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QUANTIFICATION OF HEAVY METALS AND MINERALS IN SELECTED INDIAN MEDICINAL PLANTS USING ATOMIC ABSORPTION SPECTROPHOTOMETER

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ABSTRACT

Medicinal plants form the basis of sophisticated traditional medicine system that has been in existence for thousands of years, which continue to provide mankind with new remedies. Herbal plants are consumed worldwide for the treatment of several diseases and such plants are the important source of raw material for pharmaceutical industries. As a micronutrient, heavy metal plays an essential role in proper functioning of vital organs in the human body. The main objective of the present study is to quantify the non-essential heavy metals like As, Cd, Cu, Hg and Pb and essential Minerals like Fe, Mg, Mn, Na & Zn in some selected medicinal plants using Atomic Absorption Spectrophotometer. The concentration levels (mg/l) of trace elements in selected medicinal plants were estimated by wet digestion method. The whole plant, tuber part, root , leaf, bark and seeds of 20 different medicinal plants such as *Indigofera tinctoria, Oldenlandiaumbellata, Acalpa indica, Indigofera aspalathoids ,Eclipta alba* etc., were used for the analysis purpose. The results were compared with the safety standards established by the World Health Organisation (WHO). The acceptance criteria levels in most of the medicinal plants were within the safe limits.

KEYWORDS: **Atomic Absorption Spectrophotometer, Medicinal Plants, Heavy Metals, Minerals.**

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INTRODUCTION

India is a home to a great variety of ethno medicinally important plant species. The basic resources of medicines come from nature and they are used as medicaments from ancient time to present day. People around the world possess unique knowledge about the natural resources. The traditional medicines cater about 85% of the world population for their health needs. It is essential to maintain safety, quality and efficacy of the plant and their products to avoid and serious health problems. Pharmacological evaluation of the medicinal plant and products has been recommended for the purity and quality of the drugs coming from the botanicals[1]. The phrase 'Heavy metals Contaminants refers to the unwanted presence of heavy metals in medicinal plants which might have come into plants inadvertently before, during or after processing of medicinal plants. Contamination may occur through soil, water, air, industrial pollution agricultural technology and plant processing[2]. Medicinal herbs are easily contaminated by metals and microbial growth during growth, development and processing due to factors such as environment, pollution, atmosphere, soil, harvesting and handling. 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[3].

While some inorganic elements such as iron, sodium, magnesium etc., are essential for man, the same elements can cause ill effects when consumed at higher concentration levels. Metals like As, Cd, Cu, Hg and Pb, are found to cause deleterious effects even at low levels. Such toxic metals cause health problems when consuming the plants contaminated with heavy metals. So, to avoid harmful effects, monitoring the heavy metals in medicinal plants is therefore of great importance. The metals like copper, lead, and cadmium have no beneficial effects and they are highly toxic to living organisms. Detection of toxic heavy metal contaminants like arsenic and cadmium has to be recommended for safety of the botanicals [2, 4, 5]. WHO in 1997, developed draft for guidelines for methodology on research and evaluation of traditional medicine. The contributions of medicinal plants in the traditional system of medicine for curing diseases have 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 21st century [5].

WHO recommends that medicinal plants, which form the raw materials for the finished products, has to 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 [6]. The methods for determining the toxicity and heavy metal contamination in medicinal plants and their drugs by traditional methods is problematic. Atomic absorption spectrophotometry is the technique enabling individual elements to assay. The aim of the study is to estimate the amount of toxic metals present in the selected medicinal plants and parts, which are traditionally used herbs[7].

MATERIALS AND METHODS

Sample collection

Medicinal plants (Table.3) were procured from Mazhilam Herbal garden of Salem and collected from Kolli hills, Tamil Nadu, India. After cleaning the medicinal plants, plant parts were washed in fresh running water to remove dust, dirt and possible parasites. Then treated with deionised water, dried in shade and powdered. The powdered materials were directly subject to analysis. Results were expressed on fresh weight basis, test sample weights were recorded before and after drying. During

estimation of of Cu, Mn, Zn, Fe, etc. contamination of test sample has to be avoided while drying, grinding and sieving machinery.

Reagents and standards

Analytical grade nitric acid, hydrochloric acid and hydrogen peroxide (Merck, India) were used as received. Standard sample solutions of As, Cd, Cu, Hg, Pb, Mn, Fe, Mg, Zn, and Na (1000 mg/ml) were obtained from Merck (Germany). All the solutions were prepared using triply distilled water.

Sample preparation

Wet oxidation

These procedures are applicable to a wide variety of samples and elements. The general procedure given below is suitable for most determinations.

