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Estimation of Co and Mn in Some Medicinal Plants

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Many side effects and undesirable hazards are constantly associated with the greater use of synthetic drugs. Consequently there is now a worldwide trend to go back to herbal drugs and the majority of populations in many developing countries use their indigenous medicines for their health care needs. However, indiscriminate use of herbal drugs is not always safe, as it has been found that soil pollution by heavy metals can not only restrict the growth of plants or produce, but also plant products containing high levels of heavy metals like Cd, Co, Cu, Fe, Mn, Ni, Pb, Zn and Hg could cause harmful effects on human life too viz. Cd causes osteomalacia, pyelonephritis and Pb may cause renal tumors and other carcinomas (Schumacher et al, 1991). Although, Co and Mn are micronutrients, these are toxic at higher concentrations (Browning, 1969). Acute Manganese poisoning causes metal fume fever, in its chronic form in human beings, primarily a nerve toxin having polymorphic manifestation of psychic and neurological disorders; it can also in certain conditions, cause an effect on the lungs known as manganese pneumonitis. Similarly, due to its toxicity, cobalt, can cause gastric disturbances, which include vomiting, severe pain and tenderness in the epigastrium and pain in the limbs with marked weakness, also reported by Browning (Loc. cit.). Besides, allergic dermatitis is also produced by cobalt. It is mentioned by the same author that beer-containing Co for preserving its foam may cause heart disease in heavy beer drinkers.

In the view of Co and Mn toxicities, the present communication deals with estimation of Co and Mn concentration in some important medicinal plants of indigenous systems collected from different parts of India with the objective to compare the Co and Mn concentration in different species and their variations in the same species collected from different locations. The species selected for studies are *Alpinia galanga* Willd. ('Kulanjan'), *Artemisia parviflora* Roxb. ('Masipachchai'), *Butea monosperma* Kuntze ('Palash'), *Coleus forskohlii* Briq. ('Gandira'), *Curcuma amada* Roxb. ('Amra Haridra'),

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Table 1. Plant species and their medicinal properties

Plant Species	Part used	Genuine (collected)	Commercial	Medicinal properties (Chopra et al, 1956)
Alpinia galanga Willd 'Kulanjan' (Zingiberaceae)	Rhizome	Lucknow	Bombay Delhi Jammu	Stomachic, carminative, cardio-depres sant used in rheumatism and catarrhal affections.
Artemisia parviflora Roxb.* 'Masipachchai'(Asteraceae)	Leavess	Junagadh Tarikhet	-	Diuretic and antiviral
Butea monosperma Kuntze 'Palash' (Fabaceae)	Seeds	Allahabad Ranikhet	Aligarh Bombay Pune	Aperient and rubefacient
Coleus forskohlii Briq.* 'Gandira' (Lamiaceae)	Roots	Agrakhal, Tarikhet Vijaywada	-	Cardioactive, hypotensive, used in constipation
Curcuma amada Roxb. 'Amra haridra'(Zinigiberaceae)	Rhizome	Lucknow Tirunelveli	Delhi Nagpur	Stomachic, carminative, used in bruises and sprains
Euphorbia prostrata W. Ait. 'Dudhika' (Euphorbiaceae)	Whole plant	Lucknow Tarikhet Tirunelveli	Patiala	Stimulant, astringent, anthelmintic and laxative.
Leucas aspera Spreng.* 'Thumbai' (Lamiaceae)	Whole plant	Banglore Bhubaneswar Calcutta Thiruvananthpuram Tirunelveli	-	Antipyretic, stimulant, expectorant, aperient, diaphoretic and used in chronic rheumatism
Malaxis acuminata D. Don. 'Jeevak'(Orchidaceae)	Tubers	Ranikhet Tarikhet	Aligarh Bombay	Aphrodiasiac, febrifuge and have a cooling effect.
Peuraria tuberosa DC. 'Vidarikand' (Fabaceae)	Tubers	Dehra Dun Mandi	Delhi	Aphrodiasiac, tonic, galactogogue, diuretic and cures leprosy.

* Crude drugs were not available in the markets of India surveyed.

Euphorbia prostrata W. Ait. ('Dudhika'), *Leucas aspera Spreng* ('Thumbai'), *Malaxis acuminata* D. Don ('Jeevak') and *Peuraria tuberosa* DC. ('Vidarikand'), due to their importance in indigenous systems of medicine and are frequently used in number of indigenous compound formulations.

