even cause cancer. WHO/FDA/API has identified four heavy metals viz. mercury, lead, cadmium and arsenic to pose a serious risk to human health's. The permissible limit of these metals for plant material is Pb-10.0 ppm, Cd-0.30 ppm, As-3.0 ppm, Hg-1.0ppm as per WHO & FDA.

II. QUALITATIVE AND QUANTITATIVE ANALYSIS OF HEAVY METAL IS DONE BY AAS & ICPMS.

Expected outcome of the proposed work

Proposed work will help to study the distribution of heavy metals in soil, water and their effects on human health being. We can able to forecast about increased concentration of heavy metals to evaluate potential risks to residents area. By this study we can also recommend some remedial measures to reduce the soil heavy metal toxicity. Soil contamination creates a significant risk to human health. For instance, heavy metals from industrial waste contaminate drinking water, soil, fodder, and food.[23] The implication of soils to human health is direct such as ingestion, inhalation, skin contact, and dermal absorption. Some epidemiological example includes geohelminth infection and potentially harmful elements via soil ingestion, cancers caused by the inhalation of fibrous minerals, hookworm diseases, and podoconiosis caused by skin contact with soils.[24] Pollution by heavy metals and many organic contaminants is practically irreversible excess heavy metal accumulation in soils is toxic to human and other animals.

Exposure to heavy metals is normally chronic (exposure over a longer period of time), due to food chain transfer. Acute (immediate) poisoning from heavy metals is rare, but possible, through ingestion or dermal contact. Bioconcentration factor indicated that Ni had higher capacity of absorption in food crops from soil than the other metal studied.[25] Chronic problems associated with long-term heavy metal exposure are [26] for

1. Lead – it well known to be toxic and its effects have been more extensively reviewed than the effects of other trace metals. Lead can cause serious injury to the brain, nervous system,red blood cells, and kidneys.[27]
2. Cadmium – affects kidney, liver and Gi tract.[28]
3. Arsenic – is associated with skin damage, increased risk of cancer and problems with circulatory system, affects kidneys and the central nervous system.[29]
4. Chromium is associated with allergic dermatitis in humans [30]
5. Mercury is associated with kidney damage.[31]

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