Procedure

Accurately weigh 5gm test portion, dried and ground, into 150 mLkjedhal flask. Add 10 mL HNO_3. and let soak thoroughly. Add 3 mL 60% $HCLO_4$ and heat on hot plate, slowly at first, until frothing ceases. Heat until HNO_3 is almost evaporated. If charring occurs, cool, add 10 mL HNO_3, and continue heating. Heat to white fumes of $HCLO_4$. Cool, add 10 mL HCL(1+1), and transfer quantitatively to 250 mL volumetric flask. Prepare a blank at the same time, nitric acid even in traces must be remove before proceeding for assay of metals. The commonly used oxidants are nitric acid, sulphuric acid, perchloric acid and hydrogen peroxide. As each of them possesses inherent advantages, use of mixtures containing two or more of the above reagents is recommended.

Analytical procedure

Heavy metals like Cd, Cu, Pb and Minerals like Fe, Na, Mg, Mn and Zn, in plant samples were analysed using atomic absorption spectrophotometer (AA 6300, Shimadzu, Japan) equipped with flame and graphite furnace. The metals like As and Hg was estimated by atomic absorption spectrometry (AAS) using Hydride Vapour Generator. AAS uses the phenomenon that atoms in the ground state absorb light of a specific wavelength; characteristic of the particular atom, when the light passes through an atomic vapour layer of the element to be determined. Air-acetylene flame was used for determination of metal content. The instrument was operated with the following conditions in flame mode of fuel gas acetylene 1.8 L/min to 2.2 L/min with supported gas (15 L/min) and carrier gas (argon) as per instrumental set up, The absorption wavelength for the determination of each metal together with its linear working range and correlation coefficient are given in Table 1

RESULTS AND DISCUSSIONS

The list of medicinal plants used is given in Table 2. The results of heavy metal and mineral contents present in medicinal plants are given in Tables 4 and 5, respectively and in Figures 1 and 2.

Arsenic

Arsenic content was variable among the whole plant species. The maximum concentration of As was 458.74 ppb in Plumbago zeylancia and minimum concentration was estimated as 16.22 ppb in Achyranthes aspera. Arsenic is reported to cause hypertension, peripheral Arteriosclerosis, skin diseases and neurotoxicity [8,9,10]. Arsenic affects oxidative phosphorylation, endothelial damage, and loss of capillary integrity, capillary leakage and volume loss. The level of As was lower in all medicinal plants hence the values are within the WHO permissible limit (1 mg/ kg).

Cadmium

Acute or chronic exposure of cadmium causes respiratory distress, lung and breast cancers, haemorrhagic injuries, anaemia and cardiovascular disorders [11, 12, 13]. High blood pressure and kidney disease damages nerve cells. Cadmium is used in batteries, pigments, fertilizers, detergents and it is present in refined petroleum products. Cadmium concentration ranged as 0.81 ppm in Eclipta alba and 0.13 ppm in Indigofera aspalathoides. The

permissible limit set by FAO/WHO (1984) in edible plants was 0.21 ppm. However, for medicinal plants the permissible limit for Cd set by WHO 0.3 ppm. Consuming lower concentration of cadmium over a long period may lead to health Problem. In the present study, out of 20 medicinal plants samples 11 plants like Indigofera tinctoria, Eclipta alba, Melothria maderaspatana, Achyranthes aspera, Citrullus colocynthis, Strychno sepotatorum, Asparagus racemosus, Glycyrrhiza glabra, Plumbago zeylancia, Salacia Oblonga and Lannea coromandelica samples were quantified the Cd concentration levels which exceeds the WHO limit i.e., > 0.3 µg/g.

Copper

Copper is an essential enzymatic element, which is necessary for normal biological activities of amino oxides and tyrosinase enzyme. Tyrosinase is the enzyme that is required for catalytic conversion of tyrosine to melanin, which is a vital pigment located beneath the skin, and thus protects the skin from dangerous radiations[14]. Copper normally finds its way into drinking water from copper pipes, as well as additives designed to control algal growth. The minimum content of Cu 4.07 ppm was in Corallocarpus epigeous and maximum concentration was estimated as 21.48 ppm in Asparagus racemosus. It is also essential for normal plant growth and development but it can be toxic at excessive levels. Metal fumes causes fever with flue like symptoms, hair and skin discoloration. Phytotoxicity can occur if its concentration in plants is higher than 20- 100 ppm DW (dry weight). The estimated copper values of all medicinal plants were within the limits.

