

A Review of Soil Pollution by Heavy Metals And Their Impact On Vegetables In Satna District M.P, India

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Abstract

This survey expects to investigate the degree of soil contamination by heavy metals in Satna Area, Madhya Pradesh, India, and its subsequent effect on vegetable yields. heavy metal contamination is a squeezing ecological concern internationally, with significant ramifications for rural efficiency and food handling. Satna Locale, a critical farming district, is confronting difficulties because of modern exercises, mining tasks, and rural works on prompting weighty metal defilement in soil. This audit orchestrates existing writing to break down the sources, conveyance, and impacts of weighty metal contamination on vegetable harvests in the area. Moreover, it talks about potential alleviation systems and future examination headings to resolve this basic issue.

Keywords: Soil pollution, Heavy metals, Vegetable crops, Satna District, Madhya Pradesh, India, Environmental contamination, Agricultural sustainability, Food safety, Mitigation strategies.

1. INTRODUCTION

Satna is criminate Industrialization and urbanization have negatively impacted our environment. One of the common environmental problems in semi-urban areas in India is the discharge of in efficiently treated municipal, industrial and domestic waste water in to the environment, resulting in the debasement of soil and water qualities. Depleting fresh water resources have drove Indian farmers to look for easily available, less expensive, and supplement rich wellsprings of water system water as wastewater; be that as it may, this additionally prompted expanded poison move to the dirt. Known as tenacious contaminations, weighty metals like cadmium , copper (Cu), chromium (Cr), lead (Pb), mercury (Hg), and a few others are possibly dangerous because of their non-biodegradable nature, expanded organic half-lives, and organic collaborations. These weighty metals can tie to soil surfaces and afterward be consumed by plant tissues. Vegetables

supply micronutrients, cancer prevention agents, vitamins, and different supplements essential for human development. Therefore, the consumption of vegetables/crops grown in wastewater-irrigated and represents a likely danger to people. Since wastewater water system can't be disposed of in the Indian (semi-) metropolitan regions in view of the ever-expanding interest for water system water, evaluating the effect of wastewater irrigation is significant. This audit article assembles the finding so studies from India where in heavy metal contaminations in vegetables have been reported. An attempt was made to estimate the risk to human health because of the long-term consumption of vegetables cultivated in wastewater-irrigated and from the Indian sites.

Features

- Heavy metals in vegetables produced from wastewater-inundated crop lands in India.
- Common sources on tribute to heavy metals in soils.
- Geochemistry of heavy metals controls the transfer factor more than plant physiology.
- Risk to human health associated with heavy metals.

The presence of heavy metals in food is a danger to human wellbeing. Openness to heavy metals as a aftereffect of utilization of debased vegetables, as well as their poisonousness, is a difficult issue. Various parts of industry and the street traffic fundamentally affect ecological contamination with weighty metals. Metropolitan and modern sewage moreover is a significant wellspring of those substances. Besides, the mineral substance of vegetables relies upon factors for example, the inherent substance of minor components in the climate, their levels in mineral manures, and compost dosages. In the dirt, a characteristic wellspring of these metals is bedrock. In soils utilized for farming purposes, some amounts of metals are presented along with manures, both natural and mineral. Also, another wellspring of the metals are plant assurance items. Weighty metal elements in the dirt and their take-up by plants are impacted by soil properties, which play a key job in the bioavailability of these metals. Metal portability what's more, absorption are likewise affected by the expansion of natural and inorganic matter. A huge collection of proof additionally propose that the age of the dirt plays a significant job in

regulation of metal bioavailability to plants. Aside from being impacted by the dirt related factors, assimilation of metals varies in various sorts of plants. A huge variety in metal focuses was additionally found relying upon their area in plant tissues, on plant species, or even on assortments of the equivalent species.

The issue of weighty metal defilement in the climate is inescapable. Taken up by plants, weighty metals may enter the pecking order, and accordingly, people can likewise be presented to them.

