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EFFECTS OF SOIL HEAVY METALS ON ENVIRONMENT AND HUMAN HEALTH

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Abstract

Heavy elements refer to vital elements which act as a driving force for physiological and chemical reactions of individual's body uniformly. Anthropogenic actions and industrial effluents discharge cause amalgamation of lethal elements in aquatic and terrestrial environment. Amalgamation of these lethal elements leads to metal pollution. Cadmium, zinc, mercury, lead and various other metals are essential elements although in a precise amount. Bioaccumulations of these elements in surpass limit results severe diseases such as cardiovascular, nervous and reproductive disorders. Developing countries are more concern and paying full attention to eradicate these fatal elements from the environment. In current study we evaluate and examine soil infectivity with noxious metals, impacts on plants and human being physical condition as well as eradication tools to make environment sustainable for individuals, flora and fauna life forms.

Introduction

The elements with high density and atomic weight referred to as heavy metals. A large no. of the elements presents in biosphere such as in water, soil and rocks. Anthropogenic activities also discharge lethal elements in the surrounding. Industries are basically main source of lethal elements discharge in ecosystem. Current investigations suggest that heavy elements (copper, zinc, mercury and cadmium) are essentials metals but in a confined amount (Engwa et al., 2019). 0.1% of earth surface comprises of magnesium (Rice and Walker, 2014). Many biological functions are drive by naturally occurring elements which penetrate inside the body by means of food, air and water intake (Chasapis and Loutsidou, 2012).

Infectivity of water with venomous metals is one of the painstaking subjects all over the world (Mishra, and Bharagaya, 2019). Lethal elements transmitted in to the food crops via irrigation. This contamination direct to the ruthless health hazard (Vielee and Wise, 2023). Heavy elements have constant survival which make complicated to convert into unpolluted products. These fatal elements amass into food crops which impacts the public wellbeing unkindly. Industrial effluents discharge into rivers, ponds and lakes gain attention worldwide. Different techniques either traditional or modern are use to eradicate toxic elements from the ecosystem (Acharaya et

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al., 2020). Traditional handlings of lethal elements are a less expensive method use across the world. Treatments via natural and medicinal plants show more efficacy as compared to modern practice (Briffa and Sinagra, 2020).

To eliminate adverse effects of metals from ecosystem, nanotechnology process is used. This method is more productive. Irrigation with infective metals amalgate these metals into the soil, water, fish and milk. Nerve damage, hemolytic anemia, feto-maternal blood loss, cognitive, kidney, reproductive and skin problems all arise by mean of heavy elements contagion (Bhattacharya, 2018). Irrigation with unfiltered water gain much attention across the world. Recently in developing countries it becomes a serious matter of discussion (Ugoeza and Amogu, 2021). Fatal elements years to years gather in a soil and transmitted into the food crops which become a part of individual body and results far-reaching influence to human fitness. Hg, Cd, Pb Cr and numerous other metals accretion in a soil consequence a serious challenges faced by human beings (Chao, 20140).

Sources of heavy metal

Soil is an amalgamation of H_2O, air, life forms, decayed and raw substances. This composition of soil assists the endurance of life on land. Macrobiotic matter and humus presence in a soil act as a driving force which ensures the survival of flora and fauna existence on land. The developmental growth of plants is highly depending upon the availability of basic vital nutrients such as carbon, phosphorus, nitrogen and numerous other essential nutrients. Plants take all these nutrients from the soil. Soil heavy elements present either naturally or inserted b manmade activities are major health hazard for public health (Laoya and Olagbemide, 2025).

An industries uprising is a major cause of soil contagion with heavy elements such as (cadmium, mercury, lead) and several other metals which are biologically noxious for soil, $H_{12}O$, air and life forms of flora and fauna. These heavy elements accretion in a food chain can ruthlessly distress the quality and capitulate of the food crops. Human actions are central cause of environmental adulteration. Insertion of heavy elements in soil, H_2O and food chain is a fear provoking for the wellbeing of public as well as for surroundings. Heavy elements are well known contaminants of the environment (Vielee, 2023).

Industries operations release the more noxious heavy elements like cadmium, mercury, lead and other metals. Among all toxic metals, thallium is one of the most fatal heavy metal. Thallium occurrence is natural yet in limited quantity, which cruelly affects public healthiness. Via manufacturing process industries releases, filth, exhaust and liquid material. Thallium emerges from this filthy material and get trap into the atmosphere. Ash and soil sample collected from the national park of southern Poland revealed the presence of thallium. Concentration of thallium more than 0.1mg m^{-3} penetrates into the atmosphere easily (Karbowska, 2016).

Heavy elements enter into the environment either naturally or anthropogenic actions. Volcanic explosion, crumbling of rocks, mining metallurgy, unfiltered waste water, application of fertilizers and agricultural waste all are major sources of metal infectivity. Ablaze of coal and automobile emanation also contribute in metal pollution (Chen, 2002). Paints, pigments application and vestige fuel ignition lead to inclusion of lead. Steel and iron factories release nickel in the surrounding. Rubber making, photography, tanning process add chromium. Chemicals handling, luminous bulbs, lab instruments introduce mercury. Drawing out of rayon, electronic ravage and fabric running discharge copper. Gold scalding, phosphate fertilizers application and pharmaceutical process are major source of arsenic metal insertion in nature. Dirt, exhaust of industries, PVC, paints, metallurgy and batteries eject cadmium. Galvanization, electroplating and application of fertilizers introduce zinc in the ecosystem (Nriagu and Pacyna, 19880. Major part of heavy elements amalgate into the soil which enter into the food chain and get accumulate inside the individuals (Jin et al., 2019).

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Various sources of heavy elements in a soil per annum across the world (1000 t • a^{-1})

Sources	Zn	Ni	Cd	As	Cr	Cu	Hg	Pb
Farming	149	44	0.2	0.5	89	36	1.3	25
Manure	319	35	1.1	4.2	57	77	0.1	18
Industries effluents	64	23	2.1	3.2	15	50	2.1	8.0
Municipal sludge	56	21	0.32	0.01	10	20	0.5	9.2
Metal processing	18	2.4	0.06	0.20	2.2	7.4	0.07	10
Coal residue	483	4.6	12	32	440	333	4.4	240
Fertilizers	1.1	3.4	0.24	0.02	0.35	0.55	-	2.1
Atm. Deposition	134	35	8.1	16	36	34	4.1	260

Source: Nriagu & Pacyna, 1988. [15].

