Investigation of environmental impact of heavy metal pollution on *Lantana camara* and *Solanum xanthocarpum*

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Abstract : Traditional technologies for cleaning contaminated soils have been used for a long time. Natural metal hyperaccumulator plant species are important to remove heavy metals from contaminated soils. The hypertolerance of these metals is the key characteristic of the plants required for hyperaccumulation. The phytoremediation of metal-contaminated soils offers a low-cost method for soil remediation and some extracted metals may be recycled for value. Phytoextraction of heavy metals by plants offer great scope for commercial development. These are effective, environmentally safe, easily bio-degardable, inexpensive and easily available. Therefore the present paper focuses on qualitative and quantitative estimation of different heavy metals ions from *Lantana spp.* and *Solanum spp.* by atomic absorption spectroscopy. In *Solanum xanthocarpum* microquantities of heavy metals play an important role in enzyme activation while metal co-ordinated with Lantanoid inhibits wood destroying agents in *Lantana camara*. This study supports exploitation for their application in phytoremediation and this can be further rationalized towards developing transgenic improved phytoremediation cultivars for commercial use.

Key words **:** Hyperaccumulator, Phytoremediation, Heavy Metal, Lantana camara, Solanum xanthocarpum.

Introduction

Lantana camara and Solanum xanthocarpum are waste land weeds found throughout India .

Lantana camara

Ecology

Lantana camara is one of the natural biomass sources from nature. It belongs to Verbenaceae family and found in tropical and subtropical region of world (Sharma O.P. et al., 1989) Currently, it is commonly distributed throughout India as an obnoxious weed. Contains about 150 species of perennial flowering plants.

Biodiversity

Lantana's aromatic flower clusters are mix of red, orange, yellow or blue and white florets. The flowers typically change color as they mature, resulting in inflorescences. These weeds grow well on nutrient rich and also on nutrient deficient barren soils and light availability. Most variant species needs fertile organic soil while others can survive on siliceous sands. *Lantana camara* Linn contain wide array of compounds exhibiting diverse range of bioactivity (Sharma M et al., 2011).

Uses

In herbal medicine, infusions of the leaves and other plant are used as an anti-inflammatory (Oyedapo et al., 1999), a tonic and expectorant, and besides it is added to baths as an anti-rheumatic. Lantana extracts have also been shown to be a powerful febrifuge (Liogier H.A, 1990). Storing potatoes lantana leaves nearly eliminates damage by *Phthrorimaeperculella Zeller*, the potato tuber moth (Lal L. 1987).

Solanum xanthocarpum

Morphology

The plant occurs throughout India ascending to 2200m on the Himalaya (Sharma PC et al., 2001) and often as waste land weed (Indian Herbal Pharmacopoeia, 1998). The leaves are up to 10 cm in length, their midribs and other nerves with sharp yellow prickles. The flowers are purple, about 2 cm long, few together in small bunch opposite the leaves. The fruits are glabrous, globular drooping berries, 1.5-2 cm, yellow or pale with green veins.

Uses

Solanum xanthocarpum is used especially in treating Kasa (cough), Shwasa (bronchial asthma), Genetic Diseases (anaemia, diabetes, breast cancer, Parkinson's disease, thalassemia, etc.). This plant is nontoxic and has been reported to be safe for human practices (Govindan S et al., 2004) and is clinically safe to consume.

Figure 1: Diversity in colour of flowers (images 1-2) and fruits (images 3-4) of Lantana; Flowers (images 5-6) and fruits (images 7-8) of *Solanum xanthocarpum* due to geographical and metallic diversity.

Biological role of metals

1. Iron

Iron is an essential constituent for all plants and animals. High level of iron causes tissue damage due to the formation of free radicals (Rehmnan A *et al*. 2013).

2. Zinc

Zinc is also an essential element for normal growth, cell processes, brain development, bone formation and wound healing. A zinc deficient diabetic fails to improve their power of perception and also causes loss of sense of touch and smell (Khan SA *et al*.. 2008).

