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Comparative Studies on Few Shrubs, Herbs and Climbers for Accumulation of Elements at Zinc-lead-fluoride Mine Area at Chandidongri (Chhattisgarh), India

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In these studies were carried out on 20 plant species included shrubs, herbs and climbers. Out of 20 plant species, ten species are herbs *viz.*, *Achyranthus aspera, Aerua lanata andrographis paniculata, Celosia argentea, Eranthemum purpurascens, Hemigraphis hirta, Lenonotis nepetaefolia, Polygonum glabrum, Sida cordifolia, Turnera ulmifolia*, five species are shrubs as *Annona squamosa, Casearia graveolens, Elacodendron glaucum, Holarrhena antidysentrica, Woodfordia fruticosa*, rest five species are climbers as *Abrus precatorious, Butea parviflora, Gymnema inodorum, Olax imbricata* and *Ventilago calyculata*. The concentration of the elements *viz.*, Cu, Co, Ni, Pb, Zn, Cr, Fe, F and K_2O were estimated from washed plant leaves and young twig samples which were collected from mineralized and non-mineralized area's plants for comparison. Chemical analysis showed higher elemental concentrations in comparison with the non-mineralized area's plants. The growth distribution and toxic effects of plants of the mine area may be influenced by subsurface geology, reflecting the accumulation and toxic level of these elements in comparison of elemental composition of uncontaminated plant tissues.

Key Words: Chandidongri, Accumulation, Element, Plants.

INTRODUCTION

In recent years, much interest has been shown in supplementing the usual methods of geochemical prospecting of metaliferous sites with examination and analysis of vegetation. Botanical methods of prospecting for minerals incorporate two different techniques namely geobotanical and biogeochemical. Chandidongri area, still retaining a reserve forest status, is in much degraded condition. The vegetation is distributed thick jungle and shrubs cover the low ridges the hilly region west of the area. Vegetation aparse in the plains most of which are cultivated field. The climate is that of extreme continental type, cold and dry during winter and very hot and dry in summer. Rainy season is between the months of July to the months of september with an average rain fall of 121.01 cm. Chandidongri, is falling between latitudes 21º00' and 21º13' and longitudes 80º36 and 80º40', in tropical region. The most characteristic species of are *Buchanania lanzan, Lagerstramia parviflora, Diospyros metalonoxylon, Celosia argetea, Hemigraphis hirta, Polygonum glabrum, Abrus precatorius, Butea parviflora, Olax imbricata, Tectona grandis, Ptercarpous marsupium, Woodfordia fruticosa* and *Holarrhena antidysenterica, etc*.

EXPERIMENTAL

From the study area, 20 plant species were selected after preliminary chemical analysis and visual observation for selective analysis which included the shrubs, herbs and climbers. Plants were collected for herbarium, plant leaves and young twigs were collected for chemical analysis from mineralized and non-mineralized area for comparative analysis. The leaves and young twigs were washed thoroughly under running water to remove adhering particles. This plant samples, dried in hot air oven, were powdered and kept in polythene bags for further analysis.

Weighed 0.10 g dry powder of plant sample in platinium crucible, this was mixed with 0.5 g sodium carbonate (AR grade) and 0.1 g zinc oxide. Fused at 900ºC for 0.5 h in muffle furnace. The ash were cooled and pretreatment of samples was done with conc. HNO_3. It was digested then with a mixture of 10 mL of HNO_3, 3 mL of perchloric acid and 10 mL of HF acid. Then finally added 10 mL conc. HCl. This was then transferred to a 100 mL volumetric flask and made up the volume with distilled water. The solution was then shaken well before aspiration in to the AAS[1,2]. Fluoride was estimated with the help of Orinion ion selective electrode model No. 3.5, using fluoride electrode. Potassium was estimated with the help of Flame photometer, Micro Processor Based Chemita-102, model at 766.5 nm for potassium.

RESULTS AND DISCUSSION

Result obtained (Table-1) with the analysis of leafy twigs of 20 plant species, each taken in pair, one from mineralized and another from non-mineralized areas, is of more practical value. These results had indicated the accumulators of specific elements. Accumulators are early to be identified through knowing long differences in the concentration of elements in the plants from mineralized and non-mineralized areas. Concentration of ten elements was estimated in 20 plants species analyzed for copper, cobalt, nickel, lead, zinc, chromium, iron, manganese, fluoride and potassium. Potassium was estimated as K_2O, while all the other elements were estimated in their elemental forms. Concentration of potassium as K_2O