Bioaccumulation of heavy elements in biological system

Amalgamation of vital/additional elements inside the living body cause genetic plus physiological deformation. Such types of abnormalities lead to ceased growth and development pattern (Xiao, et al., 2017). Individual contact with heavy elements is generally via consumption of food (fruits, vegetables) which is the vital source of nourishment. It contributes 90% intake via food. Inhalation in impure air plus direct dermal revelation adds reaming 10% (Khan et al., 2019). Rising demand of food augment, the probability of heavy metals disclosure across worldwide large scale. Utilization of this tainted food, turn out to be a serious matter of concern all over world (Antoine, 2012). Unfiltered water, industrial discharge and agrochemicals application frequently taint the food chain. Natural resources like cadmium, zinc, copper, chromium and mercury are vital elements for growth and development of human beings and animals although in a certain quantity (Khan et al., 2014).

Mercury traps into the food chain and become a part of food web. Living organisms especially offspring's faces rigorous health effects because of sea food consumption. Liver enzymes conc. is directly related with increased amount of mercury. Mercury in surpass amount exhibit equally positive as well as negative behavior (Jaishankar et al., 2014). Living individuals suffers from Alzheimer and Parkinson disorder because heavy elements amalgamation in a food chain. Homeostasis alteration, reproductive and developmental disarray arises due to lethal metal infectivity. Amalgamation of arsenic acid also result neural tube infection. Inorganic arsenic acid accretion cause diminution in no. of sperms and weight attenuation, gonadotropin metamorphosis as well as decrease in testosterone level (kim et al., 2015).

In expecting females, endometrial cancer arise which unkindly affects the developing embryo because of sky-scraping arsenic consumption (Milton, et al., 2017). Severe consequences like unexpected abortion, unproductiveness and prematurity (Apostoli, et al., 2011). WHO examination stated that intense contact with numerous deleterious metals, increase the probability of sterility in females as compared to males (Rattan, et al., 2017). Oocytes chromosomal alteration and lack or irregular menstrual cycles, all are symptoms of amalgamation of heavy elements inside the living body (Dippong et al., 2024). Intake of infective food is a driving force for heavy metals contact to individuals. Amalgation of these toxic metals come out with severe health hazards. Such health exposure motivating researchers to put extra efforts in finding the solution to cure these lethal elements affect (Vilee et al., 2023).

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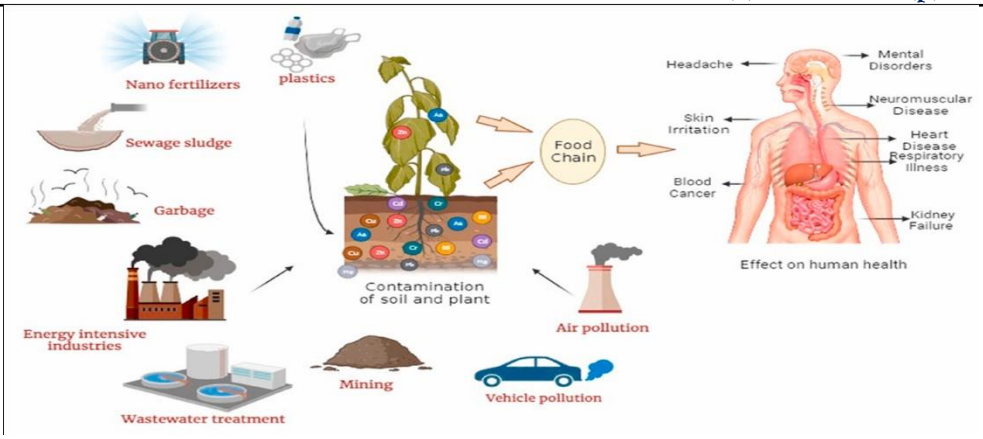

Bioaccumukation of heavy elements

Essential and non-essential heavy metals in medicinal, edible plants and drinking water permissible limits

Essential heavy elements permissible limits

Iron, cadmium, nickel, manganese, copper, zinc and cobalt are vital elements which play a significant role to run physiochemical a biological function of individuals. Men and women encompass different recommended dietary intake and maximum permissible limit for these metals intake. Iron RDA for men range from 6mg/day while for women is 16mg/day and MPL for medicinal and edible plants range ferom14-18mg/kg. WHO (MPL) of drinking water is 0.1mg/L. Manganese recommended dietary allowance for men is 2.1 and for women is 1.5mg/day. WHO (MPL) of Mn in drinking water 0.3mg/L. Whereas WHO (PML) for edible and curative plants range from 1-198mg/kg. Correspondingly RAD of Ni for men is 0.6 and for women is 0.11mg/day. Cobalt, zinc and chromium RAD for men varies as 0.003-9-33mg/day for men while for women comprises 0.02- 6 - 23mg/day.

Non-vital heavy elements

Lead, mercury, cadmium and arsenic considered as non -vital elements in periodic table but minor concentration of these elements results chronic diseases. Small amount of mercury in a soil disturbs the transpiration, H_2O transport, photosynthesis, metabolic process and ceased growth of plants. It also speeds up the process of lipids per oxidation. Enzyme's action, thrashing in potassium and manganese absorption, seed injuries, stomata finality all are symptoms of incorporation of higher amount of mercury in plants (Azevedo et al., 2012). Arsenic is fatal for individuals but its toxicity depends upon exposure and frequency. Individuals who have intense arsenic exposure are fighting with cancer, cardiovascular and respiratory problems. Lead and cadmium also referred as non-essential elements. Cadmium toxicity direct the reduction in bones compactness, while in females' major cause of bone rupture is cd amalgamation. Lead is a very fatal element yet a microscopic conc. of lead consequence memory loss, languor, annoyance, abdominal tenderness. Lead extreme exposure cause death of individuals (Tchounwou et al., 2012).