In different countries scientists worked out levels of heavy metal accumulation in medicinal plants [Wong et al (1993), Kwapulinski et al (1996), Chizzola and Franz (1996), Sathiyamoorthy et al (1997)] but in India little work has been reported till date (Jelani et al 1992). Therefore, it is of great importance to estimate the level of Co and Mn in some important medicinal plants to assure the quality of herbs to be used for various formulations.

MATERIALS AND METHODS

The plant parts which have medicinal value were collected from different parts of our country namely Agrakhal, Aligarh, Banglore, Bhubaneswar, Calcutta, DehraDun, Delhi, Jammu, Junahgadh, Lucknow, Mandi, Ranikhet, Tarikhet, Thiruvananthpuram, Tirunelveli and Vijywada. Commercial samples were also procured from different herbal drug markets being sold under the same vernacular names for estimation of heavy metals. (Table-1). A total number of 34 samples belonging to 9 different plant species were analyzed. Plants were washed in fresh running water to eliminate dust, dirt and possible parasites and then they were washed again with deionized water (Zurera, et al., 1987). 1 g of each completely dried sample was digested in concentrated nitric acid and perchloric acid (3:1) until a clear solution was obtained. After adequate cooling, solutions were reconstituted to the desired volume i.e. 25 ml with deionized water and stored in test tubes. All necessary precautions were adopted to avoid possible contamination of the samples. The prepared samples were analyzed on Atomic Absorption Spectrophotometer (Perkin Elmer 5000). Hollow cathode lamps were employed for detection of cobalt and manganese. The standard reference material of Co and Mn (E-merck, Germany) was used to provide calibration and quality assurance for each analytical batch. The efficiency of digestion of plant samples and Co and Mn test concentration was determined by adding standard reference material of Co and Mn (E-merck, Germany) to the different samples. After addition of standards, samples were digested and Co and Mn were estimated as described above. Mean recoveries of Co and Mn were 95±8% and 96±7% respectively. The detection limits of Co and Mn in HNO_3 using AAS (Perkin Elmer 5000) were 0.01 $\mu g\ ml^{-1}$ and 0.002 $\mu g\ ml^{-1}$ respectively. Replicate (n=3) analyses were conducted to assess precision of the analytical techniques.

Table 2. Heavy metals (Co and Mn) concentration [ppm (dw)] in underground parts of some herbal drugs

Herbal drug	Place	Co	Mn
Alpinia galanga	Delhi*	1.08±0.117	142.13±5.94
	Jammu*	0.166±0.235	107.25±1.968
	Lucknow	1.66±0.772	76.08±1.17
	Mumbai*	1.33±0.589	231.31±4.26
Coleus forskohlii	Agrakhal	3.08±0.117	24.16±0.849
	Tarikhet	3.58±0.117	22.25±0.353
	Vijaywada	4.08±1.64	26.58±1.63
Curcuma amada	Delhi*	2.08±0.311	259.21±5.88
	Lucknow	4.41±0.117	167.07±1.79
	Nagpur*	1.75±0.353	270.19±10.21
	Tirunelveli	3.75±0.408	40.58±4.71
Malaxis acuminata	Aligarh*	1.41±0.311	16.91±2.45
	Mumbai*	0.916±0.311	12.83±0.849
	Ranikhet	1.33±0.117	21.08±0.849
	Tarikhet	1.00±0.204	27.13±1.12
Pueraria tuberosa	Dehradun	6.25±0.204	17.25±0.408
	Delhi*	1.166±0.235	10.83±0.117
	Mandi	7.08±0.117	19.91±0.311

Table 3. Heavy metals (Co and Mn) concentration [ppm (dw)] in aerial parts of some herbal drugs

Herbal drug	Place	Co	Mn
Artemisia parviflora	Junagadh	6.91±1.12	66.75±12.96
	Tarikhet	4.33±0.311	139.21±4.74
Butea monosperma	Allahabad	1.833±0.11	21.25±0.540
	Aligarh*	1.33±0.42	29.41±1.31
	Mumbai*	1.91±0.311	27.66±1.31
	Pune*	2.00±0.353	22.58±1.54
	Ranikhet	1.75±0.612	25.16±2.51
Euphorbia prostrata	Lucknow	3.00±0.353	37.66±2.36
	Patiala*	1.75±0.735	27.25±0.707
	Tarikhet	3.41±0.235	57.08±0.656
	Tirunelveli	4.08±0.117	38.41±7.06
Leucas aspera	Banglore	5.41±0.117	112.08±8.30
	Bhubaneswar	3.41±0.311	32.5±0.735
	Calcutta	3.91±0.589	30.16±3.19
	Thiruvananthpuram	3.75±0.250	129.79±7.73
	Tirunelveli	4.35±0.538	48.08±0.716

