**TOXICITY OF HEAVY METALS IN SOME MEDICINAL PLANTS**

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**Abstract-**

The heavy metals are elements which occur naturally and occur into the water and soil mostly. In the biological process the metals are important but it is also toxic for the human when occur in more amount. In the metals trace level of copper, iron, manganese, zinc and nickel are important for the plant for their different activity. The some metals are non essential for the human activity but it causes toxicity in human like lead, mercury, aluminum and arsenic. The World Health Organization has mention that in the world herbal medicine share is reach about 60%. The plant which used in therapeutic remedy they accumulate the heavy metal from the soil and produce toxicity in human. This accumulation of heavy metals shows its effect when that herbal plant consumed as remedies or dietary supplement. The long term accumulation of heavy metals like arsenic, cadmium, leads and mercury it causes serious health problems like cancer, kidney damage, neurological damage and developmental disorders. In the modern period the plants grows under technogenic pressure for medicinal purpose, the material harvested such condition sources of different toxicant enter human body. In the toxicant primarily heavy metals, nitrates, pesticides and some other xenobiotics which affect human health. In the environment common heavy metals are mercury, lead and cadmium, the vehicles, agriculture production, industry, thermal power plants and waste incinerates are main sources. The Russian Federation Pharmacopoeia state that the medicinal plants not contain exceed than 1.0 mg per kilogram arsenic, 6.0 mg cadmium to per kilogram and mercury about 1.0 mg per kilogram.

In the Indian medicinal plants like Terminilia chebula, Terminilia belerica, Adhatoda vascia, Acorus calamus, Phyllanthus emblica, Ocimum sanctum, Asparagus, Piper longum, Withania sominifera, Tinospora cardfolia and Tribulus terrestris. The heavy metals like mercury, nickel, zinc, chromium, iron, copper and lead like heavy metals are presents in these medicinal plants. These plants used as medicinal purposes Terminilia chebula plants seed is used as laxative, Terminilia belerica plants seed is used as laxative and anti-pyretic, Phyllanthus emblica plants fruit is used as digestive and revitalize, Piper longum plants fruit is use as digestive and bronchitis, Adhatoda vascia plants leaves are used expectorant and asthmatic, Withania sominifera plants roots are used as nerve tonic and Ocimum sanctum plant used in cough and fever.

**Keywords- Heavy Metal, Pesticides, Remedies, Laxative and Thermal Power etc.**

**Introduction-**

In the world India has rich biodiversity with unique collection of flora and fauna; it contains about 45,000 plant species. In the plant many has used as medicinal and they spread in different parts of India. The chemicals extracted from plants known as secondary products, mostly plants gives alkaloids and glycosides, in the four thousands plants about three thousands different types of alkaloids are identified. The toxic and medicinal effect of alkaloid are depend upon the dose, the attached sugar molecule with component is active known as glycoside it categorized by the nature. The essential oil is important extraction get from the plants about two thousand species has come under sixty families has contains different types of essential oils. In the country about seven thousands plants are occur in ecosystem consider as medicinal plants. On the earth about 250,000 plant species known to human beings in which about eighty thousands species having medicinal properties and five thousands used in therapeutic use. In India about two thousands species has recognized as high potential medicinal values. On the earth Sumerian civilization has used herbs for medicinal purpose records found in history. This civilization listed the medicinal plants on clay tablets. The World Health Organization also listed about 21,000 plants which are used for the medicine purpose in the traditional treatments, the herbal used for their physical and psychological treatment. In India 150 species are commercially used in large scale as medicine, India produce medicinal herbs in large quantity so it also known as botanical garden of the world.

Some important heavy metals are crucial elements which require extremely in low quantities for well development. The heavy metal cause’s pollution is androgenic activities like agricultural production, resource extraction, and industrial activity, excessive use of agrichemicals, inadequate garbage management process and construction. The heavy metal enters into environment by these activities and accumulates by the living systems. The heavy metal is toxic in nature causes different chronic illness like cardiac instability, sensor motor behavior issues, psychological disorder, weakened immunity and neonatal disorder. The heavy metal like mercury, lead, arsenic and cadmium not necessary for human and plants, it causes health complication related with brain, liver, heart, lungs, kidney and nervous system. It also creates abdominal pain, rashes, internal ulcers, and different cancer symptoms. The heavy metal like copper is useful in many enzymatic reaction, but consume excess amount leads internal organ injury also induce skin infection, lung tissue infection, abdominal discomfort, vomiting, nausea and diarrhea. The medicinal plants are source of heavy metals so they are toxic for living organism. In human body toxicity heavy metals like lead, mercury, cadmium and arsenic although cobalt and aluminum causes toxicity. In the world major medicinal plants harvested and used for medicine without checking its toxicity of the heavy metals so it produces side effect to human health. The medicinal plants contain essential oils, alkaloids, flavonoids and different chemical compounds. It used as medicinal, aromatic and culinary purpose. The use of plants for the medicinal purpose for thousands of years and their trace occur in ancient civilization like Greeks, Romans and Egyptians. In the modern period also plants are used to cure different health problems.

