

STUDY OF HEAVY TRACE METALS IN SOME MEDICINAL-HERBAL PLANTS OF PAKISTAN

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Abstract

The paper presents heavy trace metals analysis in some widely used medicinal-herbal plants of Pakistan by using Inductively Coupled Plasma. Because these commonly used medicinal-herbal plants from Pakistan are being specifically utilized for the treatment of various diseases, so samples of medicinal-herbal plants were collected from open market and from the fields. Collected samples were digested and analyzed for their nutritional trace metals (Pb, Cd, Fe, Zn, Ni, Cu & Mn) composition and then the results obtained were compared to international and national standards as required by World Health Organizations. The deficiency or excess of the samples for essential trace metals are reported.

Introduction

Heavy metals are naturally present in the environment. Their occurrence, however, has gradually been increasing with the increase of industrialization. Agricultural soils, as an essential part of the environment, are no exception of this phenomenon. Cadmium (Cd), copper (Cu), lead (Pb), and zinc (Zn) are among the most abundant heavy metals in the agricultural soils (Förstner, 1995). Copper and Zn, when present in low concentrations, are important micronutrients, while in high concentrations, these two metals become toxic to plants. Although Cd and Pb have no known role as nutrients, plants readily accumulate them in their system. The ability of plants to accumulate heavy metals is used in the process of phytoremediation where the green plants are employed to cleanse contaminated soils.

The screening of the actual bioactive elements of plants origin and assessment of elemental composition of the widely used medicinal plants is highly essentials (Saiki *et al.*, 1990). The quantitative estimation of various trace elements concentrations are necessary for the effective determination of medicinal plants for the treatment of various diseases and also for the understanding of their pharmacological actions.

There are two major reasons to monitor levels of toxic metals in medicinal plants (De Smet, 1992). The first reason is contamination of the general environment with toxic metals has increased (Ali, 1983). The sources of this environmental pollution are quite varied, ranging from industrial and traffic emissions to the use of purification mud and agricultural expedients, such as cadmium-containing dung, organic mercury fungicides and the insecticide lead arsenate (Gosselin *et al.*, 1984; Schilcher *et al.*, 1987). The second reason is that exotic herbal remedies, particularly those of Asian origin, have been repeatedly reported to contain toxic levels of heavy metals and/or arsenic.

Several investigators have studied the residual levels of toxic metals in medicinal herbs (Schilcher, 1982; Ali, 1983, 1987; Peters & Schilcher, 1986; Schilcher *et al.*, 1987). Most studies on residual levels of toxic metals in medicinal herbs have focused on lead, cadmium and mercury (Schilcher, 1985; Ali, 1987; Schilcher *et al.*, 1987).

Medicinal plants appear to be a good choice for phytoremediation since these species are mainly grown for secondary products (essential oil) thus the contamination of the food chain with heavy metals is eliminated. Aromatic and medicinal plants also have a demonstrated ability to accumulate heavy metals (Schneider & Marquard, 1996; Scora & Chang, 1997; Zheljazkov & Nielsen, 1996).

Research has shown that heavy metals accumulated by aromatic and medicinal plants do not appear in the essential oil (Scora & Chang, 1997; Zheljazkov & Nielsen, 1996) and that some of these species are able to grow in metal contaminated sites without significant yield reduction. There is therefore, a need for major interest to establish the levels of some metallic elements in commonly used herbal plants because at elevated levels these metals may also be dangerous and toxic (Schumacher *et al.*, 1991).

Medicinal plants occurring wild show more anomalous values than cultivated herbs, in particular with respect to lead levels Peters & Schilcher, (1986) and Schilcher *et al.*, (1987). The reason is, of course, that drugs grown wild are more difficult to control for all the potential ways of environmental pollution. As was to be expected, the research group also demonstrated that the levels of lead and cadmium in the same crude herb may vary considerably with plant part.

It is estimated that 70-80% of people worldwide rely chiefly on traditional largely herbal - medicine to meet their primary healthcare needs (Farnsworth *et al.*, 1991; Shengji, 2001). The global demand for herbal medicine is not only large but is growing as per the increasing of the population (Srivastava, 2000). Factors contributing to the growth in demand for traditional medicine include the increasing human population and the frequently inadequate provision of Western (allopathic) medicine in developing countries (Table 1). The Traditional Medical Systems are especially concentrated in Asia and some of the more widely familiar are in Chinese Traditional Medicine, Tibetan Medicine, Ayurveda, Siddha and Unani.

