

Heavy metal distribution in some of the seasonal vegetables of Patamda, the agricultural nerve centre of East Singhbhum district in the state of Jharkhand

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Abstract : Iron, manganese, zinc, copper, calcium and magnesium contents in leaf, stem and fruit (edible part) sections of five seasonal vegetables of Patamda have been reported quantitatively. Robust Z-score analysis was used to screen out the obvious outliers and arrive at a representative composition. All these metals except zinc and copper have been found in highest concentration in the leaves. The accumulation of copper in different plant parts has been found to be fairly uniform.

Key words : *Heavy metal, Vegetable, Z-score, East Singhbhum, Jharkhand state.*

INTRODUCTION

Heavy metal pollution of agricultural fields is caused by several factors. The most notables among them are indiscriminate mining, application of sewage sludge, pesticides and inorganic manure, dumping of inorganic wastes like fly ash and blast furnace slag, contaminated irrigation water, seasonal runoffs from fields situated at higher level *etc.* These metals, most of which are toxic to plant kingdom when present even at a very low level are converted into their soluble (ionic) forms over a period of time either due to natural weathering or by some anthropogenic activity. The most immediate consequence of such metal release is the pick-up of these metals by the plants and vegetables causing yield reduction and hindered growth (Dinelli and Lombini, 1996; Planquart *et. al.*, 1999; Cobb *et. al.*, 2000; Kisku *et. al.*, 2000; Bunzl *et. al.*, 2001; Wong *et. al.*, 2001).

Vegetation is one of the main pathways in the balance of natural eco-system productivity and the exchange of chemical elements (Alexeeva-Popova *et. al.*, 1995). Metal accumulation does not solely depend on the metal concentration in the soil but also on the speciation of metals in the soil and their involvement in biological functions (Sposito, 1983; Adriano, 1986; Kabata-Pendias and Pendias, 1992). Evaluation of plant metal concentration may be used to extract information about specific plant behaviour (Sposito and Page, 1994).

Patamda is one of the nine-community development blocks of East Singhbhum district in the state of Jharkhand that comprises 162 villages. The soil of Patamda is extremely fertile though irrigation water need is entirely met through seasonal rain. Agricultural products of Patamda are sent to various corners of the state of which a sizeable proportion also reaches the market of Jamshedpur. Distribution and accumulation of a number of heavy metals in a number of seasonal vegetables of Patamda were studied in detail by National Metallurgical Laboratory, Jamshedpur as a part of its umbrella programme on metal mapping of soil, water and vegetables of Patamda. Present study provides a quantitative report on the presence of Cu, Co, Ni,

Fe, Mn, Zn in the leaf, stem and root sections of five seasonal vegetables which are regular and prime produce of Patamda.

MATERIALS AND METHODS

Description of the Study Site

Patamda is situated at a distance of about 30 kms., from Jamshedpur, bordering Purulia district of West Bengal. Seasonal rain is the primary source of irrigation here. Agriculture is mostly traditional and typical vegetables are grown during summer, monsoon and post monsoon seasons.

Study Vegetables

Five vegetables, namely, spongegourd (*L. cylindrica*), ladies' finger (*A. esculentus*), radish (*R. sativus*), tomato (*L. esculentum*), and bittergourd (*M. charantia*) were studied. These vegetables were chosen so as to cover all three seasons. All vegetable samples were collected from appropriate villages to represent the entire Patamda block.

Vegetable Sampling

Spongegourd and ladies' finger were collected during summer, bittergourd was collected during monsoon and tomato and radish were collected during post monsoon. Once collected each vegetable was cleanly separated into leaf, fruit and stem sections. Each section was repeatedly washed with distilled water, air-dried followed by demineralisation at 105°C and preserved for further analysis.

Chemical Analysis

Standard protocol was used for dissolving the vegetables (Thompson and Nicholas, 1989).

Instrumental

All the vegetable samples were analysed by GBC 908 AA atomic absorption spectrometer.

Reagent

All the reagents used were of AR grade. 18 MW ASTM grade 1 water was used for making the solutions.

Statistical Analysis

Metal contents of the vegetables determined in the present study were marked with wide variations even within the same vegetable category. While this was expected, as is normally observed in plant and vegetable samples, presence of extreme results, which in all likelihood are outliers, greatly influenced the conventional calculations of mean, standard deviation etc. following normal distribution.