3. Manganese

Manganese is another essential element for plant and animal growth. The main sources for manganese in soil are fertilizers, sewage sludge and ferrous smelters. (Khan MA *et al*., 2007)

4. Nickel

Nickel plays important role in the production of insulin. Its deficiency results in the disorder of liver but its high level causes an allergic dermatitis known as nickel itch, further more Ni adversely affects nasal cavities and lungs and also has been identified as a suspected carcinogen (Chishti KA. *Et al*., 2011)

5. Lead

Lead is one of the toxic elements that is highly risky for plants, animals and mostly for microorganisms. Lead intoxication leads to nausea, headache, constipation fatigue, muscle aches and anaemia. (Karayil S *et al*.. 2011)

6. Chromium

Trivalent chromium is a trace element which is required for normal metabolism of fats, cholesterol and glucose while hexavalent chromium is a skin and mucous membrane irritant as well as a strong oxidizing agent (Hussain I *et al*., 2006)

7. Cadmium

Cadmium is a lethal metal and can cause severe health problems. In recent times attention has been focused on its presence in water, soil, milk, dietary products, medicinal plants, herbal drugs, etc. The most common sources for cadmium in soil and plants are combustion of fossil fuels, phosphate fertilizers, lead and zinc mines, non-ferrous smelters and sewage sludge application (Pendias, A. K. *et al.*, 1992)

Above their optimum concentration the heavy metals cause a photosynthesis perturbation in plants by stomatal limitations and a dysfunction of photosystem II. The details of the above heavy metals with names and the biological role of these elements have been given in Table No.1.