Vital heavy elements in curative, edible plants and drinking H_2O (RDA), (MPL) values

Vital Heavy Elements	RDA (mg/day)	WHO(MPL)Curative Plants (mg/kg)	WHO(MPL)Edible Plants (mg/kg)	WHO(MPL)Drinking H_2O |(mg/ L)
Fe	6 (men) 16(women	14	18	0.1

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Mn	2.1 (men) 1.5 (women)	198	1	0.3
Ni	0.06-0.11	1.3	1.53	0.04
Cu	1-4	9	8	1.00
Co	0.003-0.02	---	0.05	0.6
Zn	9(men) 6(women)	48	49	2.9
Cr	33(men) 23(women)	1.4	1.2	0.03

(RDA): Recommended dietary allowance,
(MPL): Maximum permissible limit

Non-vital heavy elements in curative, edible plants and drinking H_2O (RDA), (MPL) values

Non-essential Heavy Elements	RDA(mg/day)	WHO(MPL)Curative Plants (mg/kg)	WHO(MPL)Edible Plants (mg/kg)	WHO(MPL)Drinking H_2O |(mg/ L)
Pb	---	8	0.41	0.08
Hg	---	0.5	0.031	0.003
Cd	---	0.2	0.01	0.001
As	---	0.5	0.4	0.05

RDA): Recommended dietary allowance
(MPL): Maximum permissible limit
(RDA) (Al-Fartusie & Mohssan, 2017)
(MPL) of medicinal plants (Popovici, et al., 2021)
(MPL) of edible plants (Mekassa, et al., 2015)
(MPL) of drinking water (Mahugija, 2018)

Leathelness of heavy elements

An industries uprising is a major cause of soil contagion with heavy elements such as (cadmium, mercury, lead) and several other metals which are biologically noxious for soil, $H_{12}O$, air and life forms of flora and fauna. These heavy elements accretion in a food chain can ruthlessly distress the quality and capitulate of the food crops. It also restricted the plants growth. The consumption of contaminated food crops by human beings lead to chronic diseases such as cancer, Parkinson's, neurological disorders, and respiratory diseases. It also shatters the human health ruthlessly (Karbowaska, 2016). Industries operations release the more noxious heavy elements like cadmium, mercury, lead and other metals. Among all toxic metals, thallium is one of the most fatal heavy metal. Thallium occurrence is natural yet in limited quantity, which cruelly affects public healthiness (Manecki, et al., 1988). Via manufacturing process industries releases, filth, exhaust and liquid material. Thallium emerges from this filthy material and get trap into the atmosphere. Ash and soil sample collected from the national park of southern Poland revealed the presence of thallium (OSHHA, 2015). Concentration of thallium more than 0.1mg m^{-3} penetrates into the atmosphere easily (Aceyes et al., 1999).

Microorganism's efficacy is inhibited by the presence of heavy elements in a soil. 'Biomass' is used as identifying mediator to detect the intensity of top soil infectivity. Microorganism's actions in a soil are directly allied with the accessibility of heavy metals conc. Microbe's escalation activity is prompted by the presence minute conc. of heavy elements in a soil. On the

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other hand microbe's growth and performance effectiveness is ceased by higher conc. of heavy elements (Qin and Zaho, 2008). Improper dispose of (manure, industrial effluents, irrigation without filtration) and appliance of insecticides, pesticides and fertilizers as well as dispersion of heavy metals in atmosphere all are key sources of soil infectivity (Acar et al., 1993).

Negligible conc. of soil heavy elements does not impact the growth of the plants while surpass conc. above the definite acceptance level lead to the plant's death. In Florida, examination on impact of copper on plants declared that surpass conc. of copper in soil above (50kg/mg) affects the citrus seedlings (Yabeet al., 2010). Height and length of the roots get restricted as well as leaf surface area, beans and cabbage development is ceased when cadmium conc. increases the level 30μ mol/L. proteins amalgamation, photosynthesis and membrane structure of plants is also affected by higher amount of cadmium in soil (Chan, et al., 2011).

Heavy elements enter into the living organisms by diffusion and dissemination in skin as well as via inhalation in smutty atmosphere. Children wellbeing is directly affected by these poisonous metals. Individual's physical condition is also distress by contaminated food uptake. Insufficiency of calcium leads to bone fracture and disarray of cartilage. High content of cadmium cause calcium insufficiency. These toxic metals disturb the process of metabolism. OTSMC (Organization for Toxic Substances and Management Committee) ranking stated that cadmium is on 6th level among other polluted metals, which damage the individual fitness severely (Wang et al., 2021). Nervous and reproductive disarray caused by saturation of lead in the form of ions and unsolvable salts into the blood vessels. Gene transcription process, cell, liver and kidney diseases also arise due to extreme exposure of lead. It also penetrates into the human body via digestive and respiratory tract. Cadmium, nickel, lead and other polluted metals extreme exposure lead to induction of cancer in living organisms. Intense contact with nickel and copper content in surrounding may cause respiratory cancer (Lee et al., 2020).

Higher content of cadmium nickel, mercury, zinc, lead, arsenic, copper and so many other poisonous metals may induce cancer and damage the organs. Tin and aluminum consider as unpolluted elements. Definite conc. of different elements such as Mn, Mo, Cu, Zn, Cad, Cr, and Pb act as driving force for biochemical and vital functions of human body. Arterial, systolic and diastolic pressure increases in expecting females because of diminutive conc. of di-methyl arsenic acid. Minute conc. of (DMA) increases the possibilities of heart problems in mother and infant equally. Heavy elements infectivity also built up the oxidative stress (Goldhaber, et al., 2003).

Mercury traps into the food chain and become a part of food web. Living organisms especially offspring's faces rigorous health effects because of sea food consumption. Liver enzymes conc. is directly related with increased amount of mercury. Mercury in surpass amount exhibit equally positive as well as negative behavior (Kumar et al., 2023). Living individuals suffers from Alzheimer and Parkinson disorder because heavy elements amalgamation in a food chain. Homeostasis alteration, reproductive and developmental disarray arises due to lethal metal infectivity. Amalgamation of arsenic acid also result neural tube infection. Inorganic arsenic acid accretion cause diminution in no. of sperms and weight attenuation, gonadotropin metamorphosis as well as decrease in testosterone level (Bjorklund et al., 2020).

Chromium

Chromium is 7th most significant innate element which comprises earth surface copiously. Oil drilling, oxidants, catalyst, aflame of coal and steel are all major sources of chromium. Manmade and industrial operations cause cr accumulation in atmosphere. Whereas cr in diminutive conc. run various functions of individuals body like metabolism of carbohydrates, lipids mock-up and amalgamation of cholesterol. Cr (III) is not noxious as much and vital nutrient for

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individuals. Chromium (VI) ingestion outcomes are very severe. It causes blood deficiency and nose, stomach and small intestine. On the other hand, gastrointestinal, hepatic renal, respiratory and cardiovascular diseases results due to extreme chromium disclosure. Because of elevated conc. of chromium ceased the germination of seeds in higher plants and restrain chlorophyll biosynthesis in land plants as well as abridged plants biomass (Syed et al., 2018).