Use of medicinal-herbal plants for amelioration of toxic effects in man and animals is receiving attention worldwide. The magnitude of their uses during recent years for the cure of various ailments is obvious from the report of the World Health Organization (Anon., 1998) which indicated that many people in developing countries still rely on herbal medicine for treatment of various ailments. Medicinal plants today are cultivated commercially in polluted environments where soil (Sahu *et al.*, 1987), water (Chandra, 1980) and air (Sadasivam, 1987) contain rather high levels of pollutants. Therefore, the environment required for growth and synthesis of these plants is affected drastically, and the possibility that toxic pollutants are deposited in the plants cannot be disregarded. Little is known about the status of toxic metals in these medicinal-herbal plants grown in polluted environments. The possibility that toxic pollutants can be trans-located to humans and animals through the use of herbs grown in polluted zones has concerned scientists who promote use of herbal medicines.

Table 1. Ratios of doctors (practicing western medicine) and traditional medical practitioners (TMPs) (practicing largely plant-based medicine) to patients in East and Southern Africa.

Country	Doctor : Patient	TMP: Patient
Ethiopia	1 : 33,000	
Kenya	1 : 833 (urban)	1 : 987 (urban)
Malawi	1 : 50,000	1 : 138
Mozambique	1 : 50,000	1 : 200
South Africa	1 : 17,400	1 : 700-1200
Swaziland	1 : 10,000	1 : 100
Tanzania	1 : 33,000	1 : 350-450
Uganda	1 : 25,000	1 : 708

This study was therefore, designed to assess the levels of heavy metals (i.e., Copper, Iron, Nickel, Zinc, Manganese, Lead and Cadmium) in commonly used medicinal-herbal plants in Pakistan.

Materials and Methods

A total of 17 commonly used parts of medicinal plants were used in present investigation, the plants were identified and authenticated prior to toxic metal analysis from the area of Karachi. The identities, as well as the medicinal properties, of the herbal plant samples under investigation are presented in Table 2.

Table 2. Medicinal-herbal plants under investigation; name, parts studied and medicinal properties.

Plant species	Local name	Part used	Medicinal properties
<i>Mangifera indica</i>	Aa'm	Leaf	Antidiabetic
<i>Andrographis paniculata</i>	Kalmegh	Whole plant	Stomachic, bactericidal, laxative, tonic, alterative
<i>Datura alba</i>	Dahtoora	Leaf	Sedative, hypnotic
<i>Ipomoea hederacea</i>	Kaladana	Seed	Narcotic, psychedelic
<i>Ferula foetida</i>	heing	Root-gum	Carminative and intestinal anti-septic
<i>Zingiber officinale</i>	Adrak	Root	stimulant and used to cure diarrhea
<i>Allium sativum</i>	Lahsan	Root	Antihypertensive, astringent
<i>Lagenaria sicerana</i>	Lauki	Fruit	Antibacterial, analgesic and sedative
<i>Beta vulgaris</i>	Chuqandar	Root	Cooling, diaphoretic
<i>Ocimum basilicum</i>	Niazboo	Flower	Stimulant, styptic, diuretic and carminative
<i>Pongamia glabra</i>	Tukham-karanjwa	Seed	Antihyperglycaemic
<i>Gentiana kurroo</i>	Nilkhanth	Root	Anthelmintic
<i>Emblica officinalis</i>	Amal	Fruit	Revitalizer
<i>Abelmoschus esculantus</i>	Bhindi	Fruit	Venereal diseases, pneumonia, bronchitis, pulmonary tuberculosis
<i>Achyranthes aspera</i>	Safed aghedo	plant	Laxative, anti-periodic in malaria, stomachic
<i>Azadirachta indica</i>	Neem	Leaf	Antiseptic, tonic, spermicidal

A total of 35 commonly used medicinal plants were collected from Sindh & Balochistan area of Pakistan. The plants were identified through literature (Ali *et al.*, 1983 & 1987) given in Table 3. The materials used were Nitric Acid and Perchloric Acid etc., details can be found in Ogunwande *et al.*, (2006). The samples were washed with deionized water and allowed to dry in oven for 72 hours at a temperature of 65°C. The samples were then ground and sieved through 0.5 mm sieve. The powdered sample then subjected to the acid digestion using nitric acid and perchloric acid (Ogunwande *et al.*, 2006).

Digested samples were analyzed for their metal content by using Inductively Coupled Plasma (ICP) in PCSIR Laboratories of Karachi. The performance of the instrument was checked daily. For routine analysis one of the primary parameters is the stability of the instrument.

