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Original Research Paper

Effect of Seasonal Variation on Some Heavy Metal Contents of a Medicinal Plant *Swertia densiflora* (Griscb.) Kashyap Using ICP-OES Technique

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ABSTRACT

The analysis of heavy metals of medicinal plants is an important criteria of their standardisation. Various mineral elements occur in plant and animal tissues in such minute amounts that early workers were unable to measure their precise concentration with analytical methods then available. They were, therefore, described as occurring in trace quantity. The practice is still followed despite the development of modern analytical laboratory techniques such as atomic absorption spectroscopy and neutron activation analysis, which have an ability to measure all trace elements in the smallest of biological samples with great precision and accuracy. Four common heavy metals Pb, Zn, Cu and Ni were analysed in a medicinal plant *Swertia densiflora* (Griscb.) Kashyap by optical emission spectroscopy which uses the technique of inductively coupled plasma. The increased circulation of toxic metals in soils and plants may result in the inevitable buildup of such toxins in food chains. The results of the study indicate that the concentration of copper ranged from 7.10-9.25, zinc from 36.25-71.02, lead from 6.69-13.74 and nickel from < 1.0-4.46 in *Swertia densiflora*.

INTRODUCTION

Metals play an important role in human biology, and trace amounts of some metals like zinc, for example, are essential to life. In all, there are 38 heavy metals which play a variety of roles in biological systems, ranging from regulations of biological processes to being important structural components of proteins. They are essential for the normal growth of plants but in large quantity they are toxic to most plants as well as to human beings (Ross 1994). Heavy metals when present in abnormally high levels can cause injury to plants. Healthy plants can, sometimes, contain metals at levels within the plant range of tolerance but at levels deleterious to human beings or grazing animals. The trace element content of the whole plant increases with increasing maturity; and seasonal influences may also play an important role (Fleming 1967). Heavy metals are a matter of concern in herbal drugs; especially as certain plants have the tendency of accumulating heavy metals from soils, polluted water and atmosphere (Newall et al. 1996, Ghosh & Guhasarkar 2001). *Swertia densiflora* (Griscb.) Kashyap is found on plateaus of Mahabaleshwar and Panchagani (Kirtikar & Basu 1991, Rastogi & Mehrotra 1981, Joshi et al. 2000). *Swertia densiflora* is a reputed hepatoprotectant and antidiabetic plant. It is an excellent substitute for *Swertia chirata* (Wall) Clarke and Gentian. The drug lacks odour but has an extremely bitter taste. The whole plant is medicinal but the root is reported to be most valuable part. According to the Pharmacopoeia of India the drug should contain not less than 1.3% of the bitter principles (The Wealth of India, Vol. 10). Four common heavy metals Pb, Zn, Cu and Ni were analysed from *Swertia densiflora*, which was collected from Mahabaleshwar

and Panchgani, by optical emission spectroscopy which uses the technique of inductively coupled plasma (Alloway 1990).

MATERIALS AND METHODS

Whole plant of *Swertia densiflora* (Griscb.) Kashyap was collected from Mahabaleshwar and Panchgani in different seasons. The plant was authenticated from Blatter Herbarium-Xavier's College, Mumbai. The whole plant material was washed thoroughly with water to remove the dust particles adhering to roots, dust and extraneous matter. It was drained to remove excess water by spreading on filter paper for 6 hours in shade and then placed in oven at 45± 5 °C. The plant material was allowed to dry for 4 days. Immediately after drying, it was powdered using an electrical mixer-grinder and sieved through a BSS mesh No. 85 sieve and stored in an airtight Pearlpet® container labelled with details such as date of collection, weight of powder, time of collection and the season of collection. The powdered plant material was analysed for its heavy metal content (copper, zinc, nickel and lead) by using ICP-OES technique.

Inductively coupled plasma (ICP) is based on the principle of Optical Emission Spectroscopy (OES). ICP-OES is one of the most advanced techniques for the trace element 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).

RESULTS

The range of concentrations of four heavy metals namely Zn, Cu, Ni and Pb in normal plants have been presented in Table 1 (Alloway 1990, Ross 1994), and the results of these heavy metal analysis using ICP-OES technique in Table 2 and Fig. 1. The concentration of Cu was minimum (7.10 ppm) in summer (March), while maximum in monsoon (July) (9.47 ppm). The concentration of Pb was lowest (6.69 ppm) in summer (March), and highest (13.74 ppm) in early winter (October). In the case of Ni the concentration was minimum (< 1.0 ppm) both in monsoon (July) and early winter (October), and maximum (4.46 ppm) in summer (March). The concentration of Zn was minimum (30.50 ppm) in early winter (October), and maximum (71.02 ppm) in monsoon (July).