Robust Z-score statistic was used for identifying the obvious outliers. It is generally employed to a data set that has wide variations within. Presence of extreme results, which otherwise bias the conventional normal distribution statistics of mean and standard deviation, do not influence Z-score statistics greatly. In Z-score statistic mean is replaced with median and each data point is ascribed a normalised score, a Z-score, which reflects the deviation of

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Table 1 : Metal contents in seasonal vegetables of Patamda

Vegetable	Plant part	Fe g/kg	Mn g/kg	Zn mg/kg	Cu mg/kg	Ca g/kg	Mg g/kg
Spongegourd	Leaf	0.69	0.21	39.9	7.4	19.2	3.71
	Fruit	0.10	0.03	34.6	8.7	1.08	1.23
	Stem	0.44	0.98	18.1	7.6	5.66	1.98
Ladies' finger	Leaf	0.24	0.79	43.7	11.6	24.6	5.52
	Fruit	0.18	0.35	39.6	9.5	5.65	2.21
	Stem	0.23	0.46	56.2	8.4	2.48	8.98
Bittergourd	Leaf	0.64	0.12	46.9	12.2	15.4	4.56
	Fruit	0.10	0.24	39.1	11.5	0.81	2.33
	Stem	0.81	0.57	59.4	10.5	3.43	2.14
Tomato	Leaf	0.52	0.85	32.3	14.0	18.1	4.92
	Fruit	0.14	0.19	28.5	11.5	0.54	1.74
	Stem	0.23	0.47	42.7	12.6	8.75	2.44
Radish	Leaf	0.42	0.22	43.0	6.1	23.2	4.98
	Fruit	0.17	0.11	43.0	4.9	1.56	1.28

the data point from the median value. Z-score of a data point beyond a critical value makes the point as an outlier, which in the present case was ± 3 . The details of Z-score analysis may be obtained elsewhere (NATA, 1986). The data set was pruned by excluding the outliers identified through Z-score analysis and a revised estimate of median was made for each metal in each vegetable category.

RESULTS AND DISCUSSION

Table 1 gives Fe, Mn, Zn, Cu, Ca and Mg contents in different sections of five vegetable considered in the present study. The values have been reported on dry basis. Table 1 brings to

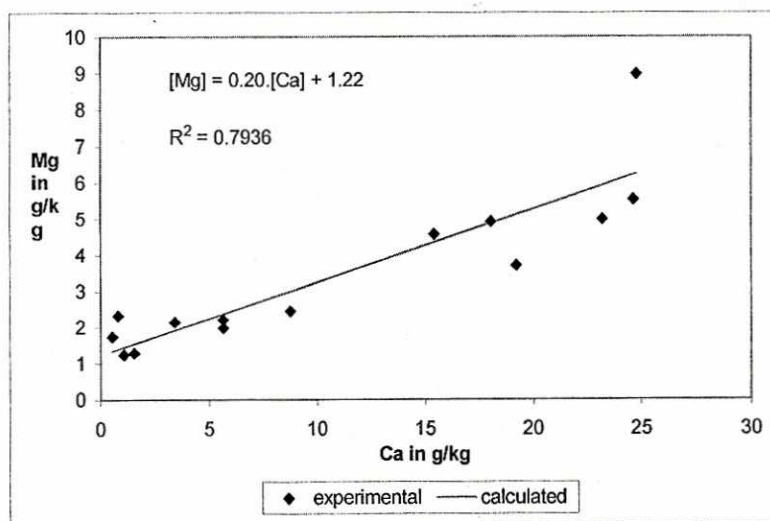


Fig. 1 : Magnesium-calcium correlation in Patamda vegetable

fore a number of interesting general trends. It may be observed that in all the vegetables leaf section contains maximum concentration of Fe, Mn, Ca and Mg. In the case of Zn and Cu, no definite pattern could be observed. It may be observed from Table 1 that Zn and Cu get almost uniformly accumulated in leaf, fruit and stem sections of all these vegetable. It was noted with some concern that the presence of Cu in the edible part (fruit) was on the higher side. Of the edible parts ladies' finger was richest in Ca and Mg though Mg content of bittergourd fruit compared well. An interesting linear correlation was observed between the Ca and Mg contents of these vegetables irrespective of their plant parts, which has been shown in Fig.1. Also given in Fig.1 are the correlation equation and the correlation coefficient.

CONCLUSION

A quantitative report has been prepared on the Fe, Mn, Zn, Cu, Ca and Mg contents in leaf, stem and fruit sections of five seasonal vegetables of Patamda. The vegetables include spongegourd, ladies' finger, tomato, bittergourd and radish. All these metals except Zn and Cu were found in highest concentration in the leaves. No pattern was observed for Zn and Cu. Cu was uniformly distributed in all the plant parts. Calcium and magnesium contents in all the plant parts for all the plants considered were linearly correlated.

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