

Metallic and Other Compound Toxicity with their Phytoremediation: A Review

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ABSTRACT

Metallic and other compounds are found in elemental, organic and inorganic forms. All the forms of metallic compounds as well as other compounds are toxic. They enter in the human being as well as in animals through contaminated water, air, food and inhalation via blood vascular system. When it enters in the blood vascular system first of all it affected the liver because liver is the site for biotransformation and detoxification. Hence, causes liver toxicity. When liver is affected then it disturbs the entire physiology of man and animals. On the other hand, herbal medicine is very effective against this toxicity and So many substances have been discovered regarding remedial aspect against this toxicity but the research in herbal preparation (phyto-remedy) direction is empty. Considering all these facts, present investigation has been taken into consideration against many toxic and metallic compounds. Hence, this manuscript is disclosing the toxicity of metallic and other compound toxicity with their remedy by herbal preparation or herbal formulations.

Keywords: Metallic compounds, other compound, herbal extract, liver, remediation, rats

INTRODUCTION

As soon as the human race marches towards 21st century the problem of environmental pollution also becomes grave and of utmost concern globally. The use of toxic chemicals, certain synthetic compounds such as pesticides, urea and various types of metallic compounds cannot be denied. The industrialization of the world has also dramatically increased the overall environmental load of heavy metal toxins to the point that our societies are dependent upon them for proper functioning. They are present in virtually every area of modern consumerism from construction materials to cosmetics, medicine to processed foods, fuel sources to agents of destruction, appliances to personal care products. It is very difficult for anyone to avoid exposure to any of the many harmful metallic compounds that are so prevalent in our environment.

There exist over 20 different metal toxins that can impact human health and each toxin will produce different behavioral, physiological and cognitive changes in an exposed individual. The degree to which a system, organ, tissue or cell is affected by a metallic compounds toxin depends on the toxin itself and the individual's degree of exposure to the toxin.

The effect metallic and other compound has been observed on liver and serum enzymes because liver is a site of biotransformation, susceptible towards xenobiotic substances, while serum being component of blood, the liquid connective tissue has all responsibility of distribution and collection throughout the body and is a major site for maintaining health status of organism. Any change in the liver and serum enzymes due to xenobiotic substances may show a change in the entire metabolism.

The hepatotoxic action of chloroform has been recognized since 1850 [1] and in the late nineteenth century Rosenbaum [2] produced liver injury by the administration of arsenic and phosphorus. The list of

experimental hepato-toxins is now very long and it would be inappropriate to consider each one in detail. We are beginning to understand the threat that metallic compounds toxins are to our health. It is reasonable to conclude that these toxins exert a dramatic effect on the health of an individual and contribute to the progression of many different debilitating conditions.

Mercuric compounds when released in the environment have been observed to reveal free radical formation [3]. Free radicals are chemical species possessing an unpaired electron that can be considered as fragment of molecules which are generally very reactive. With the acceptance of free radical some important biochemical intermediates forms, they have implicated in a very large number of human diseases such as heart failure, hemorrhaging, ageing, cancer and kidney inflammation these free radicals have been responsible for cell damage and may induce many pathological events. For minimization of such type of metallic compounds toxicity, the use of herbal drug could be of immense global importance as the adverse effects of synthetic compounds on health status may be responsible for varied types of complicated diseases. Management of hepatic disorders have become a matter of serious concern worldwide and several laboratories are engaged in identifying effective hepatoprotectant from last few decades from different sources using different experimental models.

Intoxication of Metallic and Other Compounds

Endo et al. [4] conducted renal toxicity in rats after oral administration of mercury contaminated boiled whale liver marketed for human consumption. The data indicated that the human consumption of boiled whale liver may cause acute intoxication by the contaminated inorganic mercury, while Ramalingam [5] described toxic stress of metal in animal metabolism. Sidhu et al. [6] demonstrated biokinetics of Zn in liver and whole body and its bio-distribution in nickel treated protein deficient rats. Shimada et al. [7] demonstrated strain differences of cadmium induced hepatotoxicity in wistar imamichi and Fischer 344 rats. A single cadmium (4.5 mg/kg s.c.) treatment caused significant increase in serum alanine aminotransferase activity, indicative of hepatotoxicity in Fischer rats but did not in wistar imamichi rats.

