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Heavy metal analysis from *Tridax procumbens* plant powder and effect of regional variation on its copper content using ICP-AES technique

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ABSTRACT

Most of the herbal medicines analysed for heavy metals, are found to be having higher concentration of one or more elements. Therefore, limit tests of heavy metals are essential for herbal medicines. There is also a need for heavy metal analysis to be an integral part of the standardization of herbal medicines. *Tridax procumbens* is one of the herbs abundantly found all over India growing wild in the fields as a weed. The use of *Tridax procumbens* as a wound healing plant was already known, but "Anti-diabetic activity of leaf extract of *Tridax procumbens* (1); Anti-hepatotoxic and anti-oxidant defence potential of *Tridax procumbens* (2)" are recently reported. Toxic Heavy metals such as Copper (Cu), Lead (Pb), Cadmium (Cd), Selenium (Se), Arsenic (As) and Mercury (Hg) were analyzed by Inductive Coupled Plasma (ICP) Spectroscopy and Cu metal was studied in detail for regional variation.

INTRODUCTION

Metals are significant to human as a few like Zinc, Copper and Iron form important component of cell and co-factor in several metalloenzymes. However, increased concentration of the metals in human beings can affect mineral and enzyme status. The metals irreversibly bind to active sites of enzymes, thereby destroying normal metabolism and producing high-level toxicity.

In the past few years there has been resurgence in the usage of herbal medicine among the traditional as well as the modern consumers of herbal products. As a result, the demand for high standard, reliable and contaminant free herbal medicine is increasing by the regulatory agencies, consumer groups and manufacturing units.

Heavy metals are a matter of concern in the herbal drugs, especially as certain plants have the tendency of storing heavy metals from the soil, polluted water and atmosphere. There has been considerable research on the response of plants to heavy metals, the mechanism, which helps plants to survive in metal contaminated environments, is still not very clear. This is particularly evident with respect to the plants having long life span, like trees. Most of the research carried out so far on heavy metals has been on herbaceous or short lived plants[8,9,12]. Studies carried out on higher plants reveal that they can be used as accumulative monitors of many metal elements in polluted areas. There are a number of reports indicating that plants may be able to acclimatize to presence of pollution and contamination[8,9,12]. However, the complete mechanism of metal tolerance for any plant has yet to be described. There is also limited information available on the limits of metal tolerance and the actual metal concentration above which further adaptation of metal or metals is possible[10]. Thus, metal tolerance may be the result of genetically inherited physiological mechanism. The ability of a plant to respond phenotypically to a stress may therefore be an impor-

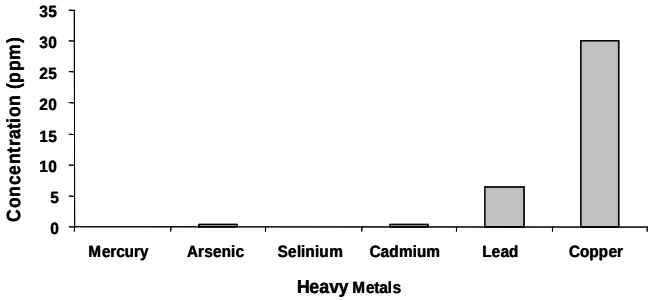

Figure 1 : A plot of heavy metals present in tridax procumbens against its concentration

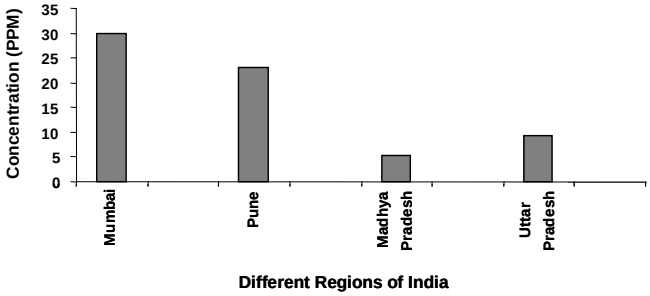

Figure 2 : A plot of copper metal concentration in tridax procumbens plant powder across India

