Trade Science Inc.

September 2010 ISSN : 0974-7419 Volume 9 Issue 3

Analytical CHEMISTRY

An Indian Journal

Full Paper

ACAIJ, 9(3) 2010 [363-370]

Determination of trace elements in medicinal plants of South India region by flame atomic absorption spectroscopy

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Received: 6th April, 2010 ; Accepted: 16th April, 2010

ABSTRACT

Medicinal plants of south Indian region were investigated for comparison of trace elements by flame atomic absorption spectrophotometer (FAAS). The levels (ppm) of Fe, Mn, Cu, Co, Ni, Zn, Na, K, Mg and Ca in twenty important herbal plants, and soil were estimated by FAAS. Among all the trace elements, the estimated amount of Fe was highest and ranged between 28.3ppm in Ficus Carica to 12979ppm in *Terminalia Arjuna*. The concentration level of Ca was highest among all the micro elements. It ranged between 0.33%-4.4%. The lowest concentration of Ca was found in *Pongamia Pinnata* and highest in *Coleus Forskohlii*.

KEYWORDS

Trace elements;
Medicinal plants;
South India;
FAAS.

INTRODUCTION

Plants have always been an exemplary source of drugs and play an important role in traditional medicine. Medicinal plants are widely consumed as home remedies. The past decade has seen a significant increase in the use of herbal medicine due to their minimal side effects, availability and acceptability to the majority of the population of third world countries. The World Health Organization (WHO) has estimated that about 80% of the global population relies mainly on traditional medicine for primary care and there are reports indicating that about 51% of all drug preparations in industrialized countries derived from plants. Medicinal plants are not only important for pharmacological research but also drug development, and as raw materials for the pharmaceutical industries. Environment, pollution, atmosphere, soil, harvesting and handling are some of the factors, which play an important role in contamination of medicinal plants by metals and microbes. Trace elements have both curative and preventive role in combating diseases. In excess ingestion, these elements would have toxic effects to human body. It is therefore of great interest to establish the levels of metallic elements in common herbal plants.

Metals have been investigated in different plant materials to establish their normal concentration range and evaluate their role in plants as part of human medicinal treatment. In recent years, with enhanced awareness of the importance of trace elements in health and disease, an increasing number of reports on the role of trace elements in traditional medicinal plants have been published. Seven of the most important Egyptian medicinal plants ('Halfa barr' (*Cympobogon proximus*), 'Salam' (*Acacia ehrenbergiana*), 'Kharaaz' (*Acacia albida*), 'Ghalqa' (*Pergularia tomentosa*), 'Argel' (*Solenostemma arghel*), 'Hegleeg' (*Balanites aegyptiaca*) and 'Handal' (*Citrullus colocynthis*)), and the soil in which they were grown were analyzed for minor (Zn, Cu, Se, Mn and Fe) and major elements (K, Na, Ca,