Takamure et al. [8] found a possible mechanism of resistance to cadmium toxicity in male long Evans rat, while Smalinskiene et al. [9] observed effects of cadmium and zinc ions and mitotic activity and protein synthesis in mouse liver. Bashir et al. [10] observed arsenic induced cell death in liver and brain of experimental rats. Glutathione levels were increased significantly in liver at all doses and significant decrease in lipid peroxidation and P-450, while Chichovska and Anguelov [11] studied the influence of L-lysine and zinc administration during exposure to lead and ethanol in rats.

Akporhonor and Egwaikhide [12] exhibited removal of selected metal ions from aqueous solution by adsorption onto chemically modified maize cobs, while Bigi et al. [13] reported catch up of delayed tooth eruption associated with uranium intoxication. Mahour and Saxena [14] assessed hepato-biochemical, histochemistry, histopathology and serum enzymes under stress of mercuric chloride in *Rattus norvegicus*, while Paula et al. [15] studied effect of Lycopene on nephrotoxicity induced by mercuric chloride in rats.

Mahour and Saxena [16] reported scavenging strategy of *Panax ginseng* against free radicals under stress of mercuric chloride in *rattus norvegicus*, while Mahour and Saxena [17] evaluated *Panax ginseng* as safe guard against raised serum electrolytes, protein and blood glucose under stress of mercuric chloride in albino rats. Mahour and Saxena [18] observed alterations in hepatosomatic index under stress of mercuric chloride intoxication and their modulation by *Panax ginseng* in albino rat, while Hazara et al. [19] performed subchronic effect of mercuric chloride on albino rats. Mahour and Saxena [20] reported haematotoxic potential of mercuric chloride in *rattus norvegicus*, while Mahour and Saxena [21] confirmed modulating role of *Panax ginseng* in phase-II reaction of hepato-biotransformation in albino rats following mercuric chloride intoxication.

Saxena et al. [22] reported alterations in hepatosomatic index and behavior under stress of arsenic trioxide and their modulation by *Curcuma aromatica* plant extract in albino rats, while Durak et al. [23] observed mercury chloride induced oxidative stress in human erythrocytes and the effect of vitamins C and E in vitro. Bashandy

et al. [24] evaluated hepatoprotective and hypolipidemic effects of *Spirulina plantensis* in rats administered mercuric chloride, while Sheikh et al. [25] found effect of mercuric chloride on oxidative stress and target organ pathology in wistar rat. Ooka et al. [26] observed the comprehensive profiling activity of metal compounds with potential novel targets and mechanistic insights using Tox21 screening, but Monar et al. [27] studied the toxicity of heavy metals and their recent advances along with removal.

Samuel et al. [28] found the systematic toxicity of heavy metal mixtures in rats and concluded their harms, while Hong Su et al. [29] reported joint toxicity of different heavy metal mixtures after a short term oral repeated administration in rats. Milena et al. [30] worked with toxic effect of acute cadmium and lead exposure in rat blood, liver and kidney, however, Ezedom et al. [31] observed the toxicological effects of the concurrent administration of cadmium and arsenic through the food chain on the liver and kidney of rat. Reddy et al. [32] reported the biomarkers of oxidative stress in rat for assessing toxicological effects of heavy metal pollution in river water, but Mahour K. [33] observed the Effect of mercuric chloride on hepatic phosphatases and transaminases in albino rat.