Mercury

Achyranthes aspera exhibits higher Hg concentration that is, 63.12ppb and Oldenlandia umbellate possess minimum concentration of Hg is 3.44ppb. At high concentrations, vapour inhalation produces acute necrotizing bronchitis, pneumonitis, and death. Long-term exposure affects central nervous system. Mercury causes neurological disorders, paralysis, digestive tract inflammation, uraemia, acrodynia and immunotoxicity[15]. The permissible limit set by FAO/WHO (1984)[16] in edible plants was 0.21 ppm. However, for medicinal plants the permissible limit for Hg set by WHO 0.3 ppm. Consuming lower concentration of mercury over a long period may lead to health Problem. Hence in the 20 medicinal plants samples 12 plants like, Indigofera aspalathoides, Melothria maderaspatana, Achyranthes aspera, Citrullus colocynthis, Strychno sepotatorum, Asparagus racemosus,etc., samples were quantified Hg concentration levels exceeding the WHO limit 0.020 ppm.

Lead

Lead has been shown to have toxic impact on a variety of metabolic processes essential to plant growth and development, including photosynthesis, transpiration, DNA synthesis, and mitotic activity[17]. Sources of lead are metal smelting, pigments, lead battery manufacturing and lead contaminated petrol. In soil lead tightly binds itself to organic soil particles which may decrease the mobility of lead in most soils and may reduce uptake[2, 15, 18, 19]. It has been suggested that the mobility of lead and copper is greater in sandy soils, which tend to lack organic matter. All the plant samples had concentration exceeding the WHO limit i.e., >10.0 µg/g reported for medicinal plants[20],Lead content was estimated in medicinal plant Indigofera tinctoria which shows higher Pb concentration about 27.97ppm and Achyranthes aspera possess minimum concentration of Pb that is, 13.85ppm. The permissible limit set by FAO/ WHO (1984) in edible plants was 0.43 ppm. However, for medicinal plants the limit was 10 ppm set by plants with those proposed by WHO.

Iron

Iron is an essential element for human beings and animals. It 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. 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[21]. All medicinal plants show moderate accumulation of Iron. Iron in the studied plants was with a minimum of 140.33 ppm in Asparagus racemosus and maximum of 1796.68 ppm in Plumbago zeylancia, but this concentration is not toxic. However, for medicinal plants the WHO (2005) limits not yet been established. Iron is necessary for the formation of hemoglobin and plays an important role in oxygen.

Sodium

Sodium is a mineral element and plays a important role in the human body. It controls the volume of fluid in the body and helps maintain the acid-base level. When sodium level in the blood is too low is dangerous and can cause seizures and coma. Very high sodium levels can lead to seizures and death. The highest concentration of sodium was recorded as 411.27 ppm in Indigofera aspalathoids and lowest content is 9.49ppm was in Glycyrrhiza glabra. All plants show moderate accumulation of Na.

Magnesium

Magnesium deficiency in humans caused muscle spasms, and has been associated with a high blood pressure, many cardiovascular diseases, diabetes and steoporosis. The necessary daily intake is 350 mg/day for men and 300 mg/day for women. The highest concentration of magnesium was recorded as 558.79 ppm in Eniocostemma littorale and lowest content is 34.07 ppm was in Mucuna Prurita.

Manganese

Manganese ranges about 8.49 ppm in Oldenlandia umbellate and 403.11ppm in Mucuna Prurita. For medicinal plants the WHO (2005) limits not yet been established for Mn. Manganese (Mn) is an essential trace element. It plays a pivotal role in the normal growth, skeleton formation and normal reproductive function. The major sources of manganese in soil are fertilizers, sewage sludge and ferrous smelters. The permissible limit for plants is estimated as 200 ppm. The maximum concentration of Mn, as 558.79ppm in Enicostemma littorale and the minimum concentration of 34.07ppm in Mucuna Prurita.

Zinc

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 has been well known to be an important trace element as a cofactor for insulin. zinc ranged as 1.08 ppm in Oldenlandia umbellate and 28.06ppm in Strychnos potatorum. Whereas the recommended daily dietary intake of zinc stands at about 15 mg. The dietary limit of Zn is 100 ppm[22]. Major sources of zinc in atmosphere are due to its use in zinc batteries and also it's widely use in furniture.