Mg) using flame atomic absorption spectroscopy (FAAS)[1]. Among all metals, Se was reported in very trace level, while Zn in very high concentration. Badri et al.[2], have analyzed metal contents in two dominant plant species viz., *Senna alexandrina* and *Cleome droserifolia*, and soil collected from the eastern desert of Egypt[2]. The results have shown that there was no correlation between the level of metal concentrations in plants and soil. The concentration levels (ppm) of selected trace elements (Fe, Mn, Cu, Pb and Zn) and macronutrients (Na, K, Mg and Ca), along with P, were estimated[3] using AAS in some of the important herbal plants of the southwest part of Nigeria. *Anacardium occidentale* had the highest concentration of Na (613±0.60) while Azadirachta indica had the highest contents of Pb (0.49±0.03) and Mg (5630±12). Seven medicinal plants collected from Egypt such as *Macroptilium atropurpureum*, *Pennisetum glaucum*, *Cyamopsis tetragonolobus*, *Dolichos purpureus*, *Cajanus cajan*, *Cajanus cajan* and *Prosopis juliflora* were chosen to estimate the metals viz., Ag, Au, Cd, Co, Cu, Fe, K, Mn, Mg, Na, Ni, Pb, Sr, and Zn using AAS[4]. While F^-, Cl^- and I^- content were determined by Ion Selective Electrodes. The work demonstrated that elemental metabolism, animal nutrition, toxicological effect and their uses as therapeutic plants. Rai et al.[5] estimated the Co and Mn concentrations in some important medicinal plants collected from different parts of the India and compared the Co and Mn concentration in different locations[5]. A large number of leafy samples of medicinally important plants were collected from Tirupati hills of south India[6]. The samples were dried, grinded, dissolved in conc. HNO_3 and analyzed using inductively coupled plasma-atomic emission spectroscopy (ICP-AES). The concentration levels of metals such as Zn, Cu, Ni, Co, Pb, As, Se, K, Cr, Na, P, S, Fe, Ca Mg, Mn and Fe were estimated. Concentrations of toxic as well as non-toxic trace elements estimated were shown a high degree of biological, seasonal and spatial variability. Curry leaves (*Murraya koenigii*), collected from different states of India, were analyzed for 6 minor (Ca, Cl, K, Mg, Na and P) and 20 trace (As, Ba, Br, Ce, Co, Cr, Cs, Cu, Fe, Hg, La, Mn, Rb, Sb, Sc, Se, Sr, Th, V and Zn) elements using instrumental neutron activation analysis (INAA)[7]. In addition, Ni, Cd and Pb were determined by AAS. Most elements varied over a wide range, depending on geo-environmental factors and local soil characteristics. Fe, Mn, Na, K, Rb, Se and P vary by a factor of 3-5 whereas Br, Cs, Sc, Th and Zn varied by an order of magnitude. Leaves collected from the southern zone were enriched with K, Mg, Mn, Cl and P but depleted in Se. However, leaves from the northern zone were particularly enriched in Ca whereas those from the western zone were enriched with Zn.

Atomic spectroscopic techniques viz., AAS, ICP-AES and ICP-MS are widely used for analysis of trace as well as micro elements. AAS is the most extensively used technique for determination of metal elements in different sample matrices. Generally flame-AAS (FAAS) and graphite furnace AAS (GFAAS) are used depending upon the concentration of the analytes to be determined. The present manuscript describes the estimation of trace levels of Fe, Mn, Cu, Co, Ni, Zn, Na, K, Mg and Ca in twenty medicinal plants and the soil collected from the south Indian region by FAAS. The present investigation compares collected plants and soil samples for the major and trace element contents.

MATERIALS AND METHODS

Sample collection

Plants and the surrounding soil were collected from botanical garden, Osmania University, Hyderabad, a south central part of India in February 2009 and identified according to Bentham Huckar classification.

Sample preparation

The plant samples were harvested at different locations within botanical garden, Osmania University, Hyderabad, India. Sampling has been carried out taking all possible precautions with respect to elemental losses and contamination. The identities, as well as the medicinal properties, of the plant samples under investigation are shown in TABLE 1. The samples were washed with sub-boiled water and allowed to dry in oven for 48 h at 105°C. The samples were then grinded with a Wiley mill for 2 to 5 min and sieved through a 0.5mm diameter sieve supplied with the mill. The pulverized and powdered plant samples were stocked in paper sample bags inside desiccators before analysis.