[1] A as of late distributed WHO/FAO report suggests utilization of least of 400 g of products of the soil per day (barring potatoes and other dull tubers) for counteraction of ongoing infections like heart sicknesses, malignant growth, diabetes, and heftiness, as well with respect to counteraction what's more, mitigation of a lacks of few micronutrient, particularly in less evolved nations. [2] Heavy metals are broadly appropriated in the climate also, are viewed as huge synthetic food pollutants. The gathering of weighty metals incorporates both components fundamental for ordinary metabolic cycles, called micronutrients (Fe, Mn, Cu, Zn, Mo), which in inordinate amounts are more hurtful to plants than to creature bodies, as well as components, for example, As, Hg, Pb, or Compact disc, which as of now at low fixations are very destructive to people and creatures, while influencing plant development and improvement less significantly.

As indicated by their poisonousness to living life forms, the weighty metals can be set up in the accompanying request: Hg > Cu > Zn > Ni > Pb > Album > Cr > Sn > Fe > Mn > Al .[3] [4]

Laid out greatest degrees of six weighty metals: arsenic, cadmium, chromium, lead, mercury (counting methylmercury), tin; & US Food and Medication Organization (FDA). The US Food and Medication Organization (FDA) has not laid out administrative cutoff points for weighty metals in completed food items other than filtered water. Nonetheless, the Office has given direction on a few weighty metal levels in specific food varieties, (for example, candy and squeeze). The greatest degrees of weighty metals in groceries of plant beginning ought to be set at the strictest conceivable level that is in all actuality reachable by great acts of agrarian industry, and considering the dangers related with food utilization. For toxins that are considered genotoxic cancer-causing agents, or in situations where the current openness of the populace or the most helpless populace bunches is near or surpasses the endured take-up, the most elevated allowed levels ought to be set at the least in all actuality feasible level. Because of contrasts in

public regulations and the related chance of bending of rivalry, it is fundamental to present estimates in regard of specific contaminations, The openness to cadmium, lead, and methylmercury compounds is particularly hazardous during pre-birth improvement also, earliest stages, as it causes irreversible changes in the focal sensory system.

Lead additionally causes cardiovascular sicknesses, upsets heme biosynthesis and nutrient digestion, causes kidney and liver dysfunctions also, issues of the safe and the regenerative frameworks, and disturbs iron, zinc, and copper digestion. Cadmium is cancer-causing, neurotoxic, and nephrotoxic, what's more, causes skeletal issues, liver harm, cardiovascular infections, dysfunctions of the sexual organs, and disturbs a mineral equilibrium in the body. Mercury, and particularly the methylmercury compounds, aggregates predominantly in the mind tissue, making harm the focal sensory system, particularly the creating fetal cerebrum. In grown-ups, it causes hearing, discourse, and visual issues, cardiovascular illnesses, and appendage muscle loss of motion. Arsenic has cancer-causing, neurotoxic (hearing problems), furthermore, genotoxic impacts, and causes cardiovascular infections, fringe vascular issues, iron deficiency, and dysfunctions of the regenerative framework [5][6] Because of their properties like poisonousness, diligence, furthermore, non-biodegradation, pollution with metals has turn into a serious and broad natural danger, especially in metropolitan regions.[7] The issue of weighty metals stems out not just from their poisonous properties yet additionally from their capacity to collect in the body, as it is a case with all components recorded above. At low degrees of openness to these components, clinical signs don't show right away and their impacts can be noticed exclusively at the physiological or biochemical level.

2. Wellsprings of Pollutions with Heavy Metals

The quick worldwide modern improvement has come about in a essentially expanded chance of natural tainting with weighty metals. Quick industrialization and confused urbanization, along with long haul utilization of largeamounts of manures and pesticides, bring about gathering of poisonous substances in soil, water, and air. [8][9]The primary wellsprings of emanations brought about by human exercises include:

& Discharges from portable sources connected with vehicle transport and powers, called straight discharge & Cycles of energy ignition of energizes, and modern mechanical cycles, releasing

substances very high through a producer (stack) in a coordinated way, called point discharge sources; & Discharges connected with house warming in the metropolitan what's more, family area, called surface discharge [10] (WIOŚ Szczecin 2015).

I.P

3.MATERIALS AND METHODS

Assortment and Handling of Tests The current review was completed in selected area satna, Madhya Pradesh, India. New examples of ten kinds of vegetables were haphazardly bought. A sum of vegetable examples were gathered. After assortment, the examples were brought to the lab and uneatable segments of the vegetables were eliminated and the consumable part were appropriately isolated and washed with refined water to eliminate dust particles and afterward slashed into little pieces utilizing a blade. The examples were then dried in a stove at 80 °C and afterward ground into a fine powder utilizing a business hardened steel blender and put away in sealed shut plastic compartments. The subsequent fine powder was kept at room temperature before investigation.