For the second time, samples analysis were made by Flame Atomic Absorption Spectrophotometer (A-1800 Hitachi Japan) following specific instrumental conditions given in Table 4. Analysis of each sample was made in duplicate Calibration of the instrument was repeated periodically during operation.

Quality control: All the samples were preserved during the whole analytical procedure from sampling to final

analysis (Cornelis *et al.*, 1994; Gardiner *et al.*, 1988). For the purpose of reliability of the data reference to environmental protection. A number of contamination risks were identified: The eventual leaching from tubes used during sample handling; impurities in the nitric acid and impurities in the internal standard selected.

For the accuracy of the analytical results by Flame Atomic Absorption Spectrophotometer, Citrus Leaves Standard Reference Material (SRM 1572, National Bureau of Standards, Washington) was analysed percent recoveries of analysed metals in the SRM were found to be in the range of 99-105%.

Analysis of Variance was performed, using SPSS Software Version 11.0. Difference between mean values were determined using Tukey's test at $p < 0.05$.

Results and Discussion

Heavy metal contents in spices and medicinal plants depend on climatic factors, plant species, air pollution, and other environmental factors (Sovljanski *et al.*, 1989). In Table 2 are listed medicinal-herbal plants analyzed for trace metals, local name, parts used and medicinal properties. The results of analysis are shown in Table 5 and Figure I & 2.

Table 3. List of studied medicinal plants.

Botinical name	Family	English name	Vernicular name	Part used
Curcuma longa	Zingiberaceae	Tumeric	Hadi	Roots
<i>Syzgium aromaticum</i>	Myrtaceae	Clove	Lounga	Flower buds
<i>Amomum Subultum</i>	Zingiberacea	Large Cardamom	Badi Elaichi	Fruits
<i>Cuminum cyminm</i>	Umbelliferae	Cumin	Zira Safaid	Fruits
Cuminum nigrium	Umbelliferae	Black Carway	Kalajira	Fruits
<i>Piper nigrum</i>	Piperaceae	Black Pepper	Black March	Fruits
<i>Cinnamomum Zeylanicum</i>	Lauracea	Cinnamon	Dalchini	Bark
<i>Myristica fragrans</i>	Myristicaceae	Mace	Javitri	Seeds
<i>Mentha arvensis</i>	Labiatae	Mint	Pudina	Leaves
<i>Eucalyptus citriodora</i>	Myrtaceae	Eucalyptus	Safaidah	Leaves
<i>Azadirachta Indica</i>	Meliaceae	Neem	Neem	Leaves
Cassia fistula	Leguminosae	Cassia	Amaltas	Pods
Coriandrum sativum	Umbelliferae	Coriander	Dhania	Fruits
Cichorium intybus	Compositae	Chicory	Kasni	Seeds
<i>Ricinus communis</i>	Euphorbiaceae	Castor	Arand	Seeds
Ocimum basilicum	Labiteasae	Basil	Niyazbo	Seeds
<i>Glycyrrhizagalbra</i>	Leguminosae	Liquorice	Mulathi	Roots
<i>Foeniculum vulgare</i>	Umbelliferae	Fennel	Saunf	Seeds
<i>Elettaria Cardamomum</i>	Zingiberacea	Small Cardamom	Choti Elliachi	Fruits
<i>Peganum harmala</i>	Zygophllaceae	Syrian rue	Harmal	Seeds
<i>Zingiber officinale</i>	Zingiberaceae	Ginger	Adrak	Fruits
Trachyspermum ammi	Umbelliferae	Bishop's weed	Ajwain	Seeds
Capcicum frutescens	Solanoceae	Chilli	Surkh Mirch	Fruits
<i>Aneilema scapiflorum</i>	Commelinaceae	Musli	Musli Siyah	Seeds
Ziziphus vulgris	Rhamnaceae	Jujube Fruit	Unnab	Fruits
Nigella sativa	Renunculaceae	Black Cumin	Kawanji	Seeds
<i>Mimosa pudica</i>	Leguminosae	Sensitive plants	Lajvanti	Seeds
<i>Syzgium cumin</i>	Myrtaceae	Black Plum	Jaman	Fruits
<i>Aloe barbedensis</i>	Lilliaceae	Aloe	Mosabar	Leaf Pulp
Citrullus colocynthis	Curcubitaceae	Colcynth	Tumba	Fruits
<i>Rheum emodi</i>	Poygonaceae	Rhubarb	Revendchini	Roots
<i>Gymnem sylvester</i>	Asciepiabaceae	God Mar	Gurmar Buti	Leaves
<i>Trapa bispinosa</i>	Onagraceae	Water chestnut	Singhar	Fruits
<i>Cassia absus</i>	Leguminosae	Chaksu	Chaksu	Seeds
<i>Withania coagulans</i>	Soleaceae	Nuts-cooling	Paneer Buti	Seeds

Table 4. Instrumental conditions for heavy trace metals analysis by FAAS.