**Objectives-**

* To study the toxicity of heavy metals in medicinal plants
* To study effect of the heavy metals toxicity on human health
* To focus on medicinal plants which accumulate heavy metals
* To aware young generation about toxicity of the heavy metal in medicinal plants

**Analysis and Results-**

On the earth metal and metalloid ions are natural part which presents in diverse layers that compose it. The high amount of metals has toxic for the human and other living organisms. The elements harmful effect on living organism and plant form rely on metallic ions for complete normal ion as cofactor to vital enzymes in metabolism. The world population increase 9.1 billion by year 2050, with increasing metalloid pollution which affect on food security also causes human illness. These metal also produce toxicity in the medicinal plants, about 700 plant species out of 300,000 vascular plants are capable undergo metal hyper accumulation. After industrial revolution many water bodies also contaminated by heavy metals. In the soil and water discharge mining activity, natural weathering of the rocks and agricultural runoff increase the heavy metal concentration. The industrial activities like mining, electroplating, smelting, chemical production and battery production contribute heavy metal pollution. The heavy metal has atomic number more than twenty and sometimes weight show six grams per cubic centimeter. The metal classified as toxic basis on their concentration in soil from one to thousand mg in the soil. The plant and animal accumulate metals from soil and water it penetrate in their parts, in the human body it enter directly from environment and indirectly by plants and animals.

* **Heavy metals-**

The plant which has accumulated hyper is normally endemic to soil the mineralization of parent rock shows metal level naturally or sometime human activity by mining and smelting. The chemical used in agriculture in the form of pesticides and fertilizer it contaminated heavy metal and produce risk in the environmental health. The fertilizer like phosphate containing has source of trace elements, contains high concentration of cadmium and zinc and leads which enters into the soil by its apply to crops. The toxicity occur by the such agrochemicals has persistent and live long time in soil ecosystem. The plants changes mechanism for deal the heavy metal stress also develop cope with metal stress like exclusion of plasma membrane, immobilization, restriction of transport and absorption, induction of stress protein and synthesis specific heavy metal transporters. In the environment astatine, neptunium, vanadium, erbium, flerovium, copernicium, titanium, cobalt, indium, zirconium, cerium, einsteinium, meitnerium, silver, lutetium, zinc, chromium, tennessine, iron, copper, tellurium, cadmium, tin, ytterbium, nobelium, radium, uranium, rhenium, hafnium, neodymium, promethium, gallium, manganese, nickel, bismuth, polonium, rhodium, palladium, protactinium, bohrium, hassium dubnimum, seaborgium, molybdenum, arsenic, germanium, californium, actinium, thallium, lead, thorium, americium, organesson, gadolinium, technetium, curium, dysprosium thulium, rutherfordium, osmium, gold, ruthenium, platinum, lanthanum, praseodymium, berkelium, fermium, darmstadtium, roentgenium samarium, terbium, niobium, moscovium, livermorium, iridium, mercury and lawrencium like metals occurs.

**Aluminum-** In the earth crust aluminum found as largest third metal it occurs 8%. The aluminum used mostly in packing, transportation, metallurgical, electrical and chemical manufacture industry. The aluminum residues used in paper manufacturing, wood preservation, sugar refining, water purification, leather tanning and textile for water resistance. The aluminum in initial phase plant absorbs by its roots and dropped by translocation after maturity the aluminum is not more toxic than other metals.

**Copper-** It is one of essential micronutrients of living organism, it occurs in redox component in cellular electron transport chain system. Its level toxic to plant if increase and stress induced suppression of two proteins, also down regulation of seven proteins and five proteins up regulated. It is toxic in medicinal plants its concentration increase in the soil.

**Cadmium-** it is present 0.1 and 0.41 mg/ kg in the earth crust, mostly it is used in battery production. It also used in large quantities as pigment contain stabilizer, it also used as alloys and stabilizer for various plastics due to some distinctive physical and chemical characters. The cadmium is harmful metal affect on all living organism biological process, its high water solubility produce toxicity it recognized seventh ranked in twenty top toxins. It is heavy metal pollutant in the plant it produce chlorosis, root tip browning and plant death ultimately.