Cobalt

Smaltite, cobaltite and erythrite all are natural form of cobalt in which it exists on earth surface. Manure, slush, vestige fuel blazing and guardian rocks all are sources of cobalt. In plants cobalt intake from soil direct to drop in level of iron, proteins, chlorophyll synthesis and decline H_2O potential or transpiration rate. It also relentlessly distresses the translocation of copper, sulphur, manganese, zinc and potassium (Li et al., 2009).

Copper

Small amount of natural element (cu) is vital for individuals. Beans, bran, avocado, meat and coca nuts are rich source of copper. Copper is also used in coating of sheet metals, pipes, cookware and wires. Smelting of ores, mining and copper distillation all are major factor which cause lift up in level of cu in environment. Small conc. of cu plays a central role in growth, bone structure, balance metabolic process while on the other hand its insufficiency results blood deficiency, pores in bones and decrease no. of (WBC). Cu consider as micronutrient for plants which drive the carbon dioxide, ATP and various proteins generation. Excessive conc. of copper in plants results generation of ROS species, ceased growth, yellowing of leaves and induce oxidative stress (Hegedus et al., 2001).

Iron

Fe is second most plentiful natural element comprises earth surface, fundamental for human beings. Mining and manmade operations cause copper infectivity. Iron is a main content of hemoglobin, cytochrome and myoglobin. Iron show both positive and adverse effects. In sulphates form it is less poisonous whereas other forms are more fatal. Lethal effects of iron comes out in four stages first stage show evidence of nausea, gastrointestinal blood loss after six hours, second stage named (apparent therapeutic recovery inactive period) appear after 6-24hours. 3rd stage appeared after twelve to ninety-six hours with symptoms of period; third stage take place after 12 to 96hrs with symptoms of tiredness, shocks, liver cells death. 4th stage come out after two-six week with induction of ulcer in intestine and emits free radicals cause lungs cancer (Soetan et al., 2010).

Manganese

Mn is fifth most abundant element comprises earth surface. Cereals, green vegetables, nuts, meat, air, batteries, manganese tricarbonyl (MMT) are major sources of manganese. Enzymes use manganese as cofactors. It drives many physiological body functions of the body in a minor concentration. Manganese tricarbonyl used in gasoline show severe affects in higher concentration become a universal concern today. Mn incorporates in central nervous system resulting neurotoxicity (Janadeleh et al., 2015).

Nickel

A transition element known as nickel occur naturally in a diminutive conc. peanut fat, unprocessed grains, cereals, beverages and hydrogenated vegetables are rich source of nickel. Manmade operations such as oil blazing, appliance of fertilizers and mining liberate nickel in the surrounding. Small conc. is vital for individual but elevated amount of nickel is a severe health danger for human being. Extreme contact with nickel results inhalation trouble, itching, lungs, larynx and nose cancer. Excessive amalgamation of nickel in plants cause cell death, chlorosis, membrane disorder and disturb ion steadiness (Ros et al., 1992).

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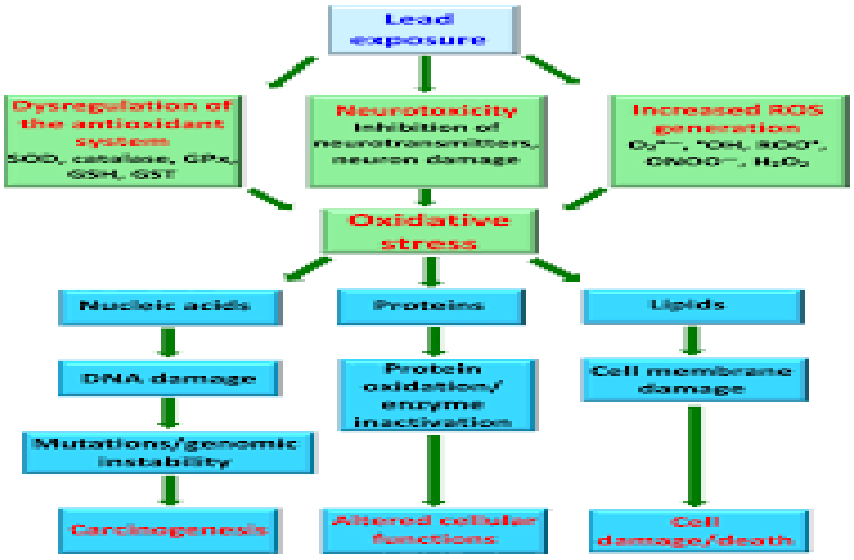

Heavy elements toxicity and individual's wellbeing

Routes of individual disclosure to heavy elements

Individuals get in touch with with lethal elements via different ways. Contaminated food intake is the main factor through which lethal elements enter into the human body. Individuals associated with mines smelting and those who have direct skin contact with these metals suffer from cruel health hazards (Briffa et al., 2020).

Ingestion

Amalgamation of lethal elements in soil, food, H_2O, air and use of essential and non-essential nutrients by human being is a major concern of the health risk throughout the world. Toddlers are more inclined for these lethal elements as compared to adults because of their low body weight and habit of putting hand in oral cavity. Expecting females are also at the risk of heavy elements contamination because of gain in body mass and constant removal of calcium from the body. Lead absorption in bones results, fetal loss reduction in fertility and birth rate. Assimilation of noxious elements in membranes of lungs causes trouble in inhalation. Development of fishes in contaminated H_2O and soil these elements via gills and food absorbed inside the body. Consumption of fishes on large scale by human being is a major concern today. Fishes are main marker for the bioaccumulation of these elements (Sheikhzadeh et al., 2021).

Inhalation

Toxic metals emission from industries into the atmosphere affects the individuals directly. Breathing is one of the treacherous ways for lethal elements incorporation in the body. Inhalation of lead is long lasting and remains permanent. Lead assimilation results respiratory imbalance. Plethora of industries is a main channel for human being's extreme contact with these metals. Food cycling, air water are main pathways for the transmission of noxious elements in the surrounding. These elements exist in fumes and particles form which are not soluble in water. Swelling and emphysema appear because of extreme cadmium contact. Nasal chronic disease in individuals working in refining nickel is more common (Wang et al., 2025).