Table-1
Optics and Operating Parameters for Heavy metals and Mineral

Element	Lamp Current Low (Peak) (m A)	Absorbance Wavelength (nm)	Slit Width (nm)	Gas Flow Rate Setup (L/Min)		Correlation Coefficient (r)
				Fuel Gas	Support gas	
Heavy Metals						
As	12	193.7	0.7	2.0	15.0	0.9797
Cd	8	228.8	0.7	1.8	15.0	0.9997
Cu	6	324.8	0.7	1.8	15.0	0.9994
Hg	4	253.7	0.7	1.8	15.0	0.9993
Pb	10	283.3	0.7	2.0	15.0	0.9995
Minerals						
Fe	12	248.3	0.2	2.2	15.0	0.9995
Na	12	589.0	0.2	1.8	15.0	0.9999
Mg	8	285.2	0.7	1.8	15.0	0.9994
Mn	10	279.5	0.2	1.8	15.0	0.9999
Zn	8	213.9	0.7	2.0	15.0	0.9999

Table -2
List of Medicinal Plants

S.NO	Sample Code	Botanical Name, Family, Siddha /Tamil Name
1	MP01-IT	Indigofera tinctoria*, Fabaceae,* Averi
2	MP20-OU	Oldenlandia umbellate*, Rubiaceae,* Impural
3	MP04-AI	Acalypha indica*, Euphorbiaceae,* Kuppaimeni
4	MP16-IA	Indigofera aspalathoides, *Fabaceae*, Sivanaar vembu
5	MP15-EA	Eclipta alba*, Asteraceae*, Vellaikarisalai
6	MP18-EL	Eniocostemma littorale, *Gentianaceae*, Vellarugu
7	MP17-AB	Aristolochina bractelata, *Aristolochiaceae,* Aadutheendapalai
8	MP12-MP	Melothria maderaspatana, *Cucurbitaceae,* Musumusukkai
9	MP10-AA	Achyranthes aspera, *Amaranthaceae,* Naayuruvi
10	MP03-MP	Mucuna Prurita*, Papilionaceae,* Poonaikali
11	MP06-SV	Strychnosnux-vomica, *Loganiaceae;Strychnaceae*, Yettikottai
12	MP08-CC	Citrullus colocynthis, *Cucurbitaceae*, Kumatti
13	MP19-SP	Strychno potatorum, *Loganiaceae;Strychnaceae,* Thetrankottai
14	MP02-CE	Corallocarpus epigeous, *Cucurbitaceae,* Aagasakarudam
15	MP05-MJ	Mirabilis Jalapa, *Nyctaginaceae,* Andhimalligai
16	MP11-AR	Asparagus racemosus, *Asparagaceae*, Thanneervittan kizhangu
17	MP14-GG	Glycyrrhiza glabra, *Papilionaceae; Fabaceae*, Adhimaduram
18	MP07-PZ	Plumbago indica, *Plumbaginaceae*, Chitramoolam
19	MP13-SO	Salacia Oblonga*,Hippocrateaceae;Celastraceae,* Ponkoranti
20	MP09-LC	Lannea coromandelica, *Anacardiaceae*, Odiyan