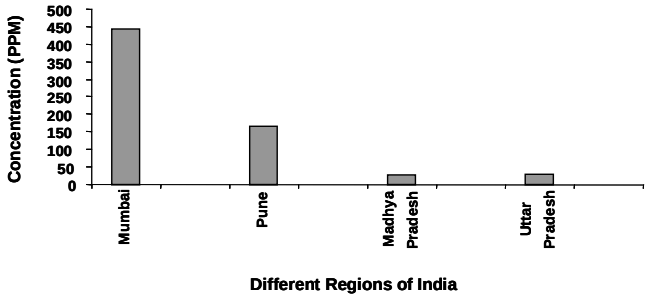

Figure 3 : A plot of copper metal concentration in soil across India

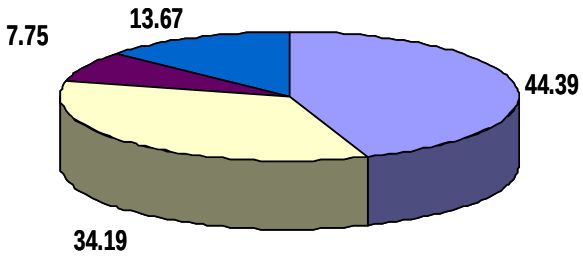

Figure 4 : Pie diagram representing relative percentage abundance of copper in tridax procumbens plant powder from different regions of India

TABLE 1 : Metal concentrations in tridax procumbens plant powder (Mumbai)

Metal	Mumbai			Average conc. (PPM)
	Conc. (PPM) sample 1	Conc. (PPM) sample 2	Conc. (PPM) sample 3	
Mercury	ND	ND	ND	0.00
Arsenic	0.39	0.36	0.41	0.39
Selenium	ND	ND	ND	0.00
Cadmium	0.46	0.45	0.46	0.46
Lead	6.49	6.44	6.52	6.48
Copper	29.99	29.88	30.02	29.96

Note : In the above table abbreviations Conc., PPM and ND stands for concentration, Parts per million and not detected respectively

tant mechanism in the survival of a plant[11]. *Tridax procumbens* is a semi-prostrate perennial herb belonging to family Asteraceae growing wild in planes throughout India. *Tridax procumbens* exhibits several pharmacological activities like used to stop bleeding, diarrheca, malaria, stomachache, pacifies vitiated pitta, inflammation, ulcers, anal fistula, and hemorrhoids, while its anti-diabetic, anti-hepatotoxic and anti-oxidant properties are recently revealed. Six toxic heavy metals such as Mercury (Hg), Arsenic (As), Selenium (Se), Cadmium (Cd), Lead (Pb), and Copper (Cu) were analyzed by Inductive Coupled Plasma Spectroscopy (ICP-AES). ICP-AES is one of the analytical techniques used for quantitative determination of trace elements.

EXPERIMENTAL

Materials and methods

Tridax Procumbens plant was collected, washed, dried in the shade, powdered, and the powder was passed through an BSS 80-mesh sieve and stored in an airtight container at 25°C. Toxic Heavy metals such as Mercury (Hg), Arsenic (As), Selenium (Se), Cadmium (Cd), Lead (Pb), and Copper (Cu) were analyzed in dried *Tridax procumbens* plant powder by Inductive Coupled Plasma Spectroscopy. Since Copper content was found to be abundant in *Tridax Procumbens* plant sample from Bhandup, Mumbai (Maharashtra). Hence from various geographical regions plant samples of *Tridax Procumbens* and respective soil samples were collected, powdered and analyzed by using ICP-AES for their Copper content. This estimation was done at parts per million (PPM) level.

ICP is based on the principle of Atomic Emission Spectroscopy. ICP-AES is one of the most advanced techniques for the trace elements analysis as well as major and minor constituents of aqueous and non - aqueous solutions as it has a wide linear dynamic range unlike Atomic Absorption Spectroscopy (AAS).

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TABLE 2 : Copper concentration (ppm) in tridax procumbens plant powder and its respective soil

Region	Copper estimation (PPM)		
	Concentration in Tridax procumbens plant powder	Concentration in soil	Bioconcentration factor ($BCF = C_{biota}/C_{soil}$)
Mumbai (Bhandup)	29.96	444	0.07
Pune (Regional research institute)	23.08	165	0.14
Madhya Pradesh (Itarsi)	5.23	25.4	0.21
Uttar Pradesh (Babhnan)	9.23	28.50	0.32

Note : Each reading in above table is mean of three readings. C_{biota} and C_{soil} ere the total metal concentration in taxa and soil respectively in μg/mL

TABLE 3 : Relative percentage abundance of copper in tridax procumbens plant powder from different regions of India

Region	Copper concentration in Tridax procumbens (ppm)	Relative % abundance
Mumbai (Bhandup)	29.96	44.39
Pune (R.R.I)	23.08	34.19
Madhya Pradesh(Itarsi)	5.23	7.75
Uttar Pradesh (Babhnan)	9.23	13.67

RESULTS AND DISCUSSION

The results of this heavy metal analysis from *Tridax Procumbens* plant sample from Bhandup, Mumbai (Maharashtra) have been presented in TABLE 1 and figure 1. Mercury and Selenium were not detected in the plant powder of *Tridax procumbens* .The concentration of Arsenic and Cadmium was found to be minimum 0.39 and 0.46 ppm respectively, while for Lead and Copper it was 6.48 and 29.96 ppm respectively.