Dermal contact

Heavy elements influence individual's health severely. At the present time noxious elements are speckled in each curve of the environment. Noxious metal revelation all the way through

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skin is more hazardous. As compared to adults' infants have more dermal contact with lethal metals. Presence of heavy elements in a soil and house floors dirt presents a more threat when ingested via food and breathing. In atmospheric particles heavy elements are present in oxidized and unsolvable form and an alarming signal for public health (Saravanan et al., 2022).

Process of heavy metals toxicity

Therefore, exact mechanism of lethalness of heavy elements is not utterly investigated but there are some specific means are observed which include DNA damage, oxidative stress enzymes inactiveness and proteins dysfunction (Balali et al., 2021). To remove heavy elements mechanism of lethalness, heavy elements make complexes with DNA, lipids and proteins by means of oxidative stress. This process cause cell death by promoting (ROS) reactive oxygen species effects (Acharya et al., 2024|).

Oxidative stress

Individuals have incorporation of fatal elements that drives various physiological and biochemical reactions of the body but in a specific limit. Some elements are vital which help to maintain balance between internal and external temperature of the boy but some elements consider as non-vital and their huge conc. show severe effects on the body. Superfluities of cadmium, lead, thallium, arsenic and mercury instead of carrying physiological functions of the body cause heavy elements infectivity and interrupt the various enzymatic processes. ROS species synthesis is conspicuous for elements regarding oxidative stress which eventually results disturbance flanked by antioxidant resistance and prooxidants mechanism (Balali-Mood et al., 2021). Oxidative stress promotes the release of free radicals which are life alarming to the cell functioning of the individual's body. Oxidative stress is unswervingly associated with contamination of fatal elements via redox cycling. Assembly of oxidants in individuals is deactivated by antioxidants which act as native resistance system (Nowicka, et al., 2022).

DNA damage

Various investigations revealed that cytogenetic and genotoxic effects of numerous elements arise because of heavy metals amalgamation in the body. Nickel in the form of NiO, $NiSO_4$ cause smash up of DNA by bond braking of DNA strands, under the exposure of ultraviolet light and nickel either nickel titanium or pure nickel synergy with UV light. This process results DNA nicking in scientific globe, while scientific investigations revealed that chromosome binding with Ni directly disturb the histone proteins linkage and as a result DNA structure get damage (Kasprzak, et al.,2023).

Neurotoxicity

Consumption of arsenic cause CNS diseases such as neuro developmental destruction, and disturb the neuro and synaptic transmitter equilibrium. It causes neural cell death (apoptosis) (Garza et al., 2019). Autism neuro developmental disease appears due to accumulation of poisonous elements (Blazewicz et al., 2022). Neurotransmitter as acetylcholine, noradrenalin, and dopamine level changes in individuals is because incorporation of heavy elements. Patients suffering from seizures and cognitive mutilation are result of metals contamination. Expecting women exposure with lethal elements induced neurological disorder in developing fetus. Recent investigations suggest that (ADHD) attention deficit hyper activity disease appear due to accumulation of lead cadmium and mercury (Dutta et al., 2022). Alzheimer, Parkinson and sclerosis appear in individuals because of amalgamation of cadmium (Branca et al., 2022).

Nephrotoxicity

Aminoaciduria, phosphaturia (fanconi symptoms), glucosuria (clinical symptoms) instigate by cadmium Nephrotoxicity. Excessive incorporation of phosphate by renal tubule, momentous level of Cd in urine, aminoaciduria affects the proximal tubular epithelium all are symptoms of kidneys intense disclosure with metals. This revelation result indicates that

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hypercalciuria along with renal tubular failure (Friberg et al., 2019). Lead exposure directly damages all organs of the body but it harshly affects the kidneys in acute conc. resulting proximal tubular dysfunction. Persistent accumulation of lead in individual body leads to interstitial fibrosis, tubules atrophy and glomerulonephritis. Acute tubular necrosis, acute dyspnea, distorted mental health, pain in abdomen, nausea, cold and hypotension all disorders arises because of kidneys severe exposure with mercury. On the other hand, constant contact with Hg causes pars recta of renal tubules cell death and rupture the epithelium (Lentini et al., 2017). After intake kidneys deferred the elimination of thallium sulfate at least it takes 2 months. Severe kidneys damage is determined by hematuria and albuminuria (Yumoto et al., 2017).

Carcinogenicity

Altered proteins expression, DNA impairment, mutation in histone proteins and methylation of DNA caused by arsenic amalgamation. When arsenic element linked with histone proteins, it increases the chances of cancer induction in the body as well as decelerating the mechanism of DNA impairment (Garcia et al., 2013). Another carcinogenic element is lead which cause induction of cellular tumor, altered chromosome structure and mutilate the DNA impairment process by generating ROS species. It disturbs the process of formation of messenger RNA by fluctuating zinc position from regulatory proteins (Silbergeld et al., 2000). Peroxidative character of Hg synthesized a specific amount of reactive oxygen species which promote the induction of cancerous cells. ROS species harm the cell proteins, fats by aiding carcinogenesis process which destroy cell completely (Reczek et al., 2017). Nickel also acts as carcinogenic element through contributing cancer introduction in the body such as disturbing transcription factor management and release of free radicals. It counters the non-coding ribosomal, messenger and micro-RNA as well as initiate promoter methylation with conversion of gene 3 into MEG3 which induce cancer (Zambelli et al., 2016).

Skin toxicity

Constant contact with arsenic lead to a numerous probable dermal disorder such as hyperkeratosis, hyper pigmentation and dermis cancer. Bowen's syndrome initial dermal cancer stage also arises because of arsenic accumulation while soles, palms, fingers, arms legs and hands infection (hyperkeratosis) which induce hostile malignancies (Huang et al., 2019). Skin is the outermost covering of the body which prevent incorporation of toxic particles inside the body. Various severe and lasting skin diseases such as skin cancer and systemic dermatitis result because of Cr contamination. Skin exposure with haptens cause by deferred hypersensitivity known as contact dermatitis. Systemic contact with allergens makes skin more subtle and cause systemic contact dermatitis (Matthews et al., 2019). Numerous dermal contagions appear due to Hg infectivity including pink disorder indicating the conversion of dermis into pink color (Horowitz et al., 2002).

Reproductive toxicity

Neural tube anomalies in investigational animals are because of arsenic exposure which is consider as reproductive pollutant in individuals. Males' reproduction system is severely affected by inorganic arsenic exposure which cause testes weight loss, decrease the sperm production, testosterone and gonadotropin level drop along with steroidogenesis mechanism interruptions (Kim and Kim, 2015). While in females' endometrial cancer is linked with arsenic exposure. In expecting females arsenic contact directly affects the development of embryo which is detected by prematurity, infertility, sudden abortion symptoms (Milton et al., 2017).