Acid Digestion

(Nitric corrosive, Perchloric corrosive Disintegration) heavy metals in vegetable examples were removed by corrosive processing. 2g of each example was weighed into a processing jar and treated with 10 ml of a corrosive blend comprised of concentrated nitric corrosive (HNO₃) and perchloric corrosive (HClO₄). A clear example was ready by applying 10 ml of above corrosive blender into an unfilled processing jar. The blend was then processed on an electric hot plate at 80-900 C to focus till the arrangements became straightforward.[11][12] (Sharma et al., 2009). In the wake of cooling, the arrangements were separated with Whatman No.4 channel paper and weakened to 50 ml utilizing de-ionized water. The arrangement was then safeguarded in a widespread container for additional examination.

4. Heavy Metals Analysis (Atomic Absorption Spectroscopy)

The resulting solutions were analyzed for concentrations of Cu, Zn, Pb, and Cd using an atomic absorption spectrophotometer (model AAS 7000, Shimadzu). The estimations were made

utilizing an empty cathode light of Cu, Zn, Pb, and Disc at frequencies of 324.8, 213.9, 213.3 and 288.8 nm individually. The cut width was adapted to every one of the weighty metals at 0.7 nm. A confirmed standard reference material was utilized to guarantee exactness and the logical qualities were inside the scope of ensured esteem. All reagents utilized were of logical grade.

Soil Elements Influencing Metal Amassing

The mineral substance of vegetables likewise relies upon factors, for example, the inherent substance of minor components in the climate, their level in mineral manures, and compost portions. In the dirt, a characteristic wellspring of these metals is bedrock. In soils utilized for rural purposes, a few amounts of metals are presented together with composts, both natural and mineral (for the most part calcium furthermore, phosphates). Moreover, one more wellsprings of metals are plant protection products .[13][14](Kabata-Pendias furthermore, Pendias 1999; Antisari et al. 2015; Ye et al. 2015).

Weighty metal elements in the dirt and their take-up by plants rely upon soil properties, which assume a critical part in the bioavailability of these metals. The level of these mixtures' aggregation in plants relies upon, among others, soil type, pH, stickiness, and micronutrients content, as well as on the hour of harvest gathering.[15] (Kabata-Pendias and Pendias 1999; Järup2003; Leitzmann 2003; Właśniewski and Hajduk 2012;Yang-Guang et al. 2016; Hu et al. 2017).

Table 1 Concentrations of heavy metals in edible parts of vegetables from UK, depending on species and cultivar (mg/kg) Alexander et al.(2006)[17]

Vegetable species	Vegetable cultivar	Cd (mg/kg)	Pb (mg/kg)	Zn Zn (mg/kg)	Cu (mg/kg)
Carrot	Amsterdam	2.521	6.310	52.590	5.770
	Nantes	1.812	5.010	19.020	4.43
	Wlewek	2.298	7.230	33.380	4.43
	European standardsb	0.1	0.1	—	-

Pea	Pilot	0.1785	0.508	59.9	6.722
	Feltham	0.2615	0.547	36.82	5.727
	European standardsb	0.05	0.2	-	-
Lettuce	Little Gem	8.173	19.68	172.17	9.97
	Corsair	9.033	11.73	160.69	12.55
	European standardsb	0.3	0.3	-	-
Onion	Shenshyu	3.7283	7.77	31.0	2.693
	Express	3.5566	8.745	60.94	3.078

B Maximum levels for certain contaminants in foodstuffs on the basis of Commission Regulation (EC) No 1881/2006 of 19 December 2006 and amending Regulation No 420/2011 of 29 April 2011

Table 2 Concentrations of heavy metals in edible parts of vegetables from Germany, depending on species (mg/kg). Data show mean \pm standard error of three replicates Säumel et al. (2012)[18]