was higher, hence, was expressed in percentage, while all other elements, having lesser concentration, were expressed in ppm. Plants have been selected grouped habit wise as herbs, shrubs and climbers, only for convenience. On the basis of biogeochemical analysis, it has been established that the concentrations of the toxicants are in direct proportion in this soil and in the plant species. In other words, the growth and distribution of a particular plant in a given area is known to be influenced by subsurface geology. It is in comparison to the elements found in uncontaminated angiospermic plant tissues were observed. However concentration of copper in the plants of mineralized area ranges from 1-15 ppm, maximum 15 ppm was recorded in *Celosia argentea*. Cobalt, detected to be present in all the plants analyzed from the mineralized area ranged in its concentrations from 1-13 ppm maximum was recorded for *Olax imbricata*. Nickel, was found in range 1-23 ppm where the maximum concentration was recorded for *Turnera ulmifolia*. The main toxic symptoms of nickel appear to be a combination of induced iron deficiency chlorosis, foliar necrosis and unusual spotting of leaves and stems. Lead concentration in mineralized area was ranged between 1-61 ppm and maximum was recorded in *Celosia argentea*. Concentration of zinc also recorded in *Celosia argentea* and ranged from 11-337 ppm. Concentration of iron was ranged 13-359 ppm highest concentration of 359 ppm for *Hemigraphis hirta*. The trend of average value of manganese in the plants from mineralized ranged from 22-2600 ppm the highest concentration 2600 ppm was recorded for *Polygonum glabrum*. Concentration of fluoride, in the plants from mineralized area was lower as compared to the concentration of iron and manganese, having ranged 1-120 ppm the highest concentration 120 ppm was recorded for *Olax imbricata*. Fluoride toxicity shows similar hidden effects as SO_2 in altering general metabolic processes by affecting plants organic and amino acids, nucleophosphates and photosynthetic and glucose breakdown processes[3]. Fluoride toxicity initially leads to granulation and collapse of the chloroplasts due to hypertrophy of the cellular organells resulting in plasmolysis. Outwardly, browning of the leaf edges of dicotyledonous plants sets in while in monocotyledonous scroching and browning starts and spreads from the tip of the leaf. The location of these symptoms allows plants to show tolerance, as unaffected parts perform significant well. However, fruit and flower senescence occurs before maturity sets in[4]. Potassium, estimated as K_2O, was detected in all the mineralized and non-mineralized area's. In mineralized area K_2O was ranged from 0.78- 8.72 % and highest concentration of K_2O was recorded for *Abrus precatorious*. As per visual survey among these plants chlorosis, necrosis of leaves, brown spot and leaf tip burns observed in mineralized area. In spite of abundant iron in soil, chlorosis observed in leaves of mineralized

TABLE-1
CHEMICAL ANALYSIS OF THE LEAFY TWIGS OF HERBS, SHURBS AND CLIMBERS FROM MINERALIZED (MA) AND NON-MINERALIZED (NA) AREAS FOR SOME ELEMENTS

Plants		Cu	Co	Ni	Pb	Zn	Cr	Fe	Mn	F	K_2O (%)
Herbs (ppm)											
A. aspera L.	MA	5.00	3.00	17.00	1.00	153.00	12.00	98.00	76.00	1.00	2.15
	NA	1.00	1.00	6.00	1.00	40.00	14.00	24.00	28.00	0.00	1.16
A. lanata Mart.	MA	2.00	9.00	13.00	1.00	141.00	70.00	276.00	499.00	1.00	2.67
	NA	2.00	5.00	7.00	1.00	37.00	22.00	107.00	215.00	0.00	1.78
A. paniculata Wallich.	MA	7.00	2.00	14.00	1.00	133.00	12.00	104.00	32.00	1.00	2.9
	NA	3.00	1.00	8.00	1.00	35.00	7.00	75.00	21.00	0.00	1.35
C. argentia L.	MA	15.00	1.00	9.00	61.00	337.0	1.00	272.00	480.00	1.00	2.97
	NA	5.00	5.00	11.00	2.00	27.00	19.00	106.00	277.00	0.00	2.52
E. purpurascens Nees.	MA	10.00	9.00	5.00	1.00	143.0	12.00	129.00	98.00	1.00	1.97
	NA	4.00	8.00	2.00	1.00	65.00	14.00	95.00	68.00	0.00	1.95
H. hirta T. Ander.	MA	10.00	2.00	7.00	16.00	108.0	11.00	359.00	480.00	1.00	2.23
	NA	6.00	1.00	4.00	1.00	54.00	7.00	10.00	187.00	0.00	1.95
L. nepetafolia (L.) R.Br.	MA	2.00	1.00	21.00	1.00	109.0	35.00	184.00	119.00	1.00	1.86
	NA	1.00	1.00	18.00	1.00	45.00	17.00	68.00	74.00	0.00	0.68
P. glabrum L.	MA	9.00	1.00	15.00	33.00	183.0	5.00	127.00	2600.00	7.00	2.68
	NA	4.00	6.00	3.00	1.00	47.00	2.00	35.00	1213.00	0.00	1.83
S. cordifolia L.	MA	7.00	5.00	18.00	1.00	109.0	12.00	160.00	326.00	1.00	1.95
	NA	2.00	9.00	7.00	1.00	55.00	8.00	35.00	156.00	0.00	0.55
T. ulmifolia L.	MA	11.00	4.00	23.00	1.00	195.0	12.00	161.00	336.00	1.00	2.78
	NA	2.00	1.00	6.00	1.00	35.00	3.00	76.00	185.00	0.00	1.84

