

## PROFILE OF HEAVY METALS IN SELECTED MEDICINAL PLANTS

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### ABSTRACT

*Essential and non-essential heavy metals like Mn, Zn, Fe, Ni, Cu, Cr, Pb and Cd were quantified in selected medicinal plants including Artemisia vulgaris L., Asparagus adscendens Roxb, Cyamopsis tetragonoloba L., Galium aparine L., Mucuna pruriens L., Stevia rebaudiana and Withania somnifera L., by using atomic absorption spectrometry. The main purpose of this study was to document evidence of essential and non-essential heavy metals in these herbs, which are extensively used in the preparation of herbal products and standardized extracts. High iron contents were observed in W. somnifera 206.69 ppm, S. rebaudiana 201.38 ppm, G. aparine 180.91 ppm, C. tetragonoloba 87.14 ppm, A. adscendens 85.27 ppm, A. vulgaris 81.39 ppm and M. pruriens 33.21 ppm. The concentration of other heavy metals particularly manganese and zinc was also found on the higher side in the selected herbs*

**Key words:** zn, Fe, Cu, Cr, plant species, heavy metals.

### INTRODUCTION

The contributions of medicinal plants in the traditional system of medicine for curing diseases has been documented. Nowadays increased scientific interest and consumer demand have promoted the development of herbal products as dietary supplements. In view of renewed interest, oriental herbal medicines have a prominent role to play in the pharmaceutical and health markets of the 21<sup>st</sup> century (Kleinschmidt & Johnson, 1977). It has been reported that whatever is taken as food could cause metabolic disturbance subject to the allowed upper and lower limits of trace metals (Prasad, 1976). Both the deficiency and excess of essential micronutrients and trace of toxic metals may cause serious effects on human health (Underwood, 1997 & Reilly, 1980).

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WHO recommends that medicinal plants which form the raw materials for the finished products may be checked for the presence of heavy metals, further it regulates maximum permissible limits of toxic metals like arsenic, cadmium and lead, which amount to 1.0, 0.3 and 10 ppm, respectively (WHO, 1989, 1998). Medicinal herbs are easily contaminated during growth, development and processing. After collection and transformation into dosage form the heavy metals confined in plants finally enter the human body and may disturb the normal functions of central nervous system, liver, lungs, heart, kidney and brain, leading to hypertension, abdominal pain, skin eruptions, intestinal ulcer and different types of cancers .

## **MATERIAL AND METHODS**

### **Collection and Post Harvest Treatment of Plant Material**

Experiment was carried out at PCSIR laboratories Peshawar. Plants were collected from natural habitat of NWFP during the appropriate season *Stevia rebaudiana* leaves were procured from Qarshi Herb Centre - Hattar. Plant parts, especially roots were washed in fresh running water to eliminate dust, dirt and possible parasites and then treated with deionized water and were dried in shade at 25-30°C. During this sample processing, necessary measures were taken in order to avoid any loss or contamination of heavy metals.

### **Acid Digestion of Plant Samples**

Weighed quantities of crushed and powdered portion from each part of plant; root, stem, leaf and flower in a china dish were heated in an oven at 110°C to remove moisture. Then the dried sample after charring, was heated in a furnace for 4h at 550°C. The contents of china dish were cooled in desiccator and 2.5 mL 6M HNO<sub>3</sub> was added into the dish to dissolve its contents. The solution was filtered and transferred to a 20 mL flask and diluted to the mark (Radojevic, 1999).

Estimation of heavy metals was carried out on flame atomic absorption Spectrophotometer [FAAS] (Polarized Zeeman Hitachi 2000 was used.)

### **Calibration of Equipment**

For the elements under investigation we established the following sensitivity and detection limits respectively of the used FAAS apparatus.