TABLE 1 : Scientific and local name of the plants, and their medicinal values

Scientific name of the plant	Local name of the plant	Part of the plant	Medicinal value of the plant
Punica Granatum	Dhanimma	Fruit	Cardiovascular protection and treatment of diabetes
Aerva Lanata	Pindikura	Root	Used as demulcent, diuretic, and, in the treatment of cough, headache
Coleus Forskohlii	Pashana beri	Tuberous root	Treatment of heart diseases, glaucoma, asthma and certain types of cancers
Ficus Carica	Medi	Fruit	High nutritive value, laxative activity and, used in Various drug preparations.
Gymnema Sylvestres	Podapathri	Leaves	Used as a stomachic, diuretic, and anti-diabetic remedy, anti-sweetening agent.
Pedilanthus tithymaloides	-----	Whole plant	Anti-inflammatory, antibiotic, antiseptic, anti-hemorrhagic, antiviral, anti tumoral, anticancer and abortive
Centella Asiatica	Saraswathiaaku	Whole plant	Anti-inflammatory ,anticancer activity ,venous hypertension, and anti-lipid peroxidative
Ocimum Sanctum	Thulasi	Leaves	Analgesic, anti-inflammatory, immunemodulatory and antimicrobial activity
Aloe barbadensis Miller	Kalabandha	Leaves	Treatment of wounds, minor burns, skin irritations constipation and diabetes
Acalypha Indica	Pippiaaku	Leaves	Treating pneumonia, asthma, rheumatism and several other ailments
Catharanthus Roseus	Billa ganneru	Whole plant	To relieve wasp stings ,cancer chemotherapy
Terminalia Arjuna	Tellamaddi	Stem bark	Cardio protective activities, urinary discharge, strangury, leucoderma, anemia, hyperhidrosis, asthma and tumours
Adhatoda Vasica	Addasaramu	Leaves	Treating cold, cough, antispasmodic dysentery and glandular tumor
Bryophyllum pinnatum	Ranapala	Leaves	Hypertension , insect bites, arthritis, rheumatism, joint pains and headaches
Ageratum Conyzoides	Mukkupudukala gaddi	Leaves	Anti-inflammatory, Analgesic, Anti-diarrheic and peptic ulcer and leprosy
Oxalis erythrorhiza	Pulichintha	Leaves	Hepatic, heart complains and antimicrobial activity
Pongamia Pinnata	Ganuga	Fruit	Treatment of tumors, piles, skin disease, wounds and ulcers,
Azadirachta Indica	Vepa	Leaves	Jaundice, gonorrhea, urinary tract infection, leprosy and blood purifier
Mangifera Indica	Mamidi	Leaves	Antioxidant, analgesic, anti-Inflammatory and immunemodulatory agent
Eucalyptus	Jamaoil	Whole plant	Blood diseases, inflammation and to treat viper venom

Samples digestion

Digestion of plant samples

One gram of the powdered plant samples were weighed into the 100mL beaker (Borosil) and treated with 5mL of 69% HNO_3. The covered beaker was placed on a heating plate. It was heated until a clear solution was obtained. After an interval of time, beaker cover was removed and the mixture was evaporated to dryness. The residue was diluted slightly with sub-boiled water and filtered through a Whatmann 42 filter paper. The filtered acid extract was diluted with sub-boiled water to 100mL.

Digestion of soil samples

0.5g of air-dried, grinded and sieved (Jayanth Test Sieve, Bombay, India, 151µ Sieve Size) sample had taken in an Erlenmeyer flask. 20mL of extracting solution (0.05 N HCl + 0.025 N H_2SO_4) was added to the flask. Flask was placed in a mechanical shaker for 15 min. The solution was filtered through whattmann 42 filter paper into 100mL standard volumetric flask and make-up to 100mL with water.

Reagents

All reagents were of analytical grade. Sub-boiled water was used in the preparation of samples. Conc. HNO_3 (65%) was obtained from Merk (Mumbai, India) and used for sample preparation. Stock standard solutions of Fe, Mn, Cu, Co, Ni, Zn, Na, K, Mg and Ca containing 1000ppm of each metal, were used. Calibration standards of each element were obtained by appropriate dilution of the stock solutions.

Flame atomic absorption spectrophotometer (FAAS)

The samples were analyzed on flame atomic absorption spectrophotometer (Perkin Elmer Aanalyst 300, USA). Hollow cathode lamps were used for de-

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TABLE 2 : Operating conditions of flame atomic absorption spectrometer

Conditions	Fe	Zn	Cu	Mn	Ni	Co	Mg	Ca	K	Na
Slit width (mm)	0.2	0.7	0.7	0.2	0.2	0.2	0.7	0.7	0.7	0.2
Cathode lamp current (mA)	30	15	15	20	25	30	6	15	20	25
Relative Noise	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Resonance line (nm)	248.8	213.9	324.7	279 .5	232	240.7	285.2	422.7	766.5	589.0
Air flow Liter. min^{-1}	10	12	10	10	10	10	10	10	10	10
Acetylene flow Liter. min^{-1}	1	2	1	3	3	1	1	1	1	1
Read Time (Sec)	2	2	2	5	3	3	3	3	3	3
Read Delay (Sec)	1	1	1	1	1	1	0	0	1	1

tection of Fe, Mn, Cu, Co, Ni, Zn, Na, K, Ca and Mg. The instrument was calibrated with standard solutions using the concentration mode and instrument conditions were given in the TABLE 2. The standard reference materials of all the metals (E.Merck, Germany) were used to provide calibration and quality assurance for each analytical batch. Replicates (n = 3) analyses were conducted to assess precision of the analytical techniques.