DISCUSSION

Swertia densiflora is a herb and its life cycle is from June to March. Being an annual, different seasons show different morphological stages of the plant (Kirtikar & Basu 1991). The trace element contents of the whole plant tend to increase with increasing maturity (Fleming 1965). In monsoon (July), the plant is just about few centimetres in height with leaves. It grows in accumulated rain water flowing down from the hills. In monsoon (July) the herb shows maximum concentration of Cu (9.47 ppm) and Zn (71.02 ppm) as compared to other seasons. These metals can be contributed from animal manure and straw compounds (Ross 1994). Zinc is also absorbed from the water, which is responsible for good vegetative growth of the plant. Thus, high concentration of Cu and Zn can be attributed to the accumulated water. At the onset of winter (October) and in summer (March), when the plant is in flowering and fruiting conditions respectively, Cu and Zn concentrations reduce considerably.

Panchgani being a hill station, high vehicular traffic ply near the place Table Land, where the plants are found. Lead, which is commonly contributed from automobiles, contamination is less in

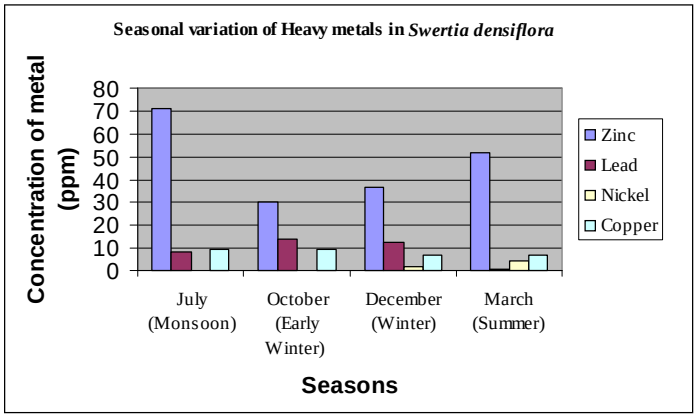

Fig. 1: Seasonal variation of heavy metals in *Swertia densiflora*.

Table 1: Typical concentration of some metals in plants.

Metal	Normal range in plant material µg/g fresh weight	Concentration in contaminated plant µg/g
Copper	4-15	20-100
Zinc	3-400	100-400
Lead	0.1-10	30-300
Nickel	0.02-5	10-100

Note: The source of readings-normal range (Alloway 1990, Ross 1994).

Table 2: Metal concentrations (ppm or µg/g) in *Swertia densiflora* collected in different seasons.

Metal	July	October	December	March
Copper	9.47	9.25	7.23	7.10
Zinc	71.02	30.50	36.25	51.70
Lead	8.26	13.74	12.46	6.69
Nickel	< 1.0	< 1.0	2.14	4.46

Note: Each reading is the mean of three values.

monsoon (July) but it keeps increasing in winter (October) and again reduces in summer (March). Probably plant has some physiological way of getting rid of Pb (Singh et al. 1995).

Nickel shows a very interesting trend in different seasons. It is in negligible concentration in monsoon (July) and early winter (October) but increases up to 4.46 ppm in fruiting stage of the herb in March. Ni is absorbed from the soil and is contributed from fungicides also. Thus, the increasing concentration of Ni can be attributed to the high concentration of Ni present in the soil coming from various environmental factors, especially from fungicides from cultivated lands nearby. In general, the heavy metal concentration of *Swertia densiflora* is quite below the permissible limits (Ross 1994).

The concentration of all the heavy metals is maximum 85.25 ppm in monsoon (July) (Zn being highest 71.02 ppm) followed by summer (March) and winter (October). Generally, annual herbs are

collected in the flowering season. Thus, winter (October) being the season for flowering stage of *Swertia densiflora*, it shows least concentration of heavy metals compared to other seasons. Therefore, *Swertia densiflora* may be collected in flowering stage when it would have highest metabolic rate.

CONCLUSION

Amongst the four metals analysed Zn was found to be in maximum concentration and Ni in the least concentration in *Swertia densiflora*. Zinc, being maximum in vegetative plant, helps in growth. There was no significant variation in the total metal concentration amongst different seasons; however, individual metal concentration varied in plant powder of different seasons. Lead showed significant variation in its range between beginning of winter (October) and proper winter season (December) in the analysed metals. These results, however, require further investigation, especially to correlate with the environmental levels of the heavy metals. It is evident from the study that *Swertia densiflora* does accumulate some heavy metals (Pb) at the levels more than normal range. Since, the levels of these heavy metals vary with the seasonal collection, it may be suggested that these higher levels could be related to the normal physiology of the plant.

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