Dooka B. D. et al. [34] disclosed heavy metal mixture induced hippocampal toxicity involve biometal accumulation, increase in oxidative stress, inflammation and caspae-3 activation in rats via Nrf-2/Ho-1/BDNF pathway, while Gajocha N., Bogacka D.I.K. and Piotowska [35] found effect of cadmium, lead and mercury on Glial cells in a rat model.

Phytoremediation

Chandan et al. [36] studied the hepatoprotective activity of alcoholic extract of whole plant *Boerhaavia diffusa* against carbon tetrachloride induced hepatotoxicity in rats and found an increase in normal bile flow in rats suggesting a strong choleretic activity, while Rana and Avadhoot [37] worked on *Gymnema sylvestre* and *Curcuma zedoaria* in rats against hepatotoxicity of carbon tetrachloride and achieved significant changes in biochemical parameters, liver weight and liver volume affected by carbon tetra chloride.

Shukla et al. [38] performed hepatoprotective activity of ursolic acid isolated from *Eucalyptus hybrid* against paracetamol and galactosamine induced hepatotoxicity in rats with reference to hepatoprotective drug, Silymarin. Bishayee and Chatterjee [39] estimated carrot aqueous extract protection against hepatic oxidative stress and lipid peroxidation induced by acute carbon tetrachloride intoxication in mice, while Vinsen et al. [40] observed prevention of galactosamine induced hepatic damage by Picroliv on isolated hepatocytes (ex vivo). Saraf et al. [41] assessed anti-hepatotoxic activity of *Cassia occidentalis* against carbon tetrachloride in rats, while Jafri et al. [42] reported hepatoprotective activity of leaves of *Cassia occidentalis* against paracetamol and ethyl alcohol intoxication in rats.

Singh and Handa [43] demonstrated hepatoprotective activity of *Apium graveolens* and *Hygrophila auriculata* against paracetamol and thioacetamide intoxication in rats with the normalency of all raised enzymatic profile, while Kamiyama et al. [44] demonstrated effects of one year cadmium exposure on hepato-renal and their relation to glutathione level. Saraswat et al. [45] revealed protective action of ursolic acid against chemical induced hepatotoxicity in rats, while Vaidya et al. [46] investigated *Picrorhiza kurroa* as a hepatoprotectant against galactosamine induced liver injury in rats. *Picrorhiza kurroa* restored reduction in liver lipid content, AST and ALT affected by galctosamine induction.

Kataria and Singh [47] demonstrated hepatoprotective effect of Liv-52 and Kumaryasava on carbon tetrachloride induced hepatic damage in rats. Kumaryasava to be more effective in reducing the liver weight increased due to hepatotoxicity of Carbon tetrachloride, while Mukherjee et al. [48] observed hepatoprotective effect of *Swertia chirata* against intraperitoneal injection of Carbon tetrachloride in albino rats. Despande et al. [49] described protective effects of turmeric (*Curcuma longa*) extract on carbon tetrachloride induced liver damage in rats, while Datta et al. [50] evaluated hepatoprotective effect of a protein isolated from *Cajanus indicus* (Spreng) on carbon tetrachloride induced hepatotoxicity in mice.

Singh et al. [51] assessed hepatoprotective activity of ellagic acid against carbon tetrachloride induced hepatotoxicity in rats, while Sandhir and Gill [52] found hepatoprotective effects of Liv-52 on ethanol induced liver damage in rats. Janbaz and Gilani [53] studied preventive and curative effects of berberine on chemical induced hepatotoxicity in rodents and confirmed the pre and post treatment of berberine (4 mg/kg b.wt.) was hepatoprotective in action, while Prabakan et al. [54] described protective effects of *Hemidesmus indicus* against rifampicin and isoniazid induced hepatotoxicity in rats.