Who investigations revealed that above 10% females are on the boarder of sterility because of continuous contact with lethal elements as cadmium, lead, arsenic, mercury and numerous other toxic elements leading to reproductive illness. Females are more sterile as compared to

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men because of extreme contact with lethal elements which lead to irregular menstrual cycle. Imbalance in menstrual cycle interrupt ovule formation mechanism promote sterility in females. Irregular menstrual cycle maintained by balancing the hormonal level in the body, (Rattan et al., 2017).

Treatment via traditional or modern methods

Three most important methods like, chelating treatment (to liberate oxidative pressure), phyto-remediation, and in-situ stabilization are proficient to abolish fatal elements from the life forms of flora and fauna (Gerhadsson, et al., 2022). To remove toxic metals from living organisms, chelation therapy is used (Bhasin et al., 2023). Chelating mediator has the aptitude to connect with lethal metals and detach them from the site of saturation in tissues. As a result, these metals released from the body via urine (Xin et al., 2003). Cardiac as well as cerebral vascular disorders are also alleviated by means of chelation therapy. Neuropathy patients go through chelation treatment to eradicate lead from the body (Siegel and Keller, 1988).

Atmospheric infectivity with heavy elements is eradicated by using the tool of (phyto and microbial remediation). In phyto-remediation practice, plants have high potential to stay alive in metals tainted environment are preferred to cultivate. Farmers reap and burn these plants when they attain ripening stage after accumulation of these lethal elements. Current investigation suggests that plants having capacity to accumulate massive number of deleterious elements are around 400 throughout the world. Plants having high acceptance rate belong to family Cruciferae (Fred et al., 2001).

Neurotoxicity handling

Numerous curative applications used to eradicate the noxiousness persuaded by manganese and pharmacokinetics. Usual as well as synthetic antioxidants such as glutamate shields and adenosine triphosphate along with adenosine diphosphate shields are used to reduced manganese neurotoxicity. PAS (Para aminosalicylic acid and EDTA (Ethylene diamine tetra acetic acid) are used to increase the effectiveness of numerous curative agents. Inflection of ER tension and cell death cause by manganese amalgamation is eradicated via antioxidants (PPEES) polyphenolic excerpt *Euphorbia suppina* obtained from Korean spurge. Lipid peroxidation release reactive oxygen species and malondialdehyde conc. suggestively abridged while conc. of catalase, GSH along with SOD boosted alternatively. PPEES treat manganese persuaded histopathological modifications in cerebral cortex and striatum was also examined in vivo situation (Bahar et al., 2017).

Current investigations revealed that cadmium is referred as bio pollutant as well as sturdy neurotoxin. Individuals brain functions are boosted by the use of nuts which are direct source of vital nutrients. Rats exposed with cadmium take 50mg/kg cadmium dose weekly by means of or deprived of walnut and almond. Nervousness, despair and reminiscence loss instigated by cadmium amalgamation was eradicated by almond and walnut consumption on daily bases. Intake of walnut along with almond reduce the chances of lethal elements toxicity and on the other hand body supplied with vital nutrients which boost immunity of individuals (Batool et al., 2019). Continuous exposure with lead, induce lipids infusion, generation of reactive oxygen species along with carbonyl protein conc. amplified in rats and at the same time superoxide dismutase, cerebellum catalase and cortex of brain correspondingly reduce continuously (Kumar Singh et al., 2018).

Nephrotoxicity handling

Cadmium infectivity also give rise to kidneys disorders. To treat cadmium toxicity curcumin which deactivate the histologic alterations. KIM-1, osteopontin, metalloproteinase-1 tissue inhibitor (TIMP-1) and lipocaline linked with neutrophil gelatinase (NGAL) harms the kidney severely which as a result decrease urinary defecation. Another important substance named curcumin is responsible to treat the cadmium induced nephrotoxicity by providing defensive effect (Kim et al., 2018). Mice treated with royal

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jelly, lipid peroxidation, tumor cell death, nitric oxide, cell death controllers Bax, interleukin-1β and renal function indicator level is boosted and at the same time cell death inhibitors Bcl-2, along with glutathione level are more momentous. Kidney tissues with overfilled glomeruli in mice treated with royal jelly is observed under histopathological examinations (Almeer et al., 2019). Protocatechuic acid application enhanced protein synthesis which was ceased by cadmium infectivity. Genotoxic disorder was treated with silymarin and dimercaptosuccinic acid which condense the blood level. Spirulina, piperine and gamma glutamyl cysteine also preferred for the same purpose. Simvastatin, extra virgin olive oil and spirulina was used to treat chromium nephrotoxicity (Alcaraz et al., 2016). Besides, gamma-glutamyl cysteine, piperine, and Spirulina platensis are also used in this regard. In contrast with spirulina accompanied by $HgCl_2$, was examined with amended LDH and ALP performance comparative to $HgCl_2$, although ACP and MDA level reduced. Kidneys dealing with Hg various pathological alteration was controlled by Spirulina and on the other hand Quuercetin also act as strong agent to treat pathological symptoms. Nephrotoxicity tempted by thallium is also eradicated by curcumin, zinc sulphate and diallyl sulfide (Abdel, et al., 2015).

Carcinogenicity handling

Current investigations suggest that urinary bladder highly infected by DMA and sodium arsenite contact. MMP-9 (metallo-peptidase9 matrix) and sustainability are meticulously associated with carcinogenesis. These are used as biomarker which identify bladder cancer. Systemic arsenic cause blood cancer which is treated by Mitogenic cells ADMSA. Prooncogenic biomarkers as MMP9 serum bladder tissue (NBII and T24) cells sustained by these mitigation techniques. These biomarkers NBT-II and T-24 arsenic amalgamation in oncogenic cells which are in contact with arsenic (Sathua et al., 2020). Recent study investigates that application of *Rosmarinus officinalis* controlled the lead infectivity which promote hepatic as well as renal impairment. It also reserved the renal along with hepatic configuration in plasma cells (Mohamed et al., 2016). Appearance of tumor in ovarian cells which congested ovarian cells lining tempted OVCAR3 and SKOV3 is induced by cadmium infectivity. Cadmium plays a substantial role in persuading ovarian cancer (Ataei et al., 2018). Liver dysfunction raises the tissues alterations which appear because of nickel toxicity eradicate the inflammatory indicators and reduce the DNMT function along with DNA methylation in rats' liver. This activity declines the chances of cancer in rats. Oncogenic cells activity is also ceased by metformin (Kang et al., 2017).