Vegetable type	Vegetable species	Pb (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Ni (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Leafy	White Cabbage	0.6–2.6	0.06–0.41	0.025–0.81	0.01–1.0	3.2–6.6	26.4–46.5
	European standardsb	0.3	0.2	-	-	-	-
Solanaceous	Tomato	0.1–6.7	0.01–0.79	0.11–0.63	0.03–0.70	3.5–16.0	15.8–84.7
	European standardsb	0.1	0.05	-	-	-	-
Stem	Kohlrabi	0.1–3.1	0.03–0.15	0.07–0.54	0.29–0.67	3.2–11.7	20.6–50.3

	European standards ^b	0.3	0.1	-	-	-	-
Root	Potato	0.3–31.3	0.02– 0.42	0.03– 4.69	0.03– 3.25	3.4–20.1	11.7– 78.2
	European standards ^b	0.1	0.1	-	-	-	-

bMaximum levels for certain contaminants in foodstuffs on the basis of Commission Regulation (EC) No 1881/2006 of 19 December 2006 and amending Regulation No 420/2011 of 29 April 2011

Alexander et al. (2006) reported that Cd, Cu, and Zn accumulated to the largest extent in lettuce and spinach, while the highest accumulation of Pb was noted in lettuce and onions. They also demonstrated that vegetables of the same species accumulated different amounts of heavy metals depending on a cultivar (Table 1).

Säumel et al. (2012) reported that the concentration of heavy metals in leafy vegetables is higher than in potato, carrot, tomato, kohlrabi, and green bean seeds (Table 2).

I. P Tripathi et al (2015) reported that the concentration of heavy metals in Vegetables from selected market sites in Chitrakoot Satna, MP, India. (Table 3) [20]

Table 3. Concentration of heavy metals in vegetables collected from Chitrakoot Marke

S.No	Vegetables	Cu	Zn	Pb	Cd
1	Potato	0.327	0.07	ND	0.089
2	Pumpkin	0.913	0.68	ND	ND
3	Carrot	0.933	0.33	ND	ND
4	Spinach	0.412	0.67	ND	0.001
5	Pigweed	1.990	0.94	ND	0.007
6	Radish	0.843	0.18	ND	ND
7	Menthi	0.841	0.31	ND	0.023

ND=Not detected. Levels were below detection limit.

. Cu = Copper; Pb = Lead; Zn =Zinc; Cd = Cadmium.

5. Wellsprings of HeavyMetals in Tainted Soils

5.1. Composts.

By and large, horticulture was the main major human effect on the dirt. To develop and finish the lifecycle, plants should obtain not just macronutrients (N, P, K, S, Ca, and Mg), yet in addition fundamental micronutrients. Some soils are lacking in the weighty metals (like Co, Cu, Fe,Mn, Mo, Ni, and Zn) that are fundamental for solid plant development [20], and yields might be provided with these as an expansion to the dirt or as a foliar shower. Cereal harvests become on Cudeficient soils are incidentally treated with Cu as an expansion to the dirt, and Mn may correspondingly be provided to cereal and

root crops. Huge amounts of composts are consistently added to soils in serious cultivating frameworks to give satisfactory N, P, and K for crop development. The mixtures used to supply these components contain follow measures of weighty metals (e.g., Disc and Pb) as pollutants, which, after proceeded with manure,

applicationmay altogether increment their substance in the dirt .Metals, like Disc and Pb, have no known physiological movement. Utilization of certain phosphatic manures accidentally adds Album and other possibly harmful components to the soil, including F, Hg, and Pb.

5.2. Pesticides. A few normal pesticides utilized decently broadly in agribusiness and agriculture in the past contained significant groupings of metals. For example in the new past, around 10% of the synthetics have endorsed for use as insect sprays and fungicides in UK depended on intensifies which contain Cu, Hg,Mn, Pb, or Zn. Models of such pesticides are copper-containing fungicidal showers like Bordeaux combination (copper sulfate) and copper oxychloride [21].

5.3. Biosolids and Composts. The utilization of various biosolids (e.g., animals fertilizers, manures, and metropolitan sewage slop) to land incidentally prompts the amassing of weighty metals, for example, As, Disc, Cr, Cu, Pb, Hg, Ni, Se, Mo, Zn, Tl, Sb, etc, in the dirt. Certain creature squanders like poultry, steers, and pig fertilizers created in horticulture are usually applied to yields and fields either as solids or slurries [22]. Albeit most composts are seen as

important manures, in the pig and poultry industry, the Cu and Zn added to counts calories as development advertisers and As contained in poultry wellbeing items may likewise have the potential to cause metal pollution of the dirt. [23].