Attri [55] conducted experiment with protective effect of N-acetylcysteine (NAC) in isoniazid induced hepatic injury (INH) in growing rats. The supplementation of NAC with INH protected the animals against hepatotoxic reactions by minimizing the free radical induced tissue injury, while Buwa et al. [56] established

hepatoprotective action of abhrak bhasma an ayurvedic drug in albino rats against hepatitis induced by carbon tetrachloride. Trivedi and Rawal [57] attained hepatoprotective and antioxidant property of *Andrographis paniculata* (Nees) in BHC induced liver damage in mice. Nees prevents the increased activity of enzyme glutathione-s-transferase and lipid peroxidation, while Asha [58] performed preliminary studies on the hepatoprotective activity of *Mamordica subangulata* and *Naragamia alata* against paracetamol induced hepatotoxicity in rats.

El-Khatib et al. [59] reported prophylactic effect of aqueous Propolis extract against acute experimental hepatotoxicity in vivo and found decrease in lactate dehydrogenase (LDH), lipid peroxide and glutathione content, while Abdel- Wahhab and Ahmed [60] suggested protective effect of Korean *Panax ginseng* against chromium VI toxicity and free radicals generation in rats. Korean *Panax ginseng* exhibited a protective action against the toxic effect of chromium VI and it had the ability to scavenge free radicals resulted from chromium VI intoxication.

Rao et al. [61] examined hepatoprotective effect of *Coccinia indica* against carbon tetrachloride hepatotoxicity in rats. Hepatic damage as evidenced by a rise in the levels of AST, ALT, ALP and GGT in serum and also change observed in other biochemical parameters in serum and liver showed a tendency to attain near normalency in animals co-administered with extract, while Hukkeri et al. [62] conducted hepatoprotective activity of stem bark of *Butea monosperma* (Kuntze) in carbon tetrachloride treated rats. The extract exhibited a positive hepatoprotective activity by decreasing the levels of biochemical parameters assessed, like serum AST, ALT and ALP. Al-Howiriny et al. [63] made preliminary evaluation of the anti-inflammatory and anti-hepatotoxic activity of 'Parsley' *Petroselinum crispum* in rats, while Ulicna et al. [64] studied hepatoprotective effect of *Aspalathus linearis* (Rooibos tea) on carbon tetrachloride induced liver damage in rats. The antifibrotic effect in the experimental model of hepatic cirrhosis of rats suggests the use of rooibos tea as a plant hepatoprotector in the diet of patients with hepatopathies.

Mathur et al. [65] overviewed on bioactivity examination of *Helleborus orientalis* plant in rat's effects on some serum parameters, while Venukumar and Lalha [66] observed hepatoprotective effect of *Coscinium fenestratum* in rats following carbon tetrachloride intoxication. Johri et al. [67] carried out analysis of time dependent recovery from beryllium toxicity following chelation therapy and antioxidant supplementation, while Kumar and Kumar [68] studied protective effects of vitamin C against copper poisoning with special reference to the liver of rat.

Kumar et al. [69] examined *Spirulina fusiformis*: a food supplement against mercury induced hepatic toxicity in Swiss albino rats. The *Spirulina fusiformis* extract (800 mg/kg b.wt.) orally before and after mercury intoxication showed a significant decrease in lipid per oxidation level, AST and ALT activity and increase in serum alkaline phosphatase activity and GSH content in spite of mercuric chloride, while Mukherjee et al. [70] evaluated aqueous extract of black tea (*Camellia sinensis*) against chronic ethanol toxicity.

Rathore and Varghase [71] exhibited effect of mercuric chloride on survival, food intake, body weight, histological and haematological changes in mice and their prevention with Liv-52, while Gajawat et al. [72] studied to screen for the hepatoprotective role of ascorbic acid against lead acetate intoxication in mice. The

ascorbic acid treatment prior to lead intoxication reduced the depletion in the normal hepatocytes count and elevation in binucleated as well as abnormal hepatocytes in comparison to their respective control. Nair [73] described protective effect of Tefroli-a polyherbal mixture on cadmium chloride induced hepatotoxic rats, while Saxena and Mahour [74] evaluated Panax ginseng as hepatoprotectants against mercuric chloride intoxicated albino rats.