Dermal toxicity handling

To examine either arsenic contamination is treated with *Solanum melongena*, two locations were selected. Eight individuals from two sites were selected in a way one sample under observation was suffering from Bowen's diseases. These individuals were facilitated by peel take out from Solanum melongena for 12 weeks with daily two dosage. Application of peel extract show that it helps a lot to overcome Bowen's illness (Sarah et al., 2018). In another research, PUVA healing was applied to extravagance two male affected who had long lasting interaction compassion to Cr. One individual with instantaneous light sensitivity had a very optimistic retort, his dermis abrasions removed and his photo lenience amended. Via local dermal process light and contact sensitivity is controlled because PUVA treatment may have some universal immunological symptoms (Jansen et al., 1981). Meanwhile, Epigallocatechin-3 gallate is applied to cure acne obscenity (Yang et al., 2017).

Reproductive toxicity handling

Current investigations revealed that proanthocyanin obtained from grapes seed is very helpful to eliminate oxidative stress from testis of mouse offsetting reproductive lethalness arise due to arsenic exposure (Liu et al., 2015). Investigations revealed that in male mice generative noxiousness is eliminated through

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Nrf2 gesturing directing probable method for lutein which is used to treat arsenic accumulation (Li et al., 2021). Less sperm production, seminal tubule demolition, tubular shedding and diminished mitochondrial performance and increase oxidative stress all symptoms represent accumulation of lead in reproductive organs. To treat lead toxicity in reproductive organs of mice histidine and carnosine dosage is used. These supplements act as barrier against lead infectivity (Ommati et al., 2019). Purple sweet potatoes release anthocyanin which helps to eliminate lead infectivity via reducing enzymatic antioxidants. APSP (purple sweet potatoes provide promote reduction in caspase three initiation, as well DNA impairment. APSP managements also inhibit the testicular JNK signing, mRNA synthesis and phosphorylation introduced by lead accumulation. APSP might be a worthwhile satisfying handling for evading lead tempted multiplicative mutilation (Zhou et al., 2021).

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Therapeutic options to eradicate lethal elements noxiousness

Study area	Remedy For	Remedy technique	Study model	Dosage	Assay	Results	Reference
Neurotoxicity	**Mn**	Polyphenolic extract of *Euphorbia supina*	Human (neuroblastoma SKNMC) Male rats (SD)	(50, 200µg/mL	RT PCR analysis and western bloating	PPEES upsurge viability Reduce cytotoxicity and LDH functioning	Bahar et al., 2017
	Arsenic	Curcumin	Rats	100mg/kg	Electrochemical detector and HLPC reserved phase	30% DOPAC 50% HVA level rise in *Corpus striatum*	Yadev et al., 2010
	Cadmium	Almond + walnut	Rats	400mg/kg/day	Raise plus maze innovative entity level identification chore	Recall impairment, reduced anxiety	Batool et al.,
	Thallium	MK-801	Rats	1mg/kg	H_2O_2 oxidation, fluorescent assay	Decrease Ti regional content of brain	Osorio et al., 2015
	Lead	Omega 3fatty acid	Rats	750mg/kg/body weight	n.m.	Decrease ROS species generation, lipids peroxidation and protein	Kumar et al., 2018

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						carbonyl content	
Nephrotoxicity	**cadmium**	curcumin	Sprague Dawley rats	50mg/kg	TUNEL assay	Shield against renal failure and hinder kidney apoptosis	Kim et al., 2018
		Royal jelly	Male mice	85mg/kg	Quantitative RT-PCR, Western Blot analysis	Apoptosis regulator Bax, caspase-3, metallothionein, interleukin-1β, tumor necrosis factor-ш, renal function markers along with lipid peroxidation level amplified	Almeer et al., 2019
	Lead	Spirulina platensis	Newborn rats	100mg/kg	n.m.	Reinstating biochemical indicators to normal level which diminish hematoxicity	Gargouri et al., 2018`
		Piperine	Male rats	50-200mg/kg	n.m.	Reduce creatinine, blood urea, nitrogen content and renal histopathology. Glutathione	Sudjarwo et al., 2017

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						peroxidase and superoxide dismutase level amplified	
	Mercury	*Spirulina fusiformis*	Swiss albino mice	800mg/kg	Malonaldehyde	Suggestively exterminate kidney pathological alterations	Sharma et al., 2017
	Thallium	Curcumin and diallyl sulphide	Rats	200mg/kg	MDA assay	Diminish hepatic lethalness	Abdel et al., 2015
Carcinogenicity	**Arsenic**	Monoisoamyl dimercaptosuccinic acid	Male rats	50mg/kg	RT-PCR, MTT assay	Reduced the GSH level while increase catalase, ROS and SOD level	Sathua et al., 2020
	Lead	*Rosmarinus officinalis*	Albino rabbits	30mg/kg	Mass spectrometry and Gas chromatography	Stifled the renal and hepatic failure along with lipid peroxidation	Mohammad et al., 2016
	Nickel	Quercetin	Male mice	Male mice	Western Blot analysis	Shield the renal dysfunction inflammatory expression, Nrf2 DNA methylation reduction,	Liu et al., 2015
	Cadmium	Piperine	Individual blood	Varying conc.	Comet assay	Amended oxidative tension and oncogenicity	Verma et al., 2020

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Dermal lethalness	**Arsenic**	*Solanum melongena* peel extract	8 individuals	100 µg/mL	SD (standard deviation)	Bowen's disorder lesions reduction	Sarah et al., 2018
		Psoralen + ultraviolet light (PUVA)	2 patients (males)	n.m.	Direct immunofluorescence method	PUVA remedy tempt immunological illness and decrease chances of dermal lethalness	Jansen et al., 1981
Reproductive lethalness	**Arsenic**	Grape's seed proanthocyanin extract	Male Kunming mice	400mg/kg	PCR	Decrease oxidative stress via triggering Nrf2 signing	Li et al., 2015
		Lutein	Mice	40mg/kg/day	PCR and Western Blot	Through Nrf2 signal activation lessen reproductive lethalness	Li et al., 2016
	Lead	Histidine subjunction	Mature male Sprague Dawley rats	500mg/kg/day	Standard deviation (SD)	Lessen male reproductive noxiousness	Ommati et al., 2019
		Anthocyanin (purple sweet potato)	Male Kunming mice	100mg/kg	Western Blot (WB)	Lessen sperm anomaly and increase sperm production rate	Zhou et al., 2021