**Cobalt-** It produces soil pollution largely by mining and smelting, sewage sludge dispersal and fertilizer use. The high dose of cobalt is toxic to plant it also affect terrestrial ecosystem.

**Chromium-** It is seventh largest component of the crust of earth; its average concentration is 100 mg/kg. It used in stainless steel, pigments, metal finishing, chromate plating and preservation of wood and chemicals. In paint, glazes, varnishes, inks and paper, it also used production of green tints. In the chromium pollution dyestuffs and leather tanning is main sources, in aquatic bodies it also directly discharge, it is consider as non essential metals in the plants growth.

**Iron-** It s essential element for animals, plants and human, the Fe occurs in plants rhizospheric zone it is largest occurring metal in earth crust. In the Fenton reaction it is reactive and toxic, it accumulate primarily by pants for stabilizing Fe3+ and reducing Fe2+ to the absorption and transportation in the root.

**Mercury-** It has occur in earth crust 0.07 mg/ kg it is used in gold mining, batteries, paints , pesticides, impregnation of wood and electric products. It accumulates in different sites and reflected as global pollutant. In the plant it takes up directly depending upon soil quantity. The mercury stored in roots, leaves and grains its high level is harmful to environment and health.

**Nickel-** Its exposure in growing medium affects activity of amylases, proteases and ribo-nuclease affects digestion and metabolism of food reserve in seed germination. The cation transport system of plant passively absorbs the soluble nickel compounds.

**Lead-** In the earth crust it occurs 15 mg/ kg in the terrestrial system it show two types primary and secondary. In primary lead formation geogenic activates and incorporate into minerals and in secondary lead formation radiogenic origin from uranium and thorium decline. The lead used in battery production, in solders, alloys, cables and chemicals. It is non-essential toxic element occur in soil. The plants root accumulate it from soil, it is toxic to all living organism.

**Arsenic-** It is metalloid occur in water it is toxic binds with sulfur, disrupting enzymes used in metabolism.

In the environment toxic and carcinogenic material release and it accumulate in food change, damage the health of wildlife and human. The heavy toxic metals occur naturally with high atomic weight and density at least five times greater than water. The heavy metals released into environment by agriculture, mining and therapeutic expertise. The release of metals pollutes environment, also produce harmful effect in animal and human. The accumulation of heavy metal by plants shows negative impact on human health and environment. In the India for the higher crop production farmer has use waste water enriched with vital nitrogen, potassium and phosphorous. These result possible pollutant transfer to crops and vegetation. The heavy metal produces risk in ecosystem and environment because of toxicity, bioaccumulation, persistence and non bio-degradability. It also contaminates water bodies and mixed with soil. The fruits and crops grows on that water produces the health effect, the plant also used in herbal medicine also produce toxicity.

* **Medicinal plants and heavy metals content-**

**Adhatoda vascia –** It is respiratory healer commonly known as Malabar nut plant, it stimulate bronchial system. It eliminates excess phlegm from throat and clear lungs with improve bronchodilator and treats bronchitis, lung disorder and tuberculosis. The chemical constitute of plant about heavy metal is 2.49 milligram per kilogram lead, 11.9 milligram per kilogram copper, 50.78 milligram per kilogram zinc, 894.81 milligram per kilogram iron, 10.94 milligram per kilogram nickel and 1.99 milligram per kilogram chromium. The drink of decoction of leaves gets relive from the cough and cold symptoms.

**Acorus calamus-** The plant is useful in neurological and metabolic disorder, it is Indian traditional herb. It also used in gastrointestinal, respiratory, kidney and liver disorder. The plant is perennial herb its rhizome is brown in color cylindrical and curved. It shows analgesic anti-pyretic and anti-obesity properties. The chemical constitute of plant about heavy metal is 2.48 milligram per kilogram lead, 108.6 milligram per kilogram copper 9.1 milligram per kilogram mercury, 6.34 milligram per kilogram zinc, 558.69 milligram per kilogram iron, 33.39 milligram per kilogram nickel and 13.26 milligram per kilogram chromium.

**Curcuma longa-** The plant recognized by common name as turmeric, in India it used as herbal medicine for many purpose commonly as wound healer. The extract of plant is anti-microbial, anti-cancer, and anti-oxidant. The plant show inhibitory action on microorganism like E. coli, S. Aureus, Salmonella typhimurium, and Pseudomonas aeruginosa. The plant cultivated in Asia, South America and Australia. The chemical constitute of plant about heavy metal 1.88 milligram per kilogram lead, 110.36 milligram per kilogram copper 8.33 milligram per kilogram mercury, 14.18 milligram per kilogram zinc, 361.76 milligram per kilogram iron, 10.91 milligram per kilogram nickel and 8.23 milligram per kilogram chromium.