RESULTS AND DISCUSSION

In the present study heavy metals viz., Fe, Mn, Cu, Co, Ni, Zn, Na, K, Mg and Ca were estimated by FAAS, in twenty important herbal plants, and soils in which the plants were grown. TABLE 1 lists the scientific identities, local name as well as the medicinal properties, of the plants under investigation. TABLE 2 and 3 give the mean concentrations of heavy metals in the plants and soils, respectively. From the on going study it was revealed that all the metals accumulated to a greater or small extent by all plants species studied. The method was developed by testing linearity, analysis of known samples and validates for real samples. Linearity of the response was determined by using each metal standard solutions of 1.0, 2.0, 5.0, 10.0µg/ml. By plotting absorbance verses its metal concentrations, a linear relationship was obtained. The results were found to be in agreement with an RSD<4% (average of three determinations).

Zinc

Plants absorb Zn as Zn^{2+}. The requirement of Zn by plants is correspondingly small. The content of Zinc ranged between 2.5ppm in *Terminella Arjuna* and 138.97ppm in *Centella Asiatica* (TABLE 3). Zn is widely distributed in soils hence the plant samples contain moderate concentrations of Zn (41.2 on average). The lowest content of Zn was in the soil in which *Pedilanthus Lithimiloidies* was grown and the highest was in the soil in which Ageratum Conyzoides was grown (TABLE 4). The content of Zn in the other soils ranged between 34.4ppm-143ppm. The mean concentration observed in the plants and soils were 41.02 and 69.55ppm, respectively. The physiological activities of the plant influences Zn absorption and the interactions with many elements like Fe, Mn and Cu also affect Zn uptake[8].

Copper

The content of copper ranged between 1.6ppm in *Terminella Arjuna* and 12.9ppm in *coleus forskohlii* (TABLE 3). The lowest content of copper was in the soil in which *Ficus Carica* was grown and the highest was in the soil in which *Ageratum Conyzoides* was grown (TABLE 4). The content of Copper in the other soils ranged between 9.29ppm in *Centella asiatica* and 62.56ppm in *Pongamia pinnata*. Although, *Acalypha Indica* growing soil, the lowest copper content was recorded; the plant tissue has shown to accumulate copper in a considerable amount. On other hand, soils of *Terminalia Arjuna, Pongamia pinnata, Azadirachta indica, Mangifera indica* and *eucalyptus* were having high copper content (60, 62.56, 65.69, 56.55 and 60.03ppm respectively), while the plants have low amount of Cu (1.6, 11.45, 7.04, 6.24 and 3.28ppm respectively. The mean concentration of Cu in plants and soils were 6.62 and 28.22ppm, respectively.

Manganese

The plants absorb manganese as Mn^{+2} from the soils. Mn activates some respiratory enzymes and photosynthetic enzymes. Mg depresses the rate of Mn uptake by plant. The Mn concentration ranged between 5.6ppm in *Ficus Carica* and 252.64ppm in *Catharanthus rosia*. However, the range of Mn in the rest of the examined plants was 14-61 ppm while in soil was 109.01-970.74ppm. The maximum concentration of Mn observed in the *Ageratum conyzoides* and *Oxalis* (970.74ppm and 893ppm, respectively) grown soils and minimum was observed in the *Centella*

TABLE 3 : Concentration of major and trace elements in the plants under investigation