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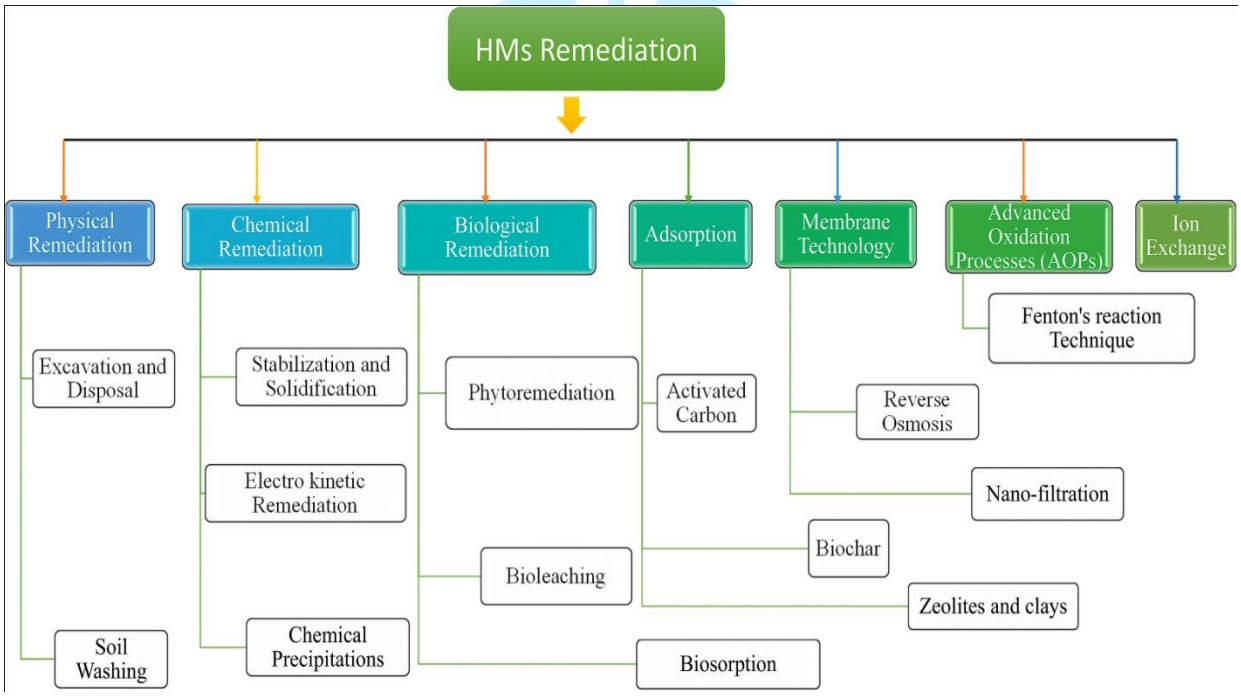
Soil treatment

Soil poisonous elements also wipe out by the use of microorganisms having capability to carry on redox reactions and power of incorporation/ precipitation as well. Fungi released organic compounds, metabolites and amino acid which abolish heavy elements from the soil (Barakat et al., 2011). Fungi *Gomus intraradices* used to recover the sunflower chromium assimilation (Aziz et al., 2008). PC (Photo catalysis), ED (Electro dialysis), UF (Ultra filtration), and MF (Membrane filtration) all are valuable tools used to wipe out fatal elements from the surroundings. Mortal elements are also eliminated from the atmosphere by using chemical precipitation and new adsorbent adsorption methodology. Application of lime stone is an inexpensive way to treat fatal elements (Igriri et al., 2018). Toxic elements are also removed from the environment by the use of bacteria, algae and fungi (Zheng, et al., 2002). To treat tainted top soil both chemical as well as physical methods are used. Numerous tools for instance, electro kinetics, adsorption, high temperature practice, physical petrification, chemical remediation plus improver, coagulation, ion exchange, biosorption hyper-accumulator, bioleaching soil discharge and soil separation are used on diverse level to alleviate noxious elements infectivity. Soil seclusion is a practice in which infected soil exterior part is coated with unadulterated soil (Kolawole, et al., 2018).



Heavy elements remediation techniques

To treat the contaminated soil both physical and chemical methods are equally approached. Physical treatment includes soil isolation, soil replacement, and electro kinetic procedure (Karaca, et al., 2018). On the other hand, chemical handling tools are soil cleaning, immobilization, encapsulation, chemical fixation, verification, and leaching (Chaney and Baklanov, et al., 2017). In vivo and in vitro techniques also applied to cure heavy elements infectivity. Surface capping is an important in situ method to get rid of soil contamination by cover soil with H_2O. It functions as surface impervious blockade between surface H_2O and

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soil. Phyto-stabilization also maintains the plants vitality from toxic metals accumulation. It stimulates the metals seepage from roots-leaves as well as makes the plants more tolerant (Liu et al., 2018). Soil filling is a ex-situ therapy in which tunnel and pull trick is applied]. Biopile remedy is a charge precious tool which improves continued existence of microbes. In freezing areas biopiling remedy is used. It converts the grimy soil into diminutive spaces. Sieving and aeration both drive the biopiling process (Delille and Pelletier, 2008).

Conclusion

This review study evaluate that some fatal elements exists naturally while some introduced in environment by manmade action. Some elements show adverse and some ruthlessly influence individual wellbeing in a small concentration. Human actions are central cause of environmental adulteration. Insertion of heavy elements in soil, H_2O and food chain is a fear provoking for the wellbeing of public as well as for surroundings. Heavy elements are well known contaminants of the environment. Living organisms suffer from sever diseases because of contaminated and fatal food intake. Amalgamations of these fatal heavy elements lead to the genetic mutations. To eradicate these heavy metals from terrestrial ecological unit and aquatic life, graphemes with its derivatives (magnetic and metal oxides nanoparticles) are used. This technology recognized as 'Nanotechnology' pay more to the human beings as compared to the traditional practices (Saikat et al., 2016). Developing countries are more concerned regarding this serious matter as compare to under developing countries. Scientist must pay attention to discover the valuable methods to cope with lethal metals effluence without any disadvantage and make environment sustainable for human beings plus flora and fauna life forms.

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