	Zn	Mn	Cu	Fe
Wavelength (nm)	213.8	279.6	324.8	248.3
Band Pass (nm)	1.3	0.4	1.3	0.2
Lamp Current (m A)	10	7.5	15	10
Fuel Pressure (Kg cm ⁻²)	0.3	0.3	0.3	0.3
Burner Height (mm)	7.5	7.5	7.5	7.5
Calibration Range (mg L ⁻¹)	0.3-3.0	1.0-7.0	0.3-5.0	1.0-10.0
Detection Limit (mg L ⁻¹)	0.01	0.2	0.04	0.4
Flame Composition ^a				
Oxidant Pressure ^b (Kg cm ⁻²)				
Atomizer ^c				
Measurement Mode ^d				

A Air: C₂ H₂; B 1.60; c Standard Burner, d Absorbance

A total of 7 metals (Pb, Cd, Fe, Zn, Ni, Cu and Mn) were determined in the medicinal herbal plant samples by Inductively Coupled Plasma (ICP). Table 5 show the mean concentration of trace metals in the medicinal herbal plants under study. Analytical results shows that the Pb concentration varies between 0.07 to 0.8 ppm in general except for *Beta*

vulgaris Linn., (0.3 ppm). *Datura alba* had the lowest Pb level and *Lagenaria sicerana* the highest. The levels of Pb were comparable in *Zingiber officinale*, *Embllica officinalis*, *Ocimum basilicum*, *Pongamia glabra* and *Abelmoschus esculentus*. The maximum limit of lead prescribed in the local food laws is 0.8 ppm (Marshall,

1998; Sahu *et al.*, 1987). The findings for lead residue in medicinal herbal plants as per present study remained within the stipulated tolerance limits. However, the level lead in *Lagenaria sicerana* Standl and *Beta vulgaris* Linn., samples is higher then permissible limit. Cd concentration varies between 0.05–2.5 ppm with *Beta*

vulgaris Linn., had the highest Cd level and *Azadirachta indica* had the lowest. The permissible limit laid down in the local law for Cd in food stuff is 0.6 ppm (Sadasivam *et al.*, 1987). Accordingly all commodities under study were found to be within permissible limits except for *Lagenaria sicerana* Standl and *Beta vulgaris* Linn., which contain Cd level higher than proposed limit.

The highest level of Fe was found in *Lagenaria sicerana* and lowest in *Mangifera indica*, whereas the Fe concentration varies from 90 to 590 ppm. The Mn concentration varied from 24 to 90 ppm and its values lying in the range of 24-70 ppm. Similar to the case

of Fe *Mangifera indica* contains the lowest level of Mn and *Lagenaria sicerana* contains highest.

The highest level of Ni occurred in *Beta vulgaris* Linn., and the lowest were in *Azadirachta indica*. The Ni concentration varied from 0.2 to 4 ppm in general, except for *Beta vulgaris*. The concentration of Ni is comparable in *Zingiber officinale*, *Datura alba*, *Mangifera indica* and *Abelmoschus esculentus* with a range of 2 to 3 ppm, the same being true for *Ipomoea hederacea* and *Lagenaria sicerana* at 3.2 to 3.5 ppm. The results of present study except for *Beta vulgaris* shows Ni contents well within the permissible limit of 8 ppm.

Table 5. Result of the metal contents from the analyzed samples (ppm).