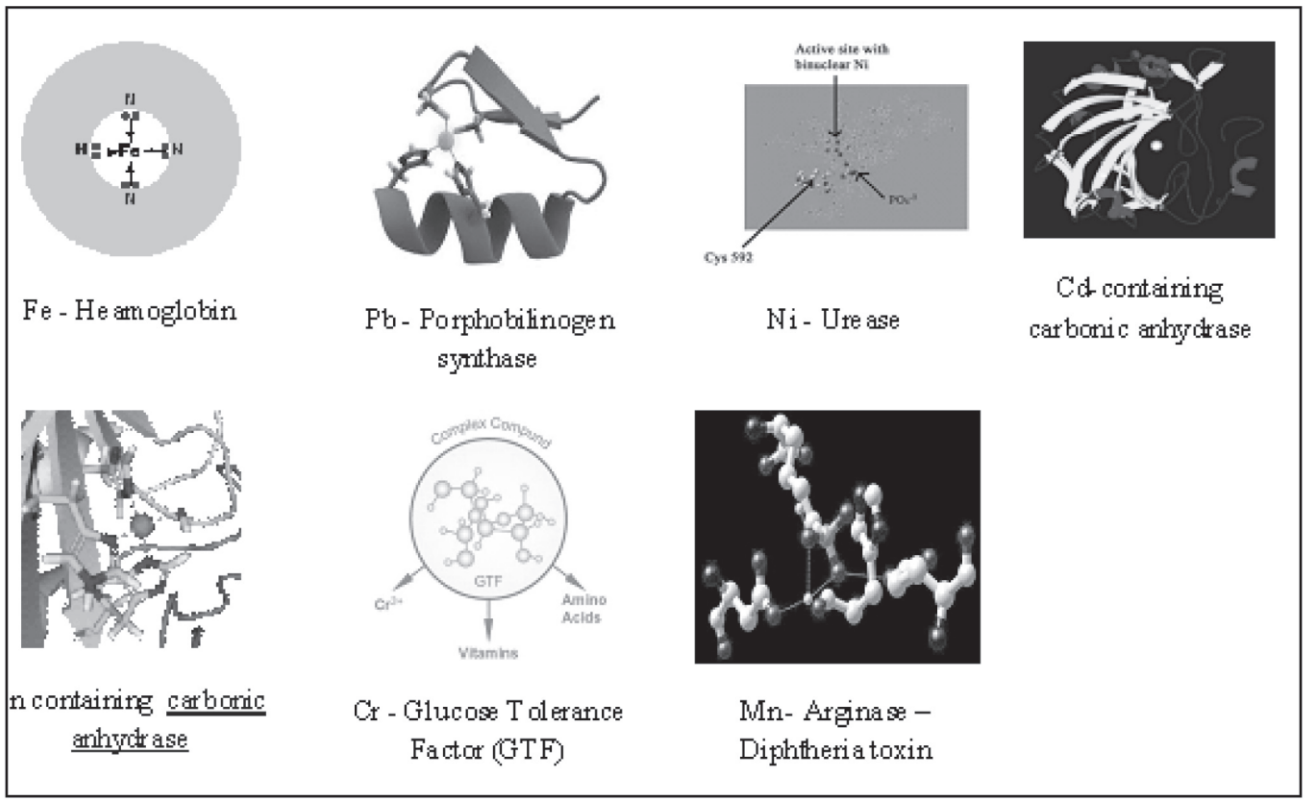

Table 1 – Heavy metals and their biological role.

Current status of phytoremediation

Phytoremediation of polluted soils, is based on the cultivation of plants that have demonstrated a high capability to absorb metals from soils by formation of organometallic complexes, which indicates their possible utilization in phytoremediation processes. Several species of Lantana among others have been already tested in pilot projects or are currently in commercial application in phytoremediation projects. More recently, the use of these plants in metal extraction (phytoremediation) has appeared as a promising alternative in the removal of heavy metal excess from the soil. This paper focuses primarily on the presence and distribution of heavy metals in *Solanum and Lantana* species. This study shall support application of these species in phytoremediation and can be further rationalized towards developing transgenic improved cultivars for commercial use.

Material And Methods:

Plant materials: The leaves, fruits and flowers of *Solanum xanthocarpum* and *Lantana camara* were collected from the campus of B.N.Bandodkar College of Science, Thane Maharashtra, India.

Methods: Flowers, leaves and fruits were sun dried for a week. Ground to fine powder and stored in packed jar to protect from humidity and light. This powder was used for extraction and estimation of heavy metals. For extraction of selected metals, dry ash of plant samples was prepared. The contents of crucibles were cooled to room temperature in desiccators and 10 ml of 20% HCl was added, the mixture was heated to dissolve its content. Further it were run on Flame Atomic Absorption Spectrophotometer under standard conditions for quantitative determination of Fe, Zn, Mn, Ni, Pb, Cr and Cd.

Results And Discussion

The estimation and concentrations of heavy metals analyzed are appended in table 2 and 3.

	Sample	Fe	Zn	Mn	Ni	Pb	Cr	Cd
SX	Flower	15.71+0.11	13.66+0.20	17.21+0.10	1.10+0.10	3.71+0.11	0.21+0.10	0.13+0.01
	Leaves	17.37+0.28	10.54+0.12	19.31+0.12	0.97+0.1	2.46+0.10	0.09+0.04	0.07+0.02
	Fruits	12.01+0.09	7.33+0.11	13.10+0.11	0.45+0.02	1.98+0.13	0.01+0.00	0.03+0.00
LC	Flowers	40.01+0.24	25.43+0.11	32.11+0.11	4.96+0.09	13.56+0.05	3.10+0.12	1.00+0.08
	Leaves	46.91+0.45	17.86+0.23	30.23+0.09	4.85+0.10	17.47+0.19	2.00+0.01	0.76+0.23
	Fruits	32.03+0.12	15.78+0.23	17.37+0.04	2.10+0.12	6.23+0.10	0.99+0.12	0.40+0.13

Table-2: Heavy metals (mg/kg) in *S. xanthocarpum* (SX) and *L. camara* (LC) aerial parts