Pb 0.2 and 1.0 ppm, Cr 0.5 and 3.0 ppm, Cd 0.2 and 1.0 ppm, Fe 0.5 and 5.0 ppm, Cu 0.5 and 3.0 ppm, Mn 0.5 and 2.50 ppm, Zn 0.05 and 5.0 ppm, Co 1.0 and 5.0 ppm, Ni 0.5 and 4.0 ppm

## RESULTS AND DISCUSSION

Concentration of essential and non-essential heavy metals in medicinal plants beyond permissible limit is a matter of great concern to public safety all over the world. The problem is rather more serious in Pakistan, because medicinal plants which form the raw materials for the finished products are neither controlled nor properly regulated by quality assurance parameters.

Table-1 summarizes pharmacognostic features of the selected medicinal herbs used as herbal remedy. As evident from table, *A. vulgaris* is antiseptic, diuretic, purgative and stimulant (Rakotonirainy and Lave drine, 2005), whereas *A. adscendens* have galactogogue, aphrodisiac, nutritive and demulcent properties (Tandon and Shakla, 1995). Similarly, *C. tetragonoloba* is recommended for oral hypoglycemic, gastrointestinal and lowering cholesterol level (Kaladharan and Kanadan, 2001). On the other hand *G. aparine* is astringent anti-inflammatory, in psoriasis, ulcers and anti-coagulant (Sinclair, 1989), whereas *M. pruriens* is associated with anthelmintic, anti-diabetic, analgesic and febrifuge (Lauk *et al.*, 1993). In addition *S. rebaudiana* is used as hypoglycemic, hypotensive, antimicrobial and also sweetener (Melis, 1999). Furthermore *W. somnifera* is claimed to possess sedative, antiseptic, abortifacient, deobstruent and arthritis properties (Iqbal *et al.*, 2004).

The concentration of Mn, Zn, Fe, Ni, Cu, Cr, Pb and Cd in selected medicinal plants are appended (Table-2). As evident from this table, maximum concentration of Mn was found in *A. vulgaris* 52.94 ppm, followed by *G. aparine* 43.16 ppm, *S. rebaudiana* 32.87 ppm, *W. somnifera* 23.77 ppm, *M. pruriens* 14.70 ppm, *A. adscendens* 9.70 ppm and *C. tetragonoloba* 1.39 ppm. Manganese concentration is high in all plants, however it is within normal background level for the element in plants under the critical concentration of 300-500 ppm DW. Mn deficiency in plants causes chlorosis. The estimated safe and adequate daily dietary intake in adults is 11 mg/day (Pendias & Pendias, 1992). Deficiency of Mn in human causes myocardial infarction and other cardiovascular diseases, also disorder of bony cartilaginous growth in infants & children and may lead to immunodeficiency disorder and rheumatic arthritis in adults (Smith, 1990; Barceloux, 1999).

### Zinc

As evident from Table-2, high concentration of Zn was found in *S. rebaudiana* 47.18 ppm followed by *G. aparine* 45.00 ppm, *W.*

*somnifera* 43.01 ppm, *A. vulgaris* 38.14 ppm, *A. adscendens* 32.87 ppm, *M. pruriens* 32.48 ppm. Zinc is an essential trace element for plant growth and also plays an important role in various cell processes including normal growth, brain development, behavioural response, bone formation and wound healing. Zinc deficient diabetics fail to improve their power of perception and also causes loss of sense of touch and smell (Hunt, 1994). The dietary limit of Zn is 100 ppm (Jones, 1987).

### Iron

Iron is an essential element for human beings and animals and is an essential component of hemoglobin. It facilitates the oxidation of carbohydrates, protein and fat to control body weight, which is very important factor in diabetes. Results in table-2 reveal that maximum concentration of Fe was found in *W. somnifera* 206.69 ppm, *S. rebaudiana* 201.38 ppm, *G. aparine* 180.91 ppm, *C. tetragonoloba* 87.14, *A. adscendens* 85.27 ppm, *A. vulgaris* 81.39 ppm and *M. pruriens* 33.91 ppm.

The results suggest that high amount of Fe in plants may also be due to the foliar absorption from the surroundings air. The dietary limit of Fe in the food is 10-60 mg/day (Kaplan *et al.*, 1993). Low Fe content causes gastrointestinal infection, nose bleeding and myocardial infarction. (Hunt, 1994).