Table -3
List of Medicinal Plants and Parts & Uses

Botanical Name & Family	Parts used	Medicinal uses/Actions
Indigofera tinctoria Fabaceae	Whole plant	Antiseptic, hepatoprotective, hypoglycaemic, nervine tonic. Used in enlargement of liver and spleen, skin diseases, leucoderma, burns, ulcers, piles, nervous disorders, epilepsy, asthma, lumbago, gout.
Oldenlandia umbellate *Rubiaceae*	Whole plant	Action-Leaves and roots-used in bronchitis, asthma, consumption. The plant gave anthraquinone derivatives. The root gave alizarin, rubichloric acid and ruberythric acid anthraquinones. Purpurin, pupuroxanthin carboxylic acid, present in Madder (Rubia tinctorum), are almost entirely absent.
lypha indica *horbiaceae*	Whole plant	Plant-emetic,expectorant(used in bronchitis, asthma, pneumonia). Tincture of fresh plant is used in homoeopathy for incipient phthisis with bloody expectorations, emaciation and rterial haemorrhagemetic expectorant (used in bronchitis, asthma, pneumonia) Action-Antibacterial (leaf used in scabies)
Indigofera aspalathoides *aceae*	Whole plant	Used in psoriasis and erysipelas. Antileprotic, antitumour, anti-inflammatory.
Eclipta alba *Asteraceae*	Whole plant	Deobstruent, antihepatotoxic, anticatarrhal, febrifuge. Used in hepatitis, spleen enlargements, chronic skin diseases. Leaf-promotes hair growth. The whole plant shows effect on liver cell regeneration. The plant is also reported to be effective in the treatment of peptic ulcer, inflammatory diseases, including rheumatoid arthritis, diseases of the gallbladder and skin infections.
Eniocostemma littorale *ıtianaceae*	Whole plant	The plant is used as a substitute for *Swertia chirayita*, and is reported to be effective against malaria. The plant contains ophelic acid which is also present in chiretta as a hydrolytic product of chiratin. The root extract showed anti-malarial activity both *in vitro* and *in vivo*. Bitter tonic, carminative, blood purifier, antirheumatic, anti-inflammatory, antipsychotic, anthelmintic, cardio stimulant glucosides- swertiamarin, a triterpene betulin[23].
Corallocarpus epigaeus *urbitaceae*	Tuber	Laxative. Root used during later stages of dysentery and chronic mucous enteritis; also in syphilitic rheumatism. The herb shows no apparent effect on acute dysentery.
Mirabilis jalapa Linn *taginaceae*	Tuber	Tuber-used as a poultice on carbuncles. Root—mild purgative, spasmolytic. The tuberous rootswere erroneously thought to be the source of jalap. The plant is used for its antitumour and virus-inhibitory activity.
Botanical Name & Family	**Parts used**	**Medicinal uses/Actions**
Asparagus racemosus wild. *aragaceae*	Tuber	The roots of *Asparagus racemosus* (Shatavari) are fleshy, whitish-brown in colour, slightly sweet in taste, emollient, cooling, nervine tonic and possesses rejuvenating, carminative and aphrodisiac properties. Different scientific studies have proved its efficacy in a number of physical and mental ailments[24]. Used as a galactagogue and for disorders of female genitourinary tract; as a styptic and ulcer-healing agent; as an intestinal disinfectant and astringent in diarrhoea; as a nervine tonic, and in sexual debility for spermatogenesis. Along with other therapeutic applications, *The Ayurvedic Pharmacopoeia of India* indicates the use of the tuberous root in gout, puerperal diseases, lactic disorders, haematuria, bleeding disorders and also recommends it for hyperacidity.
Aristolocohina bractelata *Aristolochiaceae*	Leaf	Oxytocic, abortifacient emmenagogue. Leaves and fruit contain ceryl alcohol, aristolochic acid and beta-sitosterol. Aristolochic acid is insecticidal, oisonous, nephrotoxic. Leaf juice— vermifuge.
Melothria maderaspatana *Cucurbitaceae*	Leaf	Tender shoots—gentle aperient, diuretic, stomachic.
Achyranthes aspera *Amaranthaceae*	Leaf	Astringent, pectoral (ashes of the plant used in asthma and cough), diuretic, hepatoprotective, emmenagogue haemostatic. The plant juice and ash are used for treating bleeding piles. *Achyranthes aspera* L. (Amaranthaceae) is distributed as weed throughout India, tropical Asia and other parts of the world. Ayurvedic, Yunani practitioners and Kabirajes use different parts of the plant to treat leprosy, asthma, fistula, piles, arthritis, wound, insect and snake bite, renal and cardiac dropsy, kidney stone, diabetes, dermatological disorders, gynecological disorders, gonorrhea, malaria, pneumonia, fever, cough, pyorrhea, dysentery, rabies, hysteria, toothache etc. The plant is a popular folk remedy in traditional system of medicine throughout the tropical Asian and African countries. The plant is reported to be usedasantimicrobial,larvicidal,antifertility,immunostimulant,hypoglycemic, hypolipidemic, anti-inflammatory, antioxidant, diuretic, cardiac stimulant, antihypertensive, anti-anasacra, analgesic, antipyretic, antinoiceptive, prothyrodic, antispasmodic and hepatoprotective. Phytochemical investigations revealed the presence of sterols, alkaloids, etc from different parts of the plant[24].
Citrullus colocynthis *Cucurbitaceae*	Seeds	Dried pulp of ripe fruit— cathartic, drastic purgative, irritant and toxic. The pulp is used for varicose veins and piles. A paste of root is applied to various inflammations and swellings. The cataplasm of leaves is applied in migraine and neuralgia.
Mucuna prurita *Papilionaceae; Fabaceae.*	Seeds	There are many researches and clinical trials indicating Mucuna herb as a very effective nervine tonic and a mild aphrodisiac. Mucuna has also been reported assisting in normal nerve cell function. It contains active constituent alkaloids such as mucanine, pruridine, tannic acid, resin, lecithin and L-dopa. According to ancient Indian medicinal science, *Mucuna* carries important properties to enhance the libido and therefore, the drug has been used as an aphrodisiac. Mucuna is still in use to increase libido in both men and women due to its dopamine inducing actions. Dopamine has a sound influence