Values are arithmetic mean ± SD of 3 determination in each case

* Market samples

RESULTS AND DISCUSSION

In the present studies the heavy metals Co and Mn concentration were estimated in collected as well as in commercial samples of some important herbal drugs used in indigenous systems of medicine in India. Table-1 lists the procurement as well as medicinal properties of herbal drugs. Tables 2 and 3 show the mean concentration values of Cobalt and Manganese in these drugs. From the ongoing study it was revealed that both the metals accumulated to a greater or lesser extent by all the nine plant species studied. The minimum Co concentration (0.166±0.235) was found in *Alpinia galanga* (Jammu market) and maximum (7.08±0.117) in *Pueraria tuberosa* (Mandi). While minimum concentration (10.83±0.171) of Mn was found in *Pueraria tuberosa* (Delhi market) and maximum (270.19±10.21) in *Curcuma amada* (Nagpur market). Bowen (1966) and Allaway (1968) studied the range of different metals in uncontaminated plant tissue and found that Co ranges from 0.05 to 0.5 ppm (dw) and mean Mn concentration in angiospermic plant is 630 ppm. After comparing these ranges with our result, it was found that all the samples except *Alpinia galanga* (Jammu) have Co accumulation beyond this normal range. However, the Mn concentrations in all the samples studied was found to be within the range. It is quite evident from the table -2 and 3 that accumulation of metals vary in the same species of plant collected from different places of India. Difference in heavy metal concentration in plants from different regions are related to the site from where the samples are collected. For instance the leaves of *Artemisia parviflora* collected from Tarikhet accumulated Mn 139.21 ppm as compared to Junagadh sample which has Mn 66.75 ppm. Banglore and Thiruvananthpuram sample of *Leucas aspera* accumulate Mn, almost four times higher than the other three samples of the same species. It shows that some specific sites may have metal concentration very much higher as compared to other sites due to pollution or some natural causes. Higher concentration of metals at a site is reflected by the concentration in plant tissues. Thus, from ongoing studies it can be inferred that the heavy metal accumulation even those utilized in micro quantity may cause serious hazards to human life and it should be mandatory for the pharmaceutical industries to detect the heavy metal concentration in each raw drug before processing.

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REFERENCES

Allaway WH (1968) Agronomic controls over environmental cycling of

trace elements. Adv Agron 20: 235-74.
Chopra RN, Nayar SL, Chopra IC (1956) Glossary of Indian medicinal plants. CSIR, New Delhi.
Bowen HJM (1966) Trace elements in biochemistry. New York. Academic Press.
Browning E (1969) Toxicity of industrial metals, II Edition. Butterworths & Co. (Publishers) Ltd.
Chizzola R, Franz C (1996) Metallic trace elements in medicinal and aromatic plants from Austria. J Appl Bot 70: 52-56.
Jelani S, Rao TS, Prabhakar M (1992) Quantitative estimation of certain toxic metal ions in some medicinally important plants of ocimoidae. Asian Plant Sci. 4 : 47-50.
Kwapulinski J, Miroslawaki J, Wiechula D, Rochel R, Burczyk J, Sowada B, Iwanek K (1996) The use ecotoxicological parameters for estimation of the quality of medicinal plant yielding areas. Bromatologia I chemia Toksykolo giczna 29 : 243-252.
Schumacher M, Bosque MA, Domingo JL, Corbella J (1991) Dietary intake of Lead and Cadmium from foods in Tarragona Province, Spain. Bull Environ Toxicol 46 : 320-328.
Sathiyamoorthy P, Van Damme P, Oven M, Golan Goldhirsh A (1997) Heavy metals in Medicinal and Fodder plants of the Negev Desert. J Environ Sci Health. A 32 : 2111-2123.
Wong MK, Tan P, Wee YC (1993) Heavy metals in some Chinese herbal plants. Biol Trace Element Res 36 : 135-142.
Zurera G, Estrada B, Rincon F, Pozo R (1987) Lead and Cadmium contamination levels in edible vegetables. Bull Environ Contam Toxicol 38 : 805-812.