**Table-1. Pharmacognostic Features of the Herbs.**

S. No.	Family/Plant Specie	Common Name	Medicinal Properties
1	Asteraceae <i>Artemisia vulgaris</i> L.	Mugwort	Antiseptic, Diaphoretic, Diuretic, Purgative, Stimulant, Asthmatic.
2	Liliaceae <i>Asparagus adscendens</i>	Musli sufaid	Galactogogue, Aphrodisiac, Nutritive, Tonic, Dermulcent and Stimulant.
3	Fabaceae <i>Cyamopsis tetragonoloba</i>	Guar	Oral hypoglycemic, Gastrointestinal, Lowers cholesterol level, and Low density lipoprotein level, Pharmaceutical products.
4	Rubiaceae <i>Galium aparine</i>	Cleavers or catchweed bedstraw	Diuretic, Anti-inflammatory, Astringent, Psoriasis, Ulcers, as anti-coagulant.
5	Leguminosae <i>Mucuna pruriens</i>	Rawanch	Diuretic, Astringent, Anthelmintic, Anti-diabetic, Analgesic, Febrifuge.
6	Asteraceae <i>Stevia rebaudiana</i>	Sweet herb	Diuretic, Hypoglycemic, Hypotensive, Cardiotonic Antimicrobial, Antiviral, Vasodilator, Antidiabetic, Sweetener.
7	Solanceae <i>Withania somnifera</i>	Asgandh or Ratti	Diuretic, Sedative, Antiseptic, Astringent, Abortifacient, Deobstruent, Arthritis

**Table-2. Heavy Metal Concentration (ppm) in Plant Material.**

Plant Species	Metal Concentration (ppm)							
	Mn	Zn	Fe	Ni	Cu	Cr	Pb	Cd
<i>Artemisia vulgaris</i>	52.94±0.01	38.14±0.02	81.39±0.30	4.35±0.01	9.65±0.04	4.65±0.04	nd	Nd
<i>Asparagus adscendens</i>	9.70±0.01	32.87±0.07	85.27±0.43	0.94±0.01	5.08±0.02	1.13±0.01	nd	Nd
<i>Cyamopsis tetragonoloba</i>	1.39±0.06	17.34±0.05	87.14±0.34	2.79±0.01	2.39±0.0	0.40±0.01	nd	Nd
<i>Galium aparine</i>	43.16±0.01	45.00±0.06	180.91±0.01	4.16±0.04	6.14±0.01	5.89±0.02	nd	Nd
<i>Mucuna pruriens</i>	14.70±0.01	32.48±0.04	33.21±0.03	3.18±0.02	8.43±0.07	0.27±0.01	nd	Nd
<i>Stevia rebaudiana</i>	32.87±0.01	47.18±0.03	201.38±0.34	2.36±0.00	7.71±0.01	1.45±0.01	nd	nd
<i>Withania somnifera</i>	23.77±0.01	43.01±0.01	206.69±0.23	2.64±0.02	8.67±0.02	1.13±0.01	nd	Nd

### Nickel

In case of Ni the concentration in different plants was in the order of; *A. vulgaris* 4.35 ppm, *G. aparine* 4.16 ppm, *M. pruriens* 3.18 ppm, *C. tetragonoloba* 2.79 ppm, *W. somnifera* 2.64 ppm, *S. rebaudiana* 2.36 ppm and *A. Adscendens* 0.94 ppm. The higher concentration of Ni in plants may be due to anthropogenic activities. The most common ailment arising from Ni is an allergic dermatitis known as nickel itch, which usually occurs when skin is moist, further more Ni has been identified as a suspected carcinogen and adversely affects lungs and nasal cavities. Although Ni is required in minute quantity for body as it is mostly present in the pancreas and hence plays an important role in the production of insulin. Its deficiency results in the disorder of liver (Pendias & Pendias, 1992). EPA has recommended daily intake of Ni should be less than 1 mg beyond which is toxic (McGrath & Smith, 1990).