Plants	Pb	Sigma	Cd	Sigma	Fe	Sigma	Zn	Sigma	Ni	Sigma	Cu	Sigma	Mn	Sigma
1. <i>Mangifera indica</i>	0.19	0.02	0.11	0.02	90.6	1.12	35.57	0.02	2.00	0.03	3.55	0.01	24.5	0.01
2. <i>Andrographis paniculata</i>	0.45	0.01	0.13	0.01	181	0.82	40.58	0.01	1.12	0.01	4.67	0.01	25.3	0.01
3. <i>Datura alba</i>	0.07	0.03	0.06	0.01	242	0.11	32.57	0.01	2.87	0.02	3.65	0.02	25.3	0.02
4. <i>Ipomoea hederacea</i>	0.34	0.02	0.13	0.01	319	11.3	46.09	0.01	3.49	0.03	3.92	0.01	33.8	0.01
5. <i>Ferula foetida</i>	0.78	0.01	0.11	0.01	159	10.6	62.63	0.01	4.00	0.01	7.69	0.01	42.7	0.03
6. <i>Zingiber officinale</i>	0.26	0.01	0.12	0.02	468	2.28	17.54	0.02	2.87	0.01	9.19	0.01	50.9	0.01
7. <i>Allium sativum</i>	0.41	0.03	0.06	0.01	196	1.12	37.58	0.01	4.31	0.06	5.96	0.01	58.0	0.01
8. <i>Lagenaria sicerana</i>	0.71	0.01	0.09	0.02	589	0.02	42.08	0.02	3.21	0.02	9.12	0.05	90.6	0.02
9. <i>Beta vulgaris</i>	0.30	0.01	0.34	0.03	340	1.02	32.57	0.03	1.05	0.03	4.64	0.01	68.5	0.02
10. <i>Ocimum basilicum</i>	0.26	0.01	0.25	0.01	242	0.01	27.56	0.01	0.21	0.01	6.72	0.01	72.9	0.01
11. <i>Pongamia glabra</i>	0.19	0.01	0.13	0.02	385	1.0	47.60	0.02	N.D	ND	4.93	0.02	32.8	0.01
12. <i>Gentiana kurroo</i>	0.09	0.02	0.07	0.02	317	0.02	61.62	0.02	0.61	0.01	7.78	0.02	69.3	0.02
13. <i>Emblica officinalis</i>	0.30	0.01	0.10	0.01	536	10.4	77.15	0.01	0.31	0.03	2.98	0.02	82.5	0.01
14. <i>Abelmoschus esculentus</i>	0.26	0.01	0.16	0.01	521	3.52	56.11	0.01	2.37	0.02	5.63	0.01	71.7	0.01
15. <i>Achyranthes aspera</i>	0.52	0.01	0.13	0.02	264	0.62	17.54	0.02	1.63	0.01	5.88	0.01	76.3	0.01
16. <i>Azadirachta indica</i>	0.56	0.01	0.05	0.02	196	0.02	21.04	0.02	0.12	0.01	4.99	0.01	74.7	0.03

The Zn concentration varied from 17 to 77 ppm, most samples having contents between 30 to 50 ppm. *Zingiber officinale* had the lowest Zn concentration and *Emblica officinalis* the highest. The concentration of Zn was compared in *Beta vulgaris* and *Datura alba*, similarly, between *Ipomoea hederacea* and *Pongamia glabra* in a range of 46 to 48 ppm. The concentration of Cu varied from 2 to 19 ppm. Most of the samples containing Cu level between 3 to 9 ppm, *Lagenaria sicerana* contains the highest level of Cu and *Emblica officinalis* contains the lowest. There is no permissible limit prescribed in local food law or by WHO, however, range of 4-15 ppm for Cu and 15-200 ppm for Zn is considered to be safe. After comparison of the metal limits as proposed, it is found that in the case of Cu except for *Lagenaria sicerana* all other herbs contain Cu level within the proposed limits. In case of Zn all the samples contains level of Zn within the proposed limits.

While for the second time samples collection, Atomic Absorption Spectrometry has been successfully used for the determination of four essential heavy trace metals i.e., Zn, Mn, Fe & Cu in 35 species of medicinal plants commonly used for the treatments of various ailments. Metals levels are given in Table 6.

The results show the presence of variable amount of metals in these medicinal plant samples. In general, the order of concentration of metals in these medicinal plants has been found to be: Fe > Mn > Zn > Cu given in Figure 2. Plant samples of Black Caraway (*Cuminum nigrium*), Cassia (*Cassia fistula*), Coriander (*Coriandrum sativum*), Chicory (*Cichorium intybus*), Castor (*Ricinus communis*), Basil (*Ocimum basilicum*), Bishop's weed (*Trachyspermum ammi*), Musli (*Aneilema scapiflorum*),