Solanum xanthocarpum flowers showed highest content of Zn, Ni, Pb, Cr and Cd compared to leaves and fruits whereas leaves showed higher content of Fe and Mn compared flowers and fruits. In the case of (*L. camara*,) flowers showed highest content of Mn, Zn, and Ni compared to leaves and fruits whereas leaves showed higher content of Pb and Fe content compared to flowers and fruits. Among the two species, *Lantana camara* showed higher concentration of all metals compared to *Solanum xanthocarpum*. Figure 2 gives a graphical representation of the comparative concentrations of the above heavy metals in the flower, leaves and fruits of the two species.

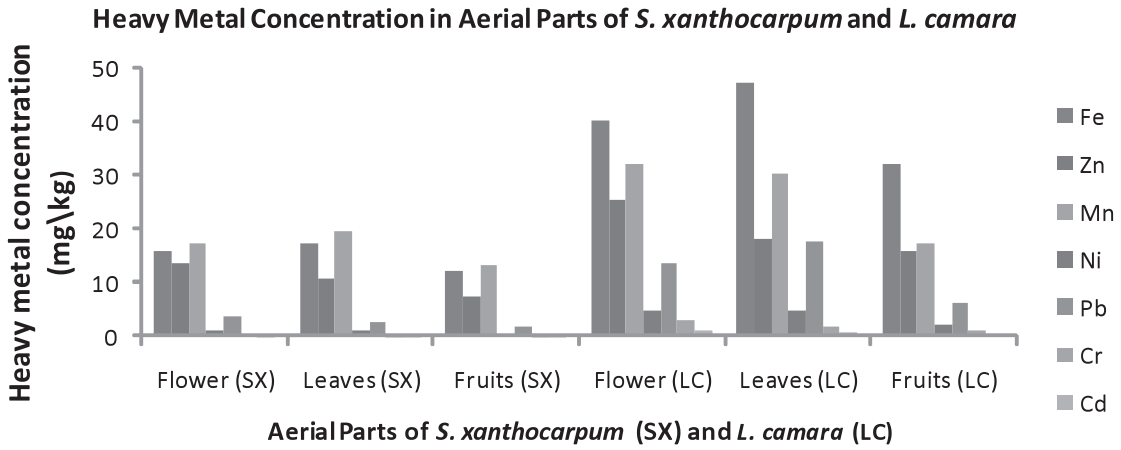

Figure 2: Comparative concentrations of heavy metals in flower, leaves and fruit samples of *Solanum xanthocarpum* (SX) and *Lantana camara* (LC)

Conclusion

Heavy metals were investigated in *Solanum xanthocarpum* and *Lantana camara* collected from the campus of B.N.Bandodkar College of Science. These species threaten agriculture and pasture production, forestry and biodiversity of conservation areas and may be toxic to stock. The highest priority for Lantana control is preventing its spread by herbicide which is effective but expensive or with integrated control should combine fire, mechanical, chemical and biological methods and revegetation. These weeds may be used for the determination of various compounds which may acts as reactant or primer in the various processes having potential applications in the society. *Solanum xanthocarpum* might be useful for the phytoremediation of soil cocontaminated with Zn, Ni, Pb, Cr, Cd, Fe and Mn whereas *Lantana camara* for Mn, Zn, Ni, Pb and Fe. Among these two species, *L. camara* showed higher concentration of all heavy metals making it a better choice for phytoremediation compared to *S. xanthocarpum*. The results also showed that the accumulation of heavy metals in medicinal plants depends upon the climate of locality, air pollution, soil contamination and other environmental factors where the plants grow. In order to revegetate in soil polluted by metals, the physiological impact of the pollution on plant species should be studied in further details. As the heavy metals fluctuate in plant as well as in soil samples

from site to site therefore each medicinal plant should be analyzed before utilization for pharmaceutical or traditional medicinal purposes.

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