Plant name	Mn	Fe	Zn	Cu	Ni	Co	%Mg	%Ca	%k	%Na
Punica Granatum	58.95±2.3	178.01±3.2	89.59±1.5	5.38±0.5	12.51±0.2	6.25±0.1	2.01	3.263	1.035	3.965
Pedilanthus Lithimiloidies	47.64±2.5	88.92±2.6	59.43±1.1	4.01±0.2	7.63±0.2	3.2±0.1	0.96	3.717	1.735	3.695
Aerva Lanata	26.99±2.6	382.28±	30.90±0.5	5.57±0.1	3.63±0.2	5.4±0.2	0.62	3.211	1.227	1.135
Gymnema Sylvestres	69.57±±3.1	129.72±2.5	22.61±0.4	6.20±0.2	5.61±0.1	5.95±0.2	0.86	2.945	2.114	1.335
Coleus Forskohlii	35.55±1.6	32.63±0.5	73.60±0.9	12.92±0.3	9.90±0.2	11.65±0.2	1.09	4.416	5.099	1.375
Ficus Carica	5.64±1.1	0	33.07±0.7	7.68±0.3	1.10±0.1	6.01±0.2	0.14	1.176	3.832	3.762
Centella Asiatica	18.79±2.1	86.96±1.5	138.97±0.5	6.29±0.2	11.81±0.2	5.25±0.1	1.44	3.626	1.475	2.418
Ocimum Sanctum	21.05±1.2	126.72±2.1	33.12±0.2	11.17±0.1	10.93±0.2	10.52±0.1	0.59	3.046	0.706	5.455
Aloe Vera	9.46±1.1	47.32±0.9	32.63±0.5	5.51±0.2	14.41±0.1	4.1±0.1	0.40	3.178	2.896	4.916
Acalypha Indica	20.38±0.9	179.68±0.8	31.98±0.7	11.14±0.2	14.47±0.1	10.54±0.1	0.69	3.357	3.204	0.318
Catharanthus Roseus	252.67±0.8	38.84±0.5	29.95±0.3	5.94±0.1	7.56±0.1	1.2±0.2	0.62	4.256	3.150	0.848
Terminalia Arjuna	61.81±1.5	12797.41±10.5	2.50±0.1	1.66±0.1	5.31±0.1	2.34±0.1	0.68	2.100	0.200	0.081
Adhatoda Vasica	26.54±1.5	208.72±2.9	38.99±0.5	5.75±0.1	7.31±0.2	0	0.85	3.332	3.577	0.190
Bryophyllum	15.19±0.9	28.80±0.9	31.33±0.6	3.76±0.2	0	1.93±0.1	0.64	0.985	1.956	0.306
Ageratum Conyzoides	13.90±1.1	201.12±2.3	7.82±0.4	7.77±0.2	0	0	1.90	0.511	1.510	2.606
Oxalis	90.76±2.5	196.73±2.5	45.38±0.2	3.73±0.2	0	0	0.98	0.934	4.094	3.735
Pongamia Pinneta	13.27±0.9	13.74±0.6	32.17±0.4	11.45±0.2	0	0	0.89	0.337	0.622	0.101
Azadirachta Indica	18.45±0.5	81.84±1.1	31.25±0.6	7.04±0.1	0	1.2±0.1	0.82	2.056	3.809	0.322
Mangifera Indica	28.99±1.2	53.23±2.4	11.88±0.5	6.24±0.1	0	0.89±0.1	1.20	3.967	1.050	0.352
Eucalyptus	93.20±1.5	107.14±1.4	43.20±0.4	3.28±0.1	5.72±0.2	0.37±0.1	1.50	2.537	1.897	0.744

Asiatica grown soil. No correlation of Mn content was observed between soil and plant species (TABLE 3 and 4) indicates that the plants are selective in accumulating Mn. The concentration of Mn in *Ocimum sanctum, Azadirachta indica* and *Aloe Vera* leaves, which are widely use in Indian Ayurvedic medicine were 21, 18.45 and 9.46ppm, respectively. The mean concentration of Mn in the plants was eight folds lesser than the soils.