		on sexual function
Strychno potatorum *Loganiaceae; Strychnaceae*	Seeds	Seed - antidiabetic, antidysenteric, emetic. Mannogalactan from seeds reduces cholesterol andtriglycerides). Seeds are also applied to abscesses, and venereal sores (internally in gonorrhoea). Seed used in dysuria, polyuria, urolithiasis, also in epilepsy.
Strychnosnux-vomica *Loganiaceae; Strychnaceae*	Seeds	Used in emotional disorders, insomnia, hysteria, epilepsy, paralytic and neurological affections, retention or nocturnal incontinence of urine, spermatorrhoea, sexual debility and impotence.
Glycyrrhiza glabra *Papilionaceae; Fabaceae*	Root	Used in bronchitis, dry cough, respiratory infections, catarrh, tuberculosis; genitourinary diseases, urinary tract infections; abdominal pain, gastric and duodenal ulcers, inflamed stomach, mouth ulcer. Also used for adrenocorticoid insufficiency.
Plumbago indica *Plumbaginaceae*	Root	*Plumbago zeylanica* Linn (Plumbaginaceae) is a perennial shrub found wild in South India and West Bengal. It is also cultivated in gardens throughout India. The roots of *P. zeylanica* (popularly known as 'Chitrak') is reported to possess great pharmacological importance in traditional system of medicine and employed clinically for their antifertility, germicidal, antileprotic and anti-inflammatory activities. Scientist are undertaking research constantly to identify a moiety to improve learning and memory since there is lack of satisfactory drugs in allopathic system of medicine[25].
Salacia Oblonga *Hippocrateaceae; Celastraceae*	Root	Root bark—used for the treatment rheumatism; also for gonorrhoea, swellings and skin diseases. Plant—mildly antiseptic.
Lannea coromandelica *Anacardiaceae*	Bark	Bark—stimulant and astringent; used in gout; decoction for aphthae of the mouth and for toothache. Leaves— boiled and applied to sprains, bruises, local swellings, elephantiasis. Gum—given in asthma; as a cordial to women during lactation.

Table-4
Heavy metal contents in Medicinal Plants

Sample Code	As (ppb)		Cd (ppm)		Cu (ppm)		Hg (ppb)		Pb (ppm)	
	Actual Conc.	% RSD	Actual Conc.	% RSD	Actual Conc.	% RSD	Actual Conc.	% RSD	Actual Conc.	% RSD
MP01-IT	93.75	18.46	0.57	8.53	6.08	5.10	6.88	78.89	27.97	2.95
MP20-OU	28.78	67.93	0.21	32.77	7.8	1.54	3.44	85.70	26.85	15.65
MP04-AI	306.8	3.01	0.22	20.40	12.49	3.147	20.41	12.48	19.43	1.19
MP16-IA	30.87	10.98	0.13	34.64	9.61	2.05	39.62	11.65	21.55	5.59
MP15-EA	19.24	27.26	0.81	11.47	9.84	2.22	56.73	16.39	20.46	9.32
MP18-EL	36.94	26.88	0.21	30.05	11.54	2.60	9.57	51.89	21.34	5.42
MP17-AB	45.26	23.52	0.18	34.64	10.41	1.99	16.11	16.43	21.04	3.81
MP12-MP	22.86	38.12	0.53	19.91	7.43	3.45	43.58	15.91	15.89	2.94
MP10-AA	141.83	7.94	0.40	17.44	10.27	2.20	63.12	13.88	13.85	5.82
MP03-MP	81.79	25.98	0.15	12.50	5.86	2.22	24.47	17.2	20.65	6.0
MP06-SV	50.44	14.07	0.28	56.96	5.96	6.55	24.96	17.48	21.34	2.90
MP08-CC	75.62	10.91	0.31	18.55	10.05	5.38	24.66	11.95	15.86	7.97
MP19-SP	23.05	10.91	0.33	39.85	15.89	1.45	53.42	4.39	27.43	2.70
MP02-CE	21.89	44.44	0.17	50.63	4.07	3.65	17.23	36.18	19.73	8.30
MP05-MJ	134.77	3.75	0.20	42.27	13.40	1.41	18.31	36.63	18.56	6.89
MP11-AR	16.22	56.54	0.47	30.66	21.48	0.33	37.28	5.38	14.93	16.44
MP14-GG	31.31	18.80	0.55	12.02	7.60	2.49	25.05	10.41	16.65	3.67
MP07-PZ	458.74	3.29	0.37	37.75	14.86	2.89	45.99	18.93	16.60	8.30
MP13-SO	19.45	47.03	0.59	3.77	9.78	2.28	40.25	8.34	16.83	3.76
MP09-LC	64.98	12.76	0.43	15.05	9.90	3.35	11.24	17.06	18.41	12.17