Plants		Cu	Co	Ni	Pb	Zn	Cr	Fe	Mn	F	K_2O (%)
Shurbs (ppm)											
A. squamosa L.	MA	8.00	2.00	1.00	1.00	17.00	2.00	13.00	22.00	1.00	0.78
	NA	2.00	3.00	1.00	1.00	12.00	5.00	17.00	18.00	0.00	1.15
C. graveolence Dalz.	MA	8.00	3.00	15.00	1.00	42.00	3.00	56.00	119.00	1.00	1.22
	NA	4.00	3.00	9.00	1.00	17.00	1.00	36.00	87.00	0.00	0.72
E. glaucum Pers.	MA	5.00	10.00	19.00	2.00	11.00	9.00	72.00	36.00	1.00	1.55
	NA	2.00	5.00	8.00	1.00	15.00	27.00	48.00	36.00	0.00	1.57
H. antidysentrica L.	MA	12.00	5.00	1.00	1.00	18.00	11.00	43.00	32.00	1.00	2.90
	NA	6.00	1.00	0.00	0.00	17.00	14.00	38.00	72.00	0.00	1.00
W. fruticosa (L.) Kurz.	MA	8.00	1.00	5.00	1.00	67.00	2.00	24.00	32.00	16.00	1.76
	NA	3.00	0.00	2.00	0.00	28.00	4.00	29.00	57.00	0.00	0.86
Climbers (ppm)											
A. precatorious L.	MA	2.00	12.00	1.00	20.00	62.0	2.00	85.00	33.00	112.00	8.72
	NA	3.00	4.00	2.00	0.00	16.00	5.00	62.00	39.00	1.00	5.12
B. parviflora Roxb.	MA	9.00	6.00	1.00	1.00	38.0	8.00	111.00	250.00	1.00	1.49
	NA	4.00	3.00	1.00	1.00	12.00	3.00	65.00	172.00	0.00	0.72
G. indorum (Lour.) Denc.	MA	8.00	2.00	6.00	4.00	34.0	15.00	87.00	199.00	8.00	3.17
	NA	3.00	1.00	4.00	1.00	19.00	11.00	37.00	85.00	3.00	1.82
O. imbricata Roxb.	MA	14.00	13.00	1.00	1.00	52.0	3.00	76.00	54.00	120.00	1.78
	NA	6.00	1.00	13.00	1.00	16.00	1.60	24.00	70.00	16.00	2.44
V. calyculata Tul.	MA	9.00	9.00	1.00	1.00	36.0	3.00	119.00	32.00	40.00	2.36
	NA	5.00	2.00	0.00	0.00	11.00	1.00	78.00	18.00	0.00	1.24

area, it may be result of the reduction of iron uptake caused by antagonistic effects of other elements present in the soil in high amounts. The chemotoxic effects can not be attributed to only one element but it can be a combined effect of other elements present in the soil. For satisfaction, on the basis of chemical analysis shows that higher concentration of elements are recorded as mild accumulator in *Celosia argentea1* for Zn and Pb, *Hemigraphis hirta* for Fe, *Polygonum glabrum* for Mn, *Olax imbricata* for fluoride and *Abrus precatorious* for F and K_2O in comparison to non-mineralized area and elemental composition of uncontaminated plant tissues[5]. The transferred toxicity to livestock feeding on fluoride accumulation plans creates more problems than the injury to crops. Dairy cattle fed on these plants show a significant drop in milk production. Also, fluoride deposition causes bone weakening in livestock. Fluoride toxicity among the livestock can be checked by increasing the calcium levels in animals feeds to improve the yield of exposed live stock[6].

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