### Copper

Although Cu is an essential enzymatic element for normal plant growth and development but can be toxic at excessive levels. Phytotoxicity can occur if its concentration in plants is higher than 20-100 ppm DW (dry weight).

As can be seen from the data (Table-2) high concentration of Cu was found in *A. vulgaris* 9.65 ppm, followed by *W. somnifera* 8.67 ppm, *M. pruriens* 8.43 ppm, *S. rebaudiana* 7.71 ppm, *G. aparine* 6.14 ppm, *A. adscendens* 5.08 ppm and *C. tetragonoloba* 2.39 ppm. The concentration of Cu in the selected herbs is high but it is beyond the critical level in plants (Kaplan *et al.*, 1993). High levels Cu may cause metal fumes fever with flue like symptoms, hair and skin decoloration, dermatitis, irritation of the upper respiratory tract, metallic taste in the mouth and nausea. WHO (1996) has recommended the lower limit of the acceptable range of Cu as 20 µg/mg body weight per day (FDA, 1993 & Waston 1993). Copper deficiency results in anemia and congenital inability to excrete copper resulting in Wilson's disease (Gupta, 1975).

### Chromium

The concentration of Cr (Table-2) found in different plants was in the tune of *G. aparine* 5.89 ppm, *A. vulgaris* 4.65 ppm, *S. rebaudiana* 1.45 ppm, similar values (1.13 ppm) for *A. adscendens* and *W. somnifera*, *C. tetragonoloba* 0.40 ppm and *M. pruriens* 0.27 ppm. The higher concentration of Cr in *G. aparine* than the critical level 5.30 ppm, could be a probable cause for yields reduction. With the exception of fall out of atmospheric pollutants through rain and accumulation in plant, it is probable that the metal was translocated

through air dust blowing from nearby. The toxic effects of Cr intake is skin rash, nose irritations, bleeds, upset stomach, kidney and liver damage, nasal itch and lungs cancer, chromium deficiency is characterized by disturbance in glucose lipids and protein metabolism (McGrath & Smith, 1990). The daily intake of Cr 50-200 µg has been recommended for adults by US National Academy of Sciences (Waston, 1993).

Lead and cadmium are non-essential trace elements having functions neither in humans body nor in plants. They induce various toxic effects in humans at low doses. The typical symptoms of lead poisoning are colic, anemia, headache, convulsions and chronic nephritis of the kidneys, brain damage and central nervous system disorders. Cadmium accumulates in human body and damages mainly the kidneys and liver. WHO (1998) prescribed limit for Pb contents in herbal medicine is 10 ppm while the dietary intake limit for Pb is 3 mg/week. The lowest level of Cd which can cause yield reduction is 5-30 ppm, while the maximum acceptable concentration for food stuff is around 1 ppm (Neil, 1993). Surprisingly no Pb or Cd were detected in plant samples (Below detection limit).

### CONCLUSIONS

The selected medicinal plants have been recommended as remedies for myriad of conditions in the traditional system of medicine. In the field of phytotherapy, tremendous progress has been documented regarding scientific evaluation of medicinal plants across the globe. The practical repercussion of the changing situation may be witnessed in the WHO monographs, National Pharmacopoeias and herbs processing industries.

The concentration of heavy metals determined in selected medicinal plants are well below the critical limit. Maximum concentration of Mn (52.94 ppm) Ni (4.35 ppm) and Cu (9.65 ppm) were found in *A. vulgaris*, Zn (47.18 ppm) in *S. rebaudiana*, Fe (206.69 ppm) in *W. somnifera* and Cr (5.89 ppm) in *G. aparine*. Lead and cadmium were below the detection limits. The implication of findings may be taken into consideration whilst using the herbs for human consumption. The results suggest that medicinal plants used for human consumption or for preparation of herbal products and standardized extracts should be collected from an unpolluted natural habitat.

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