The excrements created from creatures on such eating regimens contain high groupings of As, Cu, and Zn and, if more than once applied to confined areas of land, can cause significant development of these metals in the dirt over the long haul. Biosolids (sewage slop) are basically natural strong items, delivered by wastewater treatment processes that can be helpfully reused . Land use of biosolids materials is a typical practice in numerous nations that permit the reuse of biosolids created by metropolitan populaces. The term sewage slime is utilized in many references in light of its wide acknowledgment and its administrative definition. Be that as it may, the term biosolids is turning out to be more normal as a swap for sewage slop since it is thought to reflect all the more precisely the useful qualities innate to sewage slime . It is assessed that in the United States, the greater part of around 5.6 million dry lots of sewage slop utilized or discarded yearly is land applied, also, rural usage of biosolids happens in each locale of the country. In the European people group, over 30% of the sewage slop is utilized as manure in farming [29]. In Australia north of 175 000 tons of dry biosolids are delivered every year by the significant metropolitan specialists, also, at present most biosolids applied to agrarian land are utilized in arable trimming circumstances where they can be integrated into the dirt .

5.4. Wastewater. The application of municipal and modern wastewater and related effluents to land goes back 400 years furthermore, presently is a typical practice in many regions of the planet. Around the world, it is assessed that 20 million hectares of arable land are flooded with squander water. In a few Asian furthermore, African urban communities, studies propose that farming in view of wastewater water system represents 50% of the vegetable supply to metropolitan regions [24]. Ranchers by and large are not annoyed about ecological advantages or risks and are essentially keen on amplifying their returns and benefits. Albeit the metal fixations in wastewater effluents are generally somewhat low, long haul water system of land with such can ultimately result in heavy metal aggregation in the soil

5.5. Metal Mining and Milling Cycles and Industrial Wastes.

Mining and processing of metal minerals combined with enterprises have gave numerous nations, the tradition of wide circulation of metal foreign substances in soil. During mining, tailings (heavier and bigger particles settled at the base of the buoyancy cell during mining) are straightforwardly released into regular discouragements, including nearby wetlands coming about in raised fixations. Broad Pb and zinc Zn metal mining and purifying have brought about tainting of soil that stances hazard to human and biological wellbeing. Numerous recovery strategies utilized for these locales are extensive and costly and may not reestablish soil efficiency. Soil weighty metal natural gamble to people is connected with bioavailability. Absorption pathways incorporate the ingestion of plant material filled in (natural pecking order), or the immediate ingestion (oral bioavailability) of, sullied soil [25].

2.6. Air-Borne Sources. Airborne wellsprings of metals incorporate stack or channel discharges of air, gas, or fume streams, and outlaw discharges like residue from capacity regions or waste heaps. Metals from airborne sources are for the most part delivered as particulates contained in the gas stream. A few metals, for example, As, Compact disc, and Pb can likewise volatilize during high-temperature handling. These metals will switch over completely to oxides and consolidate as fine particulates except if a lessening air is kept up with .

5.6. Soil Concentration Ranges and Administrative Rules for Some HeavyMetals

The particular sort of metal pollution saw as in a defiled soil is straightforwardly connected with the activity that happened at the site. The scope of toxin fixations and the physical and substance types of toxins will likewise rely upon exercises and removal designs for tainted squanders on the site. Different variables that might impact the structure, fixation, and circulation of metal pollutants incorporate soil and ground-water science and neighborhood transport components..

Soils might contain metals in the strong, vaporous, or fluid stages, and this might muddle examination and translation of announced results. For instance, the most widely recognized technique for deciding the centralization of metals toxins

in soil is through all out basic examination (USEPA Technique 3050). The level not entirely settled by this method is communicated as mg metal kg⁻¹ soil. This examination doesn't

determine prerequisites for the dampness content of the dirt and may accordingly incorporate soil water. This estimation may also be provided details regarding a dry soil premise.