RSD-Relative Standard Deviation

Table- 5
Mineral contents in Medicinal Plants

Sample Code	Fe (ppm)		Na (ppm)		Mg (ppm)		Mn (ppm)		Zn (ppm)	
	Actual Conc.	% RSD	Actual Conc.	% RSD	Actual Conc.	% RSD	Actual Conc.	% RSD	Actual Conc.	% RSD
MP01-IT	801.96	0.43	328.51	7.68	462.37	0.23	61.91	0.37	14.48	0.39
MP20-OU	257.10	1.28	122.74	0.34	465.95	0.76	8.49	5.07	1.08	4.19
MP04-AI	1179.10	0.09	391.35	1.31	473.02	0.35	29.93	1.17	12.97	0.90
MP16-IA	447.62	0.94	411.27	1.16	456.88	0.87	61.30	0.24	18.46	2.08
MP15-EA	246.59	1.29	244.95	2.74	482.82	0.41	135.47	0.60	5.84	1.66
MP18-EL	371.83	0.44	188.52	0.35	558.79	0.50	17.68	3.01	15.52	0.63
MP17-AB	543.83	0.54	340.96	1.81	447.57	0.35	41.25	0.66	25.54	0.22
MP12-MP	282.55	0.36	227.20	0.65	485.51	0.49	15.80	1.68	7.30	1.13
MP10-AA	1427.25	0.72	302.65	2.98	467.81	0.49	113.72	0.09	16.93	0.23
MP03-MP	593.85	0.13	477.55	0.45	34.07	0.86	403.11	1.36	12.67	0.74
MP06-SV	302.62	0.49	459.64	0.28	38.05	0.541	109.61	0.30	22.02	0.98
MP08-CC	1290.49	0.06	480.84	0.23	109.92	0.49	399.02	0.02	16.81	0.73
MP19-SP	186.77	2.02	380.0	0.42	10.29	2.84	273.20	5.05	28.06	0.71
MP02-CE	299.94	0.000	17.92	0.40	452.22	0.71	134.89	0.31	5.22	1.26
MP05-MJ	1747.74	0.55	203.99	0.78	471.86	0.81	391.80	2.66	17.86	0.63
MP11-AR	140.33	0.87	9.85	2.09	479.14	0.31	137.33	0.12	27.88	0.74
MP14-GG	257.05	1.09	9.49	1.85	509.01	0.25	152.16	0.99	8.60	0.60
MP07-PZ	1796.68	0.38	202.42	0.54	470.31	1.02	399.54	0.07	26.80	0.67
MP13-SO	436.08	2.29	32.53	0.45	462.27	0.18	398.08	3.13	20.28	1.59
MP09-LC	1092.15	0.40	64.06	0.57	408.74	0.87	343.74	2.55	20.89	0.76