**Ocimum sanctum-** It is known as wonder herb the leaf has aromatic smell it is antioxidant plant effectively work against germs, virus and bacteria. It also used against respiratory tract infection like cough, cold, sore throat and asthma. The chemical constitute of plant about heavy metal is 8.6 milligram per kilogram copper 20.49 milligram per kilogram mercury, 67.21 milligram per kilogram zinc, 1930.54 milligram per kilogram iron, 16.29 milligram per kilogram nickel and 11.02 milligram per kilogram chromium.

**Piper longum** **–** It is effective herb for cough and cold also give relief from headache and congestion related with cold. It loose mucus and help for cough out and allow to breathe freely. It has expectorant property, treated as common respiratory woes. It boils with milk as half glass and drink give cure from common cold, asthma and bronchitis. The chemical constitute of plant about heavy metal is 1.88 milligram per kilogram lead 81.32 milligram per kilogram copper 10.64 milligram per kilogram mercury, 13.56 milligram per kilogram zinc, 403.76 milligram per kilogram iron, 9.81 milligram per kilogram nickel and 6.88 milligram per kilogram chromium.

**Phyllanthus emblica-** The plant has richest source of vitamin C and develop immunity. The fruit help excess of heat from body; it is cooling offer in pitta also helpful in gastrointestinal tract infection. It stimulates regeneration of red blood cells and improves hemoglobin content in body. The emblica has anti-inflammatory properties and soothe joint pains. The chemical constitute of plant about heavy metal is 2.03 milligram per kilogram lead 23.3 milligram per kilogram copper 1.58 milligram per kilogram mercury, 36.42 milligram per kilogram zinc, 637.5 milligram per kilogram iron, 6.55 milligram per kilogram nickel and 9.41 milligram per kilogram chromium.

**Terminilia chebula-** The plant is useful in opthalmia, hemorrhoids, dental caries, bleeding gums, ulcer oral cavity. The plants paste with water shows anti-inflammatory, analgesic and purify the wounds. The fruit power has used in chronic diarrhea, nervous weakness also used in cough, sore throat and in asthma. The chemical constitute of plant about heavy metal is 4.8 milligram per kilogram lead, 293.49 milligram per kilogram copper 4.0 milligram per kilogram mercury, 6.68 milligram per kilogram zinc, 287.22 milligram per kilogram iron, 13.44 milligram per kilogram nickel and 12.93 milligram per kilogram chromium.

**Terminilia belerica-** The plant fruit is laxative, astringent, anti-helmintic and antipyretic. In the Ayurveda it used in various disorders like hepatitis, bronchitis, asthma, dyspepsia, piles, diarrhea and eyes diseases. It also protects the liver and treats respiratory condition including respiratory tract infection, cough and sore throats. It is helpful in dysentery and also used as lotion for the sore eyes. The chemical constitute of plant about heavy metal 8.49 milligram per kilogram lead, 217.03 milligram per kilogram copper 2.55 milligram per kilogram mercury, 5.86 milligram per kilogram zinc, 364.14 milligram per kilogram iron, 23.4 milligram per kilogram nickel and 16.89 milligram per kilogram chromium.

**Tinospora cardfolia –** The all plant parts are useful, it contains polysaccharides, phenolic, triterpenoids, sesquiterpenoids and steroids. The plant contains thirteen types of alkaloids which is useful for many health problems. The chemical constitute of plant about heavy metal is 4.64 milligram per kilogram lead, 289.09 milligram per kilogram copper 8.76 milligram per kilogram mercury, 18.18 milligram per kilogram zinc, 749.81 milligram per kilogram iron, 17.18 milligram per kilogram nickel and 8.76 milligram per kilogram chromium.

**Tribulus terrestris-** It is small herbal plant occur in Asia, Europe and Africa, it has antimicrobial properties against eleven microorganisms. It occurs in India as weed mostly in statesMaharashtra, Rajasthan and West Bengal in hot, dry and sandy region. The chemical constitute of plant about heavy metal is 6.53 milligram per kilogram lead, 253.1 milligram per kilogram 7.7 milligram per kilogram mercury, 33.31 milligram per kilogram zinc, 823.56 milligram per kilogram iron, 19.19 milligram per kilogram nickel and 7.7 milligram per kilogram chromium.