Iron

Plants require more Fe than any other micronutrients, because Fe deficiency in leaves lead to the iron chlorosis. Iron chlorosis may result from an absolute Fe deficiency in soil[9]. The content of Fe ranged between 28.3ppm in *Ficus Carica* and 12979ppm in *Terminalia Arjuna* (TABLE 3). However, the range of the Fe in the rest of the plants examined was 13-382ppm. The lowest content of Fe was in which *Bryophyllum* (4055ppm) was grown soil and the highest was in which *Oxalis* (9959ppm) was grown soil (TABLE 4). Except *Terminalia Arjuna*, remaining all plants were having lesser Fe concentration than their soils. Although, *Terminalia Arjuna* growing soil was having low amount of Fe, the plant tissue has shown to accumulate Fe in a considerable amount. The mean concentration of Fe in the plants was nine times lesser than the soils. The suggested Fe requirement for animals is between 30 and 100ppm and the maximum tolerable level for cattle is suggested as 1000ppm[10-12].

Cobalt

The content of Co ranged between 0.39ppm in *Eucalyptus* and 11.65ppm in Coleus Forskolii (TABLE 3), and *Ageratum Conyzoides, Oxalis* and *Pongamia Pinnata* were lie below detection limit. The lowest content of Co was in the soil in which Pongamia Pinnata (3.56ppm) was grown and the highest was in *Ageratum Conyzoides, Oxalis* (12.77ppm) soil (TABLE 4). Although, *Ageratum Conyzoides, Oxalis* and *Pongamia Pinnata* growing soils were having Co, plants were not accumulated the Co. Cobalt requirement for sheep, dairy cattle and beef cattle is 0·1ppm. The maximum tolerable dietary level for animals is estimated at 5ppm[10-12].

Nickel

The content of Ni ranged between 1.10ppm in Fi-

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TABLE 4 : Concentration of major and trace elements in the soils under investigation

Plant name	Mn	Fe	Zn	Cu	Ni	Co	%Mg	%Ca	%k	%Na
Punica Granatum	226.61±4.5	7410.91±10.25	40.57±0.52	11.01±0.21	9.35±0.28	7.8±0.16	0.23	0.497	0.113	0.398
Pedilanthus Lithimiloidies	243.04±3.21	4746.86±6.86	28.36±0.35	11.68±0.221	8.39±0.36	6.9±0.22	0.28	0.709	0.084	0.681
Aerva Lanata	220.31±2.4	4589.70±9.84	36.75±0.45	11.35±0.14	3.15±0.35	5.7±0.15	0.31	0.630	0.183	0.189
Gymnema Sylvestres	277.60±1.52	8478.75±6.51	81.93±0.84	28.61±0.35	11.15±0.22	7.5±0.25	0.71	0.815	0.344	0.811
Coleus Forskohlii	307.43±3.11	9757.49±8.62	40.28±0.46	29.70±0.43	13.74±0.22	8.5±0.33	0.38	0.619	0.289	0.248
Ficus Carica	233.49±2.92	4312.75±5.65	*34.34*±0.58	19.24±0.25	14.07±0.25	6.1±0.34	0.46	0.301	0.302	0.421
Centella Asiatica	109.01±4.13	7311.23±7.14	49.37±0.33	9.29±0.23	12.26±0.23	5.8±0.22	0.34	5.647	0.074	0.516
Ocimum Sanctum	239.54±2.52	7773.02±5.98	91.20±0.55	18.49±0.22	16.33±0.16	9.44±0.18	0.37	3.827	0.064	0.446
Aloe Vera	192.96±3.55	5141.08±4.86	76.28±0.44	14.66±0.23	17.37±0.34	7.4±0.19	0.37	0.482	0.026	0.386
Acalypha Indica	247.32±5.25	7151.90±5.85	41.75±0.39	9.88±0.15	7.72±0.25	6.02±0.16	0.67	7.035	0.290	0.196
Catharanthus Roseus	297.08±6.24	4654.45±5.84	34.82±0.59	15.57±0.26	9.59±0.58	10.17±0.25	0.50	0.635	0.179	0.461
Terminalia Arjuna	347.03±6.26	8955.15±6.15	92.40±0.74	60.70±0.34	29.06±0.49	8.65±0.44	0.48	1.651	0.208	0.528
Adhatoda Vasica	351.72±3.55	9872.75±6.57	45.36±0.67	13.86±0.32	7.63±0.47	11.67±0.3	0.47	0.829	0.133	0.265
Bryophyllum	263.48±2.94	4055.86±6.28	54.10±0.48	12.36±0.25	24.90±0.33	4.59±0.25	0.52	0.589	0.157	0.648
Ageratum Conyzoides	970.74±5.68	9001.40±3.94	151.00±0.89	26.66±0.28	23.14±0.35	12.77±0.21	1.14	0.499	0.381	0.665
Oxalis	893.45±4.5	9959.03±8.52	*143.48*±2.25	26.60±2.21	14.36±0.22	12.77±0.36	0.61	0.496	0.223	0.331
Pongamia Pinnata	151.29±3.5	8205.74±6.54	92.29±3.56	62.56±2.31	12.99±0.32	3.56±0.25	0.36	0.560	0.092	0.132
Azadirachta Indica	157.14±2.9	8610.21±8.54	86.58±4.42	65.69±2.54	20.89±0.24	5.07±0.56	0.49	0.417	0.160	0.334
Mangifera Indica	826.72±6.5	8001.39±6.98	91.80±3.51	56.55±3.56	16.14±0.31	5.95±0.35	0.83	0.513	0.198	0.265
Eucalyptus	648.58±4.5	8668.50±6.58	78.49±4.56	60.03±2.34	14.69±0.21	9.66±0.45	0.65	0.438	0.223	0.397