Riley et al. [33] and NJDEP [34] have reported soil concentration ranges and regulatory guidelines for some heavy metals (Table-4). In Nigeria, in the interim period, whilst suitable parameters are being developed, the Department of Petroleum Resources has recommended guidelines on remediation of contaminated land based on two parameters intervention values and target values (Table- 5).

Table - 4: Soil concentration ranges and regulatory guidelines for some heavy metals.

Metal	Soil concentration range†	Regulatory limits‡ (mg kg ⁻¹)
Pb	1.00–69 000	600
Cd	0.10–345	100
Cr	0.05–3 950	100
Hg	<0.01-1800	270
Zn	150-5000	1500

Table-5: Target and intervention values for some metals for a standard soil [60].

Metal	Target value (mg kg ⁻¹)	Intervention value (mg kg ⁻¹)
Ni	140.00	720.00
Cu	0.30	10.00
Zn	-	-
Cd	100.00	380.00
Pb	35.00	210.00
As	200	625
Cr	20	240
Hg	85	530

6. Fundamental Soil Science and Expected Dangers of Heavy Metals

The most normal heavymetals found at debased destinations, arranged by overflow are Pb, Cr, As, Zn, Album, Cu, and Hg [26]. Those metals are significant since they are skilled of diminishing yield creation because of the gamble of bioaccumulation what's more, biomagnification in the natural pecking order. There's likewise the gamble of shallow and groundwater defilement. Information on the fundamental science, natural, and related wellbeing impacts of these weighty metals is vital in grasping their speciation, bioavailability, and medicinal choices.

6.1. Lead. Lead is a metal having a place with bunch IV and period 6 of the intermittent table with nuclear number 82, nuclear mass 207.2, thickness 11.4 g cm^{-3} , dissolving point 327.4°C , and edge of boiling over 1725°C . It is a normally happening, bluishgray metal normally viewed as a mineral joined with other components, like sulfur (i.e., PbS , PbSO_4), or oxygen (PbCO_3), and goes from 10 to 30 mg kg^{-1} in the world's hull [27]. Average mean Pb fixation for surface soils

overall midpoints 32 mg kg^{-1} and goes from 10 to 67 mg kg^{-1} . Lead positions fifth behind Fe, Cu, Al, and Zn in modern creation of metals. About portion of the Pb used in the U.S. goes for the assembling of Pb stockpiling batteries.

Different purposes incorporate fastens, heading, link covers, ammo, plumbing, colors, and caulking. Metals ordinarily alloyed with Pb are antimony (away batteries), calcium (Ca) and tin (Sn) (in upkeep free capacity batteries), silver (Ag) (for patch and anodes), strontium (Sr) and Sn (as anodes in electrowinning processes), tellurium (Te) (pipe furthermore, sheet in substance establishments and atomic safeguarding), Sn (fastens), and antimony (Sb), and Sn (sleeve heading, printing, and high-detail castings)

6.2. Chromium.

Chromium is a first-row d-block progress metal of gathering VIB in the occasional table with the accompanying properties: nuclear number 24, nuclear mass 52, thickness 7.19 g cm^{-3} , softening point 1875°C , and limit 2665°C . It is one of the more uncommon components and doesn't happen normally in essential structure, however just in compounds. Chromium is mined as an essential mineral item in the structure of the mineral chromite, FeCr_2O_4 . Significant wellsprings of

Crcontamination incorporate deliveries from electroplating processes furthermore, the removal of Cr containing squanders [28]. Chromium(VI) is the type of Cr normally found at defiled locales. Chromium can likewise happen in the +III oxidation state, contingent upon pH and redox conditions. Chromium(VI) is the predominant type of Cr in shallow springs where high-impact conditions exist. Chromium(VI) can be diminished to Cr(III) by soil natural matter, S₂- and Fe²⁺ particles under anaerobic conditions frequently experienced in more profound groundwater.

6.3. Zinc.

Zinc is a progress metal with the accompanying qualities: period 4, bunch IIB, nuclear number 30, nuclear mass 65.4, thickness 7.14 g cm⁻³, softening point 419.5°C, and limit 906°C. Zinc happens normally in soil (about 70mg kg⁻¹ in crustal rocks) [29], however Zn focuses arerising unnaturally, because of anthropogenic augmentations. Most Zn is added during modern exercises, like mining, coal, and waste ignition and steel handling. Numerous staples contain specific groupings of Zn. Drinking water likewise contains specific measures of Zn, which might be higher when it is put away in metal tanks. Modern sources or on the other hand harmful material locales might cause the groupings of Zn in drinking water to arrive at levels that can cause medical conditions. Zinc is a minor component that is fundamental for human wellbeing. Zinc deficiencies can cause birth absconds.