Black Cumin (*Nigella sativa*), Sensitive plants (*Mimosa pudica*), Water chestnut (*Trapa bispinosa*), Chaksu (*Cassia absus*) and Nuts-cooling (*Withania coagulans*) contained comparatively higher amount of Zinc (i.e., <50 $\mu\text{g g}^{-1}$) whereas Clove (*Syzygium aromaticum*), Large Cardamom (*Amomum subultum*), Black Pepper (*Piper nigrium*), Cinnamon (*Cinnamomum zeylanicum*), Basil (*Ocimum basilicum*), Small Cardamom (*Elettaria cardamomum*), Fennel (*Foeniculum vulgare*), Syrian rue (*Peganum harmala*), Ginger (*Zingiber officinale*), Bishop's weed (*Trachyspermum ammi*), Musli (*Aneilema scapiflorum*), Black Cumin (*Nigella sativa*), Sensitive plants (*Mimosa pudica*), Rhubarb (*Rheum emodi*), God Mar (*Gymnem sylvestre*), Water chestnut (*Trapa bispinosa*), Chaksu (*Cassia absus*) and Nuts-cooling (*Withania coagulans*). Iron levels in these plant samples were found to be comparatively higher than all other metals investigated but some of the plants including Mint (*Mentha arvensis*), Liquorice (*Glycyrrhiza glabra*), Syrian rue (*Peganum harmala*), Musli (*Aneilema scapiflorum*), Sensitive plants (*Mimosapudica*), Rhubarb (*Rheum emodi*), God Mar (*Gymnem sylvestre*), Chaksu (*Cassia absus*) and Nuts-cooling (*Withania coagulans*) Showed very high Iron contents (i.e., >400 $\mu\text{g g}^{-1}$).

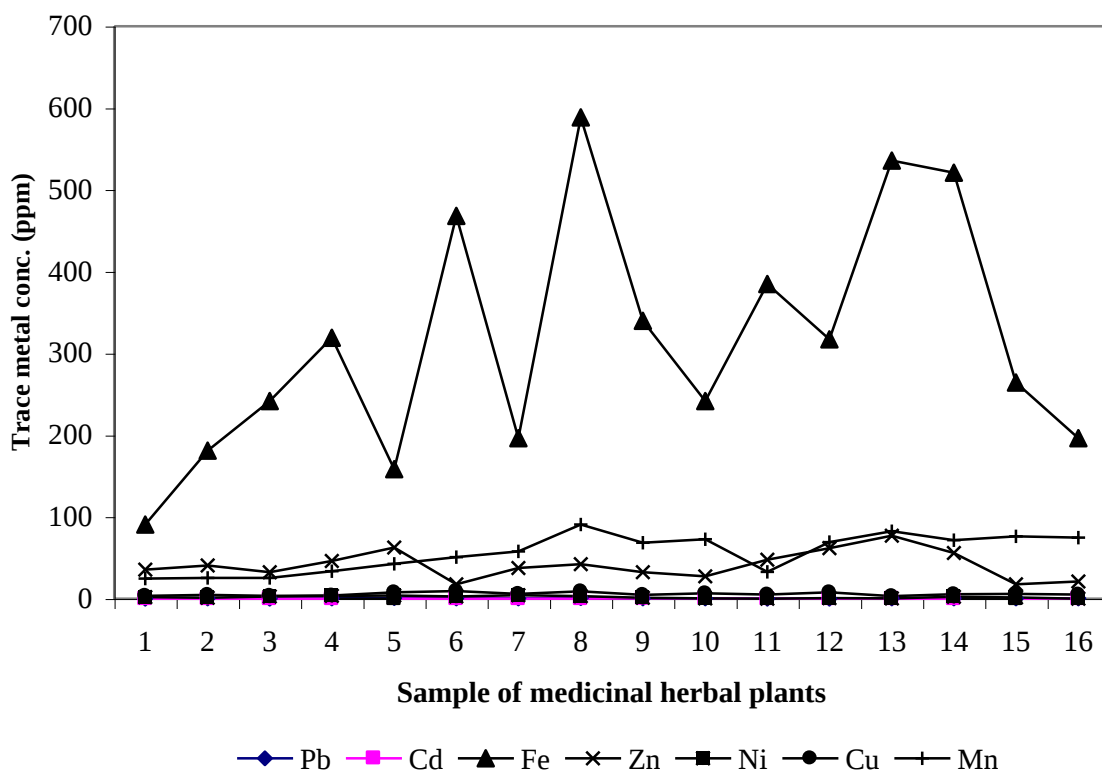


Fig. 1. Plot of trace metals conc. (ppm) vs Medicinal Herbal Plants.