cus Carica and 14.41ppm in *Acalypha indica* and *Aloe Vera* (TABLE 3), and *Bryophyllum, Ageratum Conyzoides, Oxalis,* and *Pongamia Pinnata* were lie below the detection limit. Lowest content of Co was in the soil in which *Aerva Lanata* (3.15ppm) was grown and the highest was in the soil in which *Terminalia Arjuna* (29.06ppm) was grown (TABLE 4). Except *Punica granatum*, remaining all plants were having lesser Fe concentration than their soils. The mean concentration of Ni in the plants and soils were 5.9 and 28.22ppm, respectively.

Potassium

Potassium has highest concentration in the leafy materials than other nutrients, as it is an activator of some enzymes. One main feature of K^+ is the high rate at which it is taken up by plant tissues. Usually the absorption of K depends on the soil type. The Concentration of K ranged between 0.2%-5.09% (TABLE 3). The lowest concentration of K appeared in *Terminalia Arjuna* and highest concentration in *Coleus Forskohlii*. All the studied plants showed high K contents. The K requirement for animals is from 0·5 and 0·8% K and the maximum tolerable level is 3% K of dry matter[10]. The mean value of calcium level in all studied plants (2.49%) is near the maximum dietary level (TABLE 3).

Calcium

Ca is abundant in most soils. Generally the concentration of Ca^{+2} in soil solution is Several times higher than that of K^+. The uptake rate of Ca^{+2}, however, is usually lower than that of K^+. This low Ca^{+2} uptakes potential occur because Ca^{+2} can be absorbed only by young root tips in which the cell walls of the endodermis are still unsuberized[10]. Among all the macro elements, the amount of Ca is high. The concentration of Ca ranged between 0.33%-4.4% (TABLE 3). The lowest concentration of Ca appeared in *Pongamia Pinnata* and highest concentration was in Coleus Forskohlii. Except *Centella asiatica, Ocimum sanctum* and *Acalypha indica*, the amount of Ca in the all plants is higher then the amounts of Ca in the soil in which plants are growing. The maximum level is 2% of diet dry matter[9]. The mean value of calcium level in all studied plants

TABLE 5 : Comparison of heavy metals (ppm) in *Azadirachta indica*

Element	This study (2009)	Reddy and Reddy et al. (1997)	Isiaka Ajani Ogunwande et al. (2004)
Cu	7.04	39.88	1.12
Zn	31.25	21.35	15.7
Ni	0	4.087	-
Co	1.2	1.318	-
Mn	18.5	11.23	46.5
Fe	81.84	-	188
Na	0.3%	-	138
K	3.8%	-	19220
Ca	2.05%	-	3543
Mg	0.82%	-	5630

(2.49%) is near the maximum dietary level (TABLE 3). Ca requirement for cattle (0·18-1·04%), lactating dairy cows (0·45-0·60%) and for sheep and goats (0·21-0·52%). The maximum tolerable level of Ca is 2% of diet dry matter[10].