**Withania sominifera-** The plants all parts are useful mostly roots are used in many medicine. It prescribed for immunity strengthen after illness. It shows anti-inflammatory properties and helps in rheumatoid arthritis, autoimmune diseases and certain skin diseases. This herb has proven its efficacy in nervous system disorders. It has shown to improve brain cell function, nervous exhaustion, anxiety and depression. It also refreshes the body by relieving fatigue. The chemical constitute of plant about heavy metal is 4.34 milligram per kilogram lead, 131.01 milligram per kilogram copper 3.85 milligram per kilogram mercury, 7.03 milligram per kilogram zinc, 309.95 milligram per kilogram iron, 17.05 milligram per kilogram nickel and 3.85 milligram per kilogram chromium. These type many medicinal herbs and plants has contaminated by the heavy metals and produce toxicity. The medicine produced from such affected medicinal plants shows the side effect on the health. In the following table some medicinal plants and their parts used for the medicinal use and its cure health problem described. These plants shows the some heavy metal concentration in it like lead, mercury, copper, zinc, iron, nickel and chromium.

**Table - Heavy meals concentration in some medicinal plants mg/kg-**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Srno** | **Medicinal plants** | **Part use** | **Medicinal use** | **Pb** | **Hg** | **Cu** | **Zn** | **Fe** | **Ni** | **Cr** |
| 01 | Adhatoda vascia | Leaves | expectorant | 2.49 | - | 11.09 | 50.78 | 0894.81 | 10.94 | 01.99 |
| 02 | Acorus calamus | rhizome | Asthma | 2.48 | 108.6 | 09.01 | 06.34 | 0558.69 | 33.79 | 16.26 |
| 03 | Ocimum sanctum | Leaves | Cough, fever | - | 008.6 | 20.49 | 67.21 | 1930.54 | 16.29 | 11.02 |
| 04 | Piper longum | Fruit | Digestive | 1.88 | 081.32 | 10.64 | 13.56 | 0403.76 | 09.81 | 06.88 |
| 05 | Phyllanthus emblica | Fruit | Revitalize | 2.03 | 23.03 | 01.58 | 36.42 | 0637.5 | 06.55 | 09.41 |
| 06 | Terminilia chebula | Seed | Laxative | 4.08 | 293.49 | 04.00 | 04.68 | 0287.22 | 13.44 | 12.93 |
| 07 | Terminilia belerica | Seed | Antipyretic | 8.49 | 217.03 | 02.55 | 05.86 | 0364.14 | 23.4 | 16.89 |
| 08 | Tinospora cardfolia | Plant | immuno-modulatory | 4.64 | 289.09 | 08.76 | 18.18 | 0749.81 | 17.18 | 08.76 |
| 09 | Tribulus terrestris | leaves | Diuretic | 6.53 | 253.01 | 07.07 | 33.71 | 0823.56 | 19.19 | 07.7 |
| 10 | Withania sominifera | Root | Nerve tonic | 4.34 | 131.01 | 03.85 | 07.03 | 0309.95 | 17.05 | 03.85 |
| 11 | Curcuma longa | rhizome | Wound healing | 1.88 | 110.36 | 08.23 | 14.18 | 0361.76 | 10.91 | 08.23 |

**Conclusion-**

The metals like aluminum, arsenic, lead, cadmium and mercury are not essential for human activity it causes toxicity. The World Health Organization has mention that in the world herbal medicine share is reach about 60%. The plant which used in therapeutic remedy they accumulate the heavy metal from the soil and produce toxicity in human. This accumulation of heavy metals shows its effect when that herbal plant consumed as remedies or dietary supplement. The long term accumulation of heavy metals like arsenic, cadmium, leads and mercury it causes serious health problems like cancer, kidney damage, neurological damage and developmental disorders. The heavy metals like mercury, nickel, zinc, chromium, iron, copper and lead like heavy metals are presents in these medicinal plants. These plants used as medicinal purposes Terminilia chebula plants seed is used as laxative, Terminilia belerica plants seed is used as laxative and anti-pyretic, Phyllanthus emblica plants fruit is used as digestive and revitalize, Piper longum plants fruit is use as digestive and bronchitis, Adhatoda vascia plants leaves are used expectorant and asthmatic, Withania sominifera plants roots are used as nerve tonic and Ocimum sanctum plant used in cough and fever. The toxicity produced by metals in living organism and plants is highly persistent and present in soil ecosystem for long time. The plants change accurate mechanism to deal heavy metal stress in order to survive. The plants changes mechanism for deal the heavy metal stress also develop cope with metal stress like exclusion of plasma membrane, immobilization, restriction of transport and absorption, induction of stress protein and synthesis specific heavy metal transporters. The medicinal plants accumulate this material from the soil or water in the environment and produce side effect on human health.

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