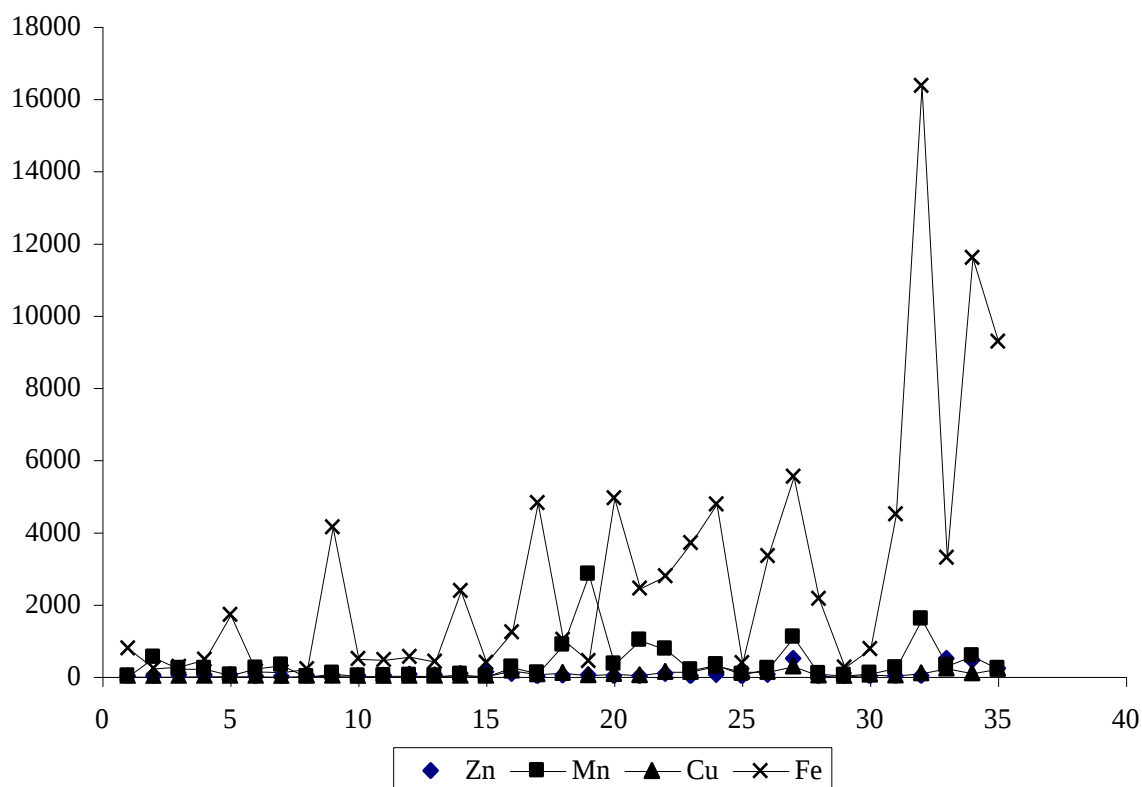


Fig. 2 . Heavy trace metals (Fe, Cu, Mn & Zn) in plants.

Earlier reported data show variation in studies related to the determination of mineral constituents in some medicinal plants of Pakistan. Syed *et al.*, (1987), estimated lead in tumeric by atomic absorption spectrometry. Ahmad *et al.*, (1994) reported the leaves of

major, minor and trace elements in Henna (*Lawsonia intermis*) leaves. Saleem *et al.*, reported the chemistry of the medicinal plants of the genus *Acacia*. They collected about 11 species of this genus and described the medicinal importance in treatments of various diseases.

Table 6. Heavy Trace Metal levels in medicinal plants determined by flame atomic absorption spectrometry [metal concentration * (ug g-1 of the dried plant materials)].

