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Research Article

MULTIELEMENT DETERMINATION IN METHANOLIC SOXHLET LEAF EXTRACT OF SEMECARPUS ANACARDIUM (LINN.F.) BY ICP-AES TECHNIQUE

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ABSTRACT

Objective: Multielement analysis was carried out on methanolic soxhlet leaf extract of *Semecarpus anacardium* using the ICP-AES technique.Methods: ICP-AES technique is one of the most powerful and quick multi elemental analysis with high sensitivity. 41 elements Na, Mg, Si, Cl, K, Ca, Cr, Mn, Fe, Ni, Cu, Zn, Co, Cd, Se, Al, S, Pb, Ba, Hg, As, B, P, Sr, Br, Ti, Bi, Ge, In, La, Li, Mo, Pd, Sb, Sc, Sn, Te, V, W, I, Th were screened.Results: 12 elements were detected out of 41 elements in the above plant in various proportions depending on soil composition and the climate in which the plant grows.Conclusion: The elements present in the medicinal plant plays an important role in the treatment of diseases as described in Ayurveda. The methanolic soxhlet leaf extract of *Semecarpus anacardium* showed the presence of essential elements that could enhance the curative process of ill health and the potentially toxic elements were not detected in the present plant extract.

Keywords: ICP-AES, multielement analysis, *Semecarpus anacardium* (Linn.F.), Ayurveda.

INTRODUCTION

The medicinal efficacy of the plants are accounted for their organic constituents like flavanoids, alkaloids, essential oils, vitamins, glycosides, etc., present in them and little attention has been given to their inorganic constituents[1]. Excess doses or prolonged intake of medicinal plants can lead to accumulation of trace elements which can cause various health problems[2,3]. Heavy metal elements are naturally present in the environment. Occurrence of these heavy metal elements has been increasing with the increasing industrialization. Agricultural soils, as an essential part of the environment, are no exception of this phenomenon[4]. Additional sources of heavy metal contamination are rainfall, atmospheric dust, plant protective agents and fertilizers[5-7]. The human beings require both metallic and nonmetallic elements within certain permissible limits for growth and good health. Analyzing the elemental composition in foods and related medicinal products is therefore very important for understanding their nutritive and medicinal value.

Semecarpus anacardium is a deciduous tree belonging to Anacardiaceae family. It grows in tropical and temperate regions of south east asian countries. Its seed, the 'Marking Nut' is used in Ayurveda for the treatment of rheumatoid arthritis, gout and other inflammatory diseases, tumours, asthma, epilepsy, psoriasis and leprosy. The antimicrobial activity of the methanolic leaf extract of *Semecarpus anacardium* was evaluated against medicinally important bacteria *Staphylococcus epidermidis*, *Micrococcus luteus*, Methicillin-resistant *Staphylococcus aureus*, *Propionibacterium acnes* and yeast, *Malaassezia furfur* using the MIC and MBC/MFC analysis[8]. The methanolic leaf extracts of this plant were also subjected to evaluation of antioxidant activity by using DPPH free radical scavenging method and also Nitric oxide radical scavenging method[8]. The preliminary phytochemical studies on *Semecarpus anacardium* showed the presence of alkaloids, saponins, tannins, flavonoids, steroids, glycosides, hexose sugars, diterpenes, mucilages and gums. Further fluorescent analysis of different soxhlet extracts and leaf powder provided the additional support for the qualitative chemical analysis findings. The results suggest that the leaves of *Semecarpus anacardium* has phytochemical properties and may be used for curing various ailments[9]. Various functional groups were present in the crude powder and extracts of *Semecarpus anacardium* leaves were identified using FT-IR spectrometry. The FT-IR analysis of leaf powder of *Semecarpus anacardium* proved the presence of alcohols, phenols, alkanes, alkenes, carboxylic acids, ethers, esters, aliphatic iodo compounds and polysulfides. The above FT-IR studies of *Semecarpus anacardium* leaves revealed the different characteristic peak values with various functional groups present in them[10]. Gold nanoparticles were synthesized using *Semecarpus anacardium* leaf extracts in water. Gold nanoparticles were then quantified by using UV and ICP-AES analysis[11].

To determine the contents of the herbs, medicinal or aromatic plants and tea leaves from many parts of the world, various techniques such as Flame Atomic Absorption Spectrometry (FAAS), Electrothermal Atomic Absorption Spectrometry (ETAAS), Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) were used[12-21]. Therefore, the objective of the present study is to determine the levels of Na, Mg, Si, Cl, K, Ca, Cr, Mn, Fe, Ni, Cu, Zn, Co, Cd, Se, Al, S, Pb, Ba, Hg, As, B, P, Sr, Br, Ti, Bi, Ge, In, La, Li, Mo, Pd, Sb, Sc, Sn, Te, V, W, I, Th in above medicinal plant by using nitric acid digestion procedure with ICP-AES technique[22]. The data obtained will provide significant information on whether this plant contains some metal elements in the amounts which can be toxic at the normal doses if consumed as medicine.

MATERIALS AND METHODS

Collection and Authentification of the plant

The leaves of *Semecarpus anacardium* were collected from an open field around Mumbai, Maharashtra. The identification of the plant was done at the Blatter Herbarium, St. Xavier's College, Mumbai. The plant *Semecarpus anacardium* (Linn.F.) specimen matches with the Blatter Herbarium specimen no. T-472 of S.C. Tavakari. The leaves were thoroughly washed with distilled water, dried in an oven at 40°C and subsequently ground into fine powder by using a mechanical grinder.

Chemicals

A standard solution of each element was prepared by dilutions of a 1000 mg/L stock solution (Merck, Darmstadt, Germany) prior to use. Milli-Q deionized water (Millipore, Milford, MA) was used throughout this experiment. Solvents such as nitric acid and methanol were of analytical reagent grade (Merck). All glassware were soaked with 10% nitric acid overnight and then rinsed with deionized water prior to use.

Soxhlet Extraction of Plant Material

The leaf powder of *Semecarpus anacardium* (20 gm) was extracted with 250 ml methanol by soxhlet extraction for 8 hours. The extract was concentrated on water bath at 60ºC. The dark greenish brown thick liquid obtained was stored in a glass vial in refrigerator.

Digestion Procedure of Soxhlet Leaf Extracts

1 gm of sample by weight was taken in a beaker and