RSD-Relative Standard Deviation

Figure -1
Heavy metal contents in Medicinal Plants

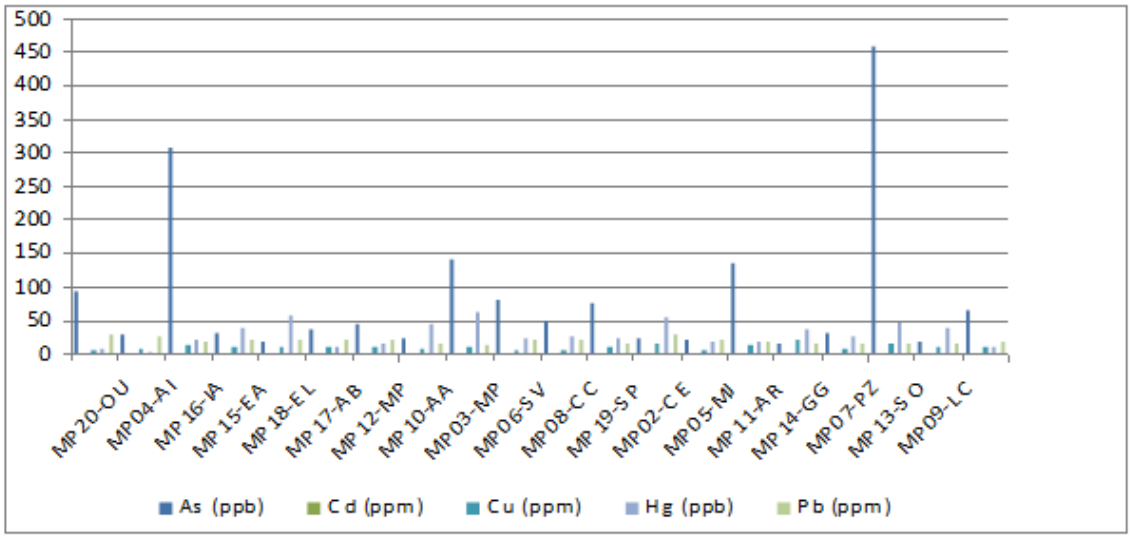
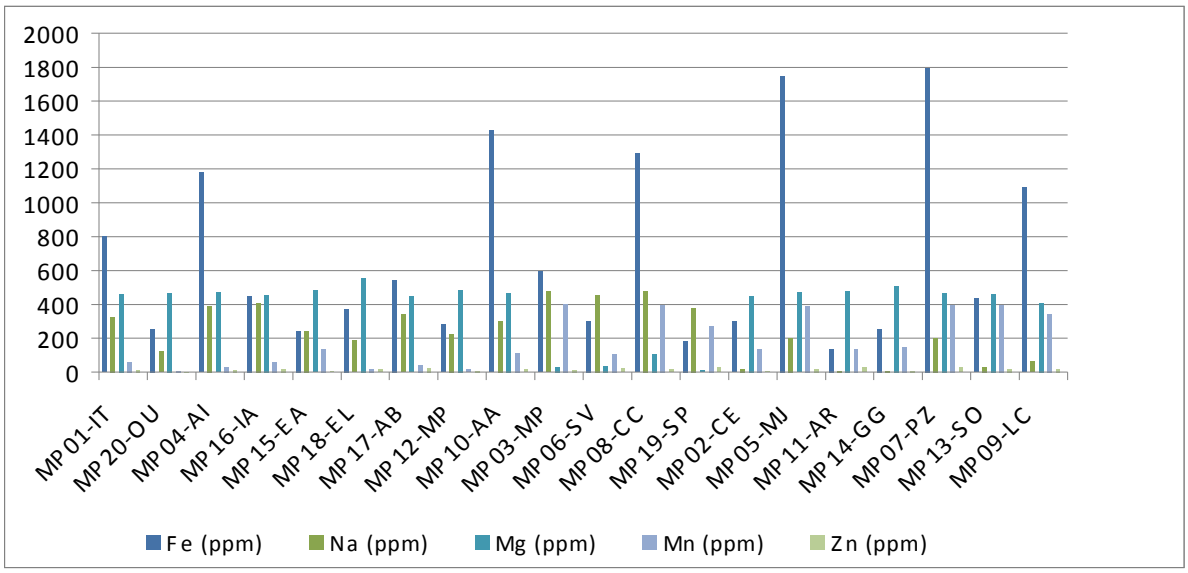


Figure -2
Mineral contents in Medicinal Plants



CONCLUSION

Lead and cadmium are non-essential trace elements having functions neither in human body nor in plants. They induce various toxic effects in humans at low doses. The typical symptoms of Pb poisoning are colic, anemia; headache, convulsions and chronic nephritis of the kidneys, brain damage, vascular and immune system and central nervous system disorders, aluminum may cause strong effects including dysuria, discomfort, cataract and neurotoxicity, if intake is more than recommended values. Cadmium accumulation in the human body could damage mainly the kidneys and liver, causing both acute and

chronic poisoning Likewise, Mercury (Hg) has several effects on human such as damage to brain functions, DNA damage and chromosomal damage, allergic reactions, resulting in skin rashes, tiredness and headaches, disruption of nerve system, negative reproductive effects, such as sperm damage, birth defects and miscarriages. Whole Health Organization (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.

Furthermore the European commission has established the lead,cadmium and mercury limits in food supplements that have been in force since March 2001.There are several acts to provide healthy food and drugs, whereas in 2003 the Food and Drug Administration (FDA) proposed regulation that would make dietary supplement manufacturing, packaging and storage be in compliance with current good manufacturing practices (cGMPs). The heavy metal recommendation level varies for babies from adults both in preparation of food materials and medicine89. 88 prescribed limits 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 ppm90. The implication of findings may be taken into consideration whilst using the herbs for human consumption. Therefore, the results of elemental analysis suggest that the plant may be used for human consumption or for preparation of herbal products and standardized extracts should be collected from an unpolluted natural habitat human consumption or for preparation of herbal products and standardized extracts should be collected from an unpolluted natural habitat[3]. People generally use herbal medicine for prolonged period to get desirable effects. Prolong consumption of such herbal medicine might reduce chronic or subtle health hazards. Nevertheless, consuming plants grown in contaminated areas have high risk of intaking heavy metal concentrations beyond the permissible limit, which cause health hazards. Medicinal plants should be collected from the area that is not contaminated with heavy metals. Thus, our findings indicate that the medicinal plant or plant parts used for different diseases must be checked for heavy metals contamination in order to make it safe for human consumption.

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