Amongst all the metals analyzed from *Tridax Procumbens* plant powder the concentration of Copper metal was found to be in major quantity 29.96 ppm in this region hence Copper metal was decided to be studied in detail.

Tridax Procumbens plant samples were collected from Mumbai, Pune, Madhya Pradesh, and Uttar Pradesh in India. Plant samples were dried and powdered and with its soil sample from respective region it was analyzed for Copper content for regional variation. The results obtained are mentioned in TABLE 2 and graphically represented in figure 2 and 3 of plant samples of *Tridax Procumbens* and respective soil samples.

Copper content in *Tridax procumbens* plant powder was observed to be maximum in sample from Mumbai (29.96 ppm) followed by Pune (23.08 ppm), while it was observed to be comparatively lower in *Tridax procumbens* plant powder from Madhya Pradesh and Uttar Pradesh (5.23 ppm and 9.23 ppm respectively).

Soil analysis for copper content from Mumbai, Pune, Madhya Pradesh, and Uttar Pradesh was found to be 444 ppm, 165 ppm, 25.4 ppm and 28.5 ppm respectively. Hence from the above data and from observations recorded in TABLE 2 we can say that the amount of copper in *Tridax procumbens* Plant powder from Mumbai is highest followed by Pune, and Uttar Pradesh. While it is the lowest in Plant powder from Madhya Pradesh, which can be concluded from TABLE 3 and the following Pie diagram figure 4.

The abundance of copper metal in *Tridax procumbens* plant powder is higher in Mumbai followed by Pune, Uttar Pradesh and Madhya Pradesh is due to higher uptake of copper metal from its respective soil. Since the abundance of copper metal in respective soil also existed in the same manner higher in Mumbai followed by Pune, Uttar Pradesh and Madhya Pradesh (TABLE 2). As the lowest BCF (Bioconcentration Factor) value of 0.07 was found for *Tridax procumbens* plant sample from Mumbai, hence the accumulation of copper in the plant was due to higher copper content in the soil.

The relative Percentage abundance of copper in *Tridax procumbens* plant powder is found to be maximum in Mumbai (44.39 %) followed by Pune (34.19 %). While plant samples from Madhya Pradesh and Uttar Pradesh had a relative percentage abundance of 7.75 % and 13.67 % respectively (Figure 4).

Copper is an essential metal for normal plant growth and development, although it is also potentially toxic. Copper participates in numerous physiological processes and is an essential cofactor for many metalloproteins, however, problems arise when excess copper is present in cells.

At concentrations above those required for optimal growth copper inhibits growth and interfere with important cellular processes such as photosynthesis and respiration. Plants grown in the presence of high levels of copper normally show reduced biomass, a lower

content of chlorophyll and alterations of chloroplast structure. It is said, that copper interferes with the biosynthesis of the photosynthetic machinery modifying the pigment and protein composition of photosynthetic membranes.

The higher content of copper in the respective soil may be due to the natural composition of the soil or due to anthropogenic release of heavy metals into the environment through mining, smelting, manufacturing, agriculture and waste disposal technologies.

In Mumbai *Tridax Procumbens* plant and soil samples were collected from Bhandup station, railway yard which is in the vicinity of GKW, Crompton greaves, Indian Smelting Link chain, Jai Hind Oils, Aditya Birla Alloy company at Bhandup, Mumbai. The plant and soil samples exhibited higher concentration of copper 29.96 and 444 ppm respectively and hence the observed BCF (Bioconcentration Factor) value found was 0.07. The copper concentration of 444 ppm in the soil clearly illustrated the effect of smelting and waste disposal technologies.

The capability of *Tridax procumbens* to grow on copper rich soils exhibits its developed copper resistance mechanism and hence evolved ecotypes. The heavy metal analysis of *Tridax procumbens* plant powder and profiling of copper content can be used as a supporting data for standardization of *Tridax procumbens*.

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