	Zn	Mn	Cu	Fe
Metals detection limits	1.0 (ug g-1)	10 (ug g-1)	4.0 (ug g-1)	40 (ug g-1)
SRM 1572 certified value	29.0 ± 2.0	23.0 ± 2.0	16.5 ± 1.0	90.0 ± 1.3
Determined value	30.4 ± 1.6	23.0 ± 0.6	16.3 ± 0.2	89.0 ± 1.3
% Recovery	105	100	99	99
<i>Curcuma longa</i>	18.3 ± 3.8	16.5 ± 2.2	5.3 ± 0.9	800 ± 103
<i>Syzygium aromaticum</i>	13.3 ± 0.6	539 ± 26	4.7 ± 1.7	235 ± 48
<i>Amomum subultum</i>	45.3 ± 5.2	223 ± 18	14.0 ± 3.3	285 ± 44
<i>Cuminum cyminum</i>	43.0 ± 2.6	228 ± 0.9	17.0 ± 3.7	482 ± 35
<i>Cuminum nigrum</i>	55.6 ± 22.2	43.3 ± 9.5	14.3 ± 2.5	1726 ± 138
<i>Piper nigrum</i>	5.0 ± 5.3	237 ± 3	14.3 ± 1.7	155 ± 69
<i>Cinnamomum zeylanicum</i>	10.0 ± 3.7	323 ± 15	4.0 ± 0.0	129 ± 49
<i>Myristica fragrans</i>	28.0 ± 11.5	4.3 ± 3.4	32.6 ± 4.9	222 ± 44
<i>Mentha arvensis</i>	40.3 ± 4.0	92.5 ± 4.8	30.6 ± 6.0	4144 ± 193
<i>Eucalyptus citriodora</i>	32.3 ± 6.5	19.1 ± 2.7	14.3 ± 2.05	501 ± 15
<i>Azadirachta indica</i>	33.3 ± 9.9	29.5 ± 4.1	BDL	475 ± 23
<i>Cassia fistula</i>	66.3 ± 20.4	35.3 ± 6.8	8.7 ± 2.5	559 ± 14
<i>Coriandrum sativum</i>	51.6 ± 19.4	21.0 ± 0.5	18.0 ± 2.5	424 ± 74
<i>Cichorium intybus</i>	89.6 ± 31.6	67.9 ± 6.6	21.3 ± 3.1	2390 ± 88
<i>Ricinus communis</i>	133 ± 12	14.0 ± 1.0	17.3 ± 0.9	397 ± 81
<i>Ocimum basilicum</i>	83.3 ± 6.2	264 ± 21	179 ± 10	1237 ± 124
<i>Glycyrrhiza glabra</i>	12.7 ± 0.0	107 ± 15	80.4 ± 24.2	4823 ± 1370
<i>Foeniculum vulgare</i>	37.5 ± 3.0	877 ± 85	117 ± 22	1034 ± 293
<i>Elettaria cardamomum</i>	50.6 ± 2.4	2840 ± 112	48.2 ± 20.6	441 ± 61
<i>Peganum harmala</i>	20.5 ± 9.5	352 ± 123	81.0 ± 5.7	4954 ± 684
<i>Zingiber officinale</i>	19.7 ± 1.9	1014 ± 52	49.4 ± 2.7	2457 ± 1110
<i>Trachyspermum ammi</i>	80.6 ± 24.1	771 ± 11	145 ± 27	2792 ± 304
<i>Capicum frutescens</i>	22.8 ± 12.7	194 ± 10	141 ± 34	3708 ± 919
<i>Aneilema scapiflorum</i>	61.2 ± 20.6	330 ± 41	316 ± 315	4782 ± 470
<i>Ziziphus vulgaris</i>	7.5 ± 4.0	67 ± 2	146 ± 34	384 ± 13
<i>Nigella sativa</i>	52.3 ± 4.5	231 ± 19	138 ± 40	3355 ± 333
<i>Mimosa pudica</i>	498 ± 30	1102 ± 99	293 ± 52	5547 ± 947
<i>Syzygium cumin</i>	1.1 ± 0.4	88 ± 9	42.3 ± 21.3	2165 ± 464
<i>Aloe barbedensis</i>	BDL	34 ± 3	BDL	269 ± 127
<i>Citrullus colocynthis</i>	13.6 ± 1.9	98 ± 11	63.7 ± 18.9	779 ± 127
<i>Rheum emodi</i>	16.7 ± 5.2	242 ± 27	33.9 ± 19.9	4507 ± 776
<i>Gymnem sylvestre</i>	33.0 ± 5.2	1599 ± 179	102 ± 24	16373 ± 384
<i>Trapa bispinosa</i>	502 ± 6.0	310 ± 279	232 ± 226	3300 ± 1393
<i>Cassia absus</i>	451 ± 145	582 ± 52	100 ± 25	11613 ± 2691
<i>Withania coagulans</i>	231 ± 253	226 ± 9	230 ± 214	9293 ± 1200

Mean of triplicate measurements ± standard deviation; BDL below detection

Conclusion

In conclusion that the analysis of medicinal herbs/plants in treating various diseases on the regard of their pharmacological action are helpful in regulating their use as certain elements are toxic at elevated levels. Further, it was found that all the studied plants contain good amount of trace elements like Pb, Cd, Zn, Fe, Ni, Cu & Mn etc., which have immunomodulatory functions in human system and the use of various species of herbs in local foods recipes and medicinal preparations is a source of essential trace metal supplements in addition to their antimicrobial characteristics. Therefore, it is suggested that the environment required for growth and synthesis of these plants and the possibility that trace metals are

deposited in the plants cannot be disregarded. Moreover, the Inductively Coupled Plasma is very sensitive instrument for the determination of the trace metals concentration (ppm) reference to the chemical constitutional composition of the medicinal - herbal plants for the daily use by the public of society.

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