6.4 Cadmium.

Cadmium is situated toward the finish of the second line of progress components with nuclear number 48, nuclear weight 112.4, thickness 8.65 g cm⁻³, dissolving point 320.9°C, also, limit 765°C. Along with Hg and Pb, Disc is one of the huge three weighty metal toxic substances and isn't known for any fundamental organic capability. In its mixtures, Compact disc happens as the divalent Cd(II) particle. Cadmium is straightforwardly beneath Zn in the occasional table and has a compound likeness to that of Zn, an essentialmicronutrient for plants and creatures. This may account to some degree for Disc's poisonousness; since Zn being an fundamental minor component, its replacement by Disc might cause the breaking down of metabolic cycles [30].

Cadmium in the body is known to influence a few proteins. It is trusted that the renal harm that outcomes in proteinuria is the aftereffect of Cd antagonistically influencing chemicals capable for reabsorption of proteins in kidney tubules. Cadmium additionally diminishes the movement of delta-aminolevulinic corrosive synthetase, arylsulfatase, liquor dehydrogenase, and lipoamide dehydrogenase, though it upgrades the movement of deltaaminolevulinic corrosive dehydratase, pyruvate dehydrogenase, also, pyruvate decarboxylase .

6.5 Copper.

Copper is a change metal which has a place with period 4 and gathering IB of the occasional table with nuclear number 29, nuclear weight 63.5, thickness 8.96 g cm^{-3} , liquefying point 1083°C and limit 2595°C . The metal's normal thickness and fixations in crustal rocks are $8.1 \times 10^3 \text{ kgm}^{-3}$ and 55mg kg^{-1} , individually.

Copper is the third most involved metal on the planet [31]. Copper is a fundamental micronutrient expected in the development of the two plants and creatures. In people, it helps in the creation of blood hemoglobin. In plants, Cu is particularly significant in seed creation, sickness obstruction, and guideline of water. Copper is for sure fundamental, yet entirely in high dosages it can cause frailty, liver and kidney harm, and stomach and gastrointestinal disturbance. Copper regularly happens in drinking water from Cu pipes, as well as from added substances intended to control algal growth. While Cu's communication with the climate is complicated, research shows that most Cu brought into the climate is, or quickly becomes, stable and results in a structure which doesn't represent a gamble to the climate.

6.6 Mercury.

Mercury has a place with same gathering of the intermittent table with Zn and Compact disc. It is the main fluid metal at stp. It has nuclear number 80, nuclear weight 200.6, thickness 13.6 g cm^{-3} , dissolving point -13.6°C , and edge of boiling over 357°C and is typically recuperated as a result of metal handling .

Arrival of Hg from coal ignition is a significant wellspring of Hg pollution. Sets free from manometers at pressure measuring stations along gas/oil pipelines additionally contribute to Hg pollution. After delivery to the climate, Hg for the most part exists in mercuric (Hg^{2+}),

mercurous (Hg^{2+}), natural (Hg^0), or alkylated structure (methyl/ethyl mercury). The redox potential and pH of the framework decide the steady types of Hg that will be available. Mercurous also, mercuric mercury are more steady under oxidizing conditions. While gently diminishing circumstances exist, natural or on the other hand inorganic Hg might be diminished to essential Hg, which may then be changed over completely to alkylated structures by biotic or abiotic processes. Mercury is most poisonous in its alkylated structures which are dissolvable in water and unpredictable in air [32].

Conclusion: Soil pollution by heavy metals poses significant challenges to vegetable cultivation and food safety in Satna District, M.P., India. Urgent actions are needed to address this issue through concerted efforts from government agencies, industries, farmers, and researchers. Implementing effective pollution control measures, adopting sustainable land management practices, and enhancing public awareness are crucial steps towards mitigating the adverse effects of heavy metal contamination on agriculture and safeguarding human health. Future research should focus on monitoring soil quality, assessing crop health, and developing innovative solutions for sustainable soil management in the region.

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