Sharma et al. [75] demonstrated the protective effect of *Mentha piperita* against arsenic induced toxicity in liver of Swiss albino mice, while Gill et al. [76] reported the role of phytochelations in phytoremediation of heavy metals. Mahour and Saxena [77] assessed hepato-biochemical, histochemistry, histopathology and serum enzymes under stress of mercuric chloride in *Rattus norvegicus*, while Paula et al. [78] studied effect of Lycopene on nephrotoxicity induced by mercuric chloride in rats.

Mahour and Saxena [79] reported scavenging strategy of Panax ginseng against free radicals under stress of mercuric chloride in *rattus norvegicus*, while Mahour and Saxena [80] evaluated Panax ginseng as safe guard against raised serum electrolytes, protein and blood glucose under stress of mercuric chloride in albino rats. Mahour and Saxena [81] observed alterations in hepatosomatic index under stress of mercuric chloride intoxication and their modulation by Panax ginseng in albino rat, while Hazara et al. [82] performed subchronic effect of mercuric chloride on albino rats.

Mahour and Saxena [83] reported haematotoxic potential of mercuric chloride in *rattus norvegicus*, while Mahour and Saxena [84] confirmed modulating role of Panax ginseng in phase-II reaction of hepato-biotransformation in albino rats following mercuric chloride intoxication. Saxena et al. [85] reported alterations in hepatosomatic index and behavior under stress of arsenic trioxide and their modulation by *Curcuma aromatica* plant extract in albino rats, while Durak et al. [86] observed mercury chloride induced oxidative stress in human erythrocytes and the effect of vitamins C and E in vitro.

Bashandy et al. [87] evaluated hepatoprotective and hypolipidemic effects of *Spirulina plantensis* in rats administered mercuric chloride, while Sheikh et al. [88] found effect of mercuric chloride on oxidative stress and target organ pathology in wistar rat. Mahour K. [89] found the effect of mercuric chloride on hepatic phosphatases and transaminases in albino rat, while Mahour K. [90] carried out standardization of free radical scavenging activity of some indigenous medicinal plants by using thin layer chromatography.

Mahour K. [91] demonstrated the effect of solvent evaporation methods on biological activity of crude extract of *Feronia elephantum* corr. leaves, moreover, Mahour K. [92] explored the multiple approach of natural hepato-protectant against chemical toxicity.

Mahour K. [93] disclosed the mercury retention after Panax ginseng treatment against mercuric chloride intoxication in hepato-haemato indices in albino rats; again Mahour K. [94] reported in vitro antioxidant studies of some terrestrial indigenous plants. Mahour K. [95] disclosed the phytochemical and toxicological profile of some indigenous plant extracts, while Kavitha B. et al. [96] explored the phytoremediation of heavy metals with their significant importance. Sabreena et al. [97] disclosed the phytoremediation of heavy metals: An indispensable contrivance in green remediation technology, while Yan et al. [98] demonstrated the phytoremediation: A promising approach for revegetation of heavy metal polluted land.

Chandra and Hoduck [99] found the physiological effects of mixed heavy metals on popular hybrids and their phytoremediation. Moreover, Hasan et al. [100] assessed the phytoremediation of heavy metals using chemical amendments. Ahmed T. [101] reported the phytoremediation of heavy metals their techniques, challenges and prospects, while Okpoghono and Osikemekha [102] found phytoremediation recovery against heavy metals.

Kamagata M. et al. [103] evaluated cadmium toxicity alleviation in rats using *Lactobacillus* and *Ficus indica* and found that both have mitigative property against cadmium chloride, However, Balkrishna A. et al. [104] disclosed the phytoremediation of toxic metals and their post remediation management approach.

CONCLUSION

This manuscript is discloses the various metal toxicity in human being and other animals with their phyto-remediation. Hence, it is the best practice for new comer in the heavy metal toxicity along with herbal medicine.

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