Magnesium

Generally, the concentrations of Mg^{2+} in soil is higher than that of K^+ but the uptake of Mg^{2+} by root cells is much lower than the uptake of K^+. The level of Mg in plants depends to a large extent on soil type. Although, the uptake of Mg is low, our medicinal plants contain 0.94% of Mg on average (TABLE 3). The magnesium concentration ranged between 0.14 % in *Ficus Carica* and 2.1% in *Punica granatum*. Although the average of Mg contents in the soils were small (0.51%), the studied plants showed high concentration of Mg. A magnesium concentration of 0.2 in plants is commonly regarded as the minimum "safe" dietary concentration for adequate animal health[13].

Sodium

The range of sodium in the studied plants was high with a minimum of 0.081% in *Terminalia Arjuna* and a maximum of 5.4%in *Ocimum Sanctum* (TABLE 3). Although the range of sodium contents in the soils were small (0.132%-0.811%), the studied plants showed high concentration of it (TABLE 4). This may be due to increasing the osmotic pressure to obtain their water requirement[15].

The comparison of trace elements in *Azadirachta indica*, reported by Reddy and Reddy[6] and Ogunwande et al.[3] with our study is given in the TABLE 5. Rai et al.[5] reported the Co and Mn metals concentration in the nine important medicinal plants (including *Coleus Forskohlii*) of indigenous systems collected from different parts of the India. The comparison of Co and Mn, in the *Coleus Forskohlii*, reported by Rai et al.[5] with our study is given in the TABLE 6. Ogunwande et al.[3] have reported concentration of trace metals i.e. Zn, Cu, Fe, Mn, Na, K, Mg and Ca in the *Mangifera indica*. The comparison of trace metals in *Mangifera indica* is given in the TABLE 7.

TABLE 6 : Comparison of heavy metals (ppm) in *Coleus Forskohlii*

Element	This study (2009)	V.Rai et al. (2001)
Co	5.77	4.08
Mn	35.55	26.58

TABLE 7 : Comparison of heavy metals (ppm) in *Mangifera indica*

Element	This study (2009)	Isiaka Ajani Ogunwande et al. (2004)
Zn	11.88	3.24
Cu	6.24	3.07
Fe	53.23	46.6
Mn	28.99	133
Na	0.352%	43.6
K	1.050%	7470
Mg	1.20%	1372
Ca	3.967%	18810

CONCLUSION

The present study gives a new picture about the presence of some major and trace elements in some indigenous medicinal plants and the soils they were grown. The differences in the concentrations of the elements are not attributed to the composition of the soil in which the plant grows, but may depend on the interactions of elements or the plant genotype. The lowest Zn concentration was found in *Terminalia Arjuna* (2.5ppm) and highest was found in *Centella Asiatica* (138.97ppm) where as lowest Zn concentration was found in *Pedilanthus Lithimiloidies's* soil and highest was found in *Ageratum Conyzoides's* soil. The lowest Cu concentration was reported *Terminalia Arjuna* (1.6ppm) and highest was reported in *coleus forskohlii*

(12.9ppm) whereas lowest concentration of Cu was reported in *Ficus Carica's* soil and highest was reported in the *Ageratum Conyzoides's* soil. Among all the trace elements, the amount of Fe is high in the plants and soils. The concentration of Fe ranged between 28.3ppm in *Ficus Carica* and 12979ppm in *Terminalia Arjuna*. Among all the macro elements, the amount of Ca is high. The lowest concentration of Ca appeared in *Pongamia Pinnata* and highest concentration in *Coleus Forskohlii*. The range of sodium in the studied plants was high with a minimum of 0.081% in *Terminalia Arjuna* and a maximum of 5.4% in *Ocimum Sanctum.* The results indicated that the herbal plants contain large amounts of nutrients and are rich in Fe, Mg, Ca, Na and K. The abundance of Fe, K, Na, Mg and Ca, in the result of this analysis, was in agreement with previous findings that these five metals represent the most abundant metal constituents of many plants[16,17]. This study indicates that some of these plants accumulate certain elements, and this property is exploited by the use of these plants for medicinal purposes in addition to their bioactive secondary metabolites constituents. The elucidation of element specification in these plants helps interpret the therapeutic actions and may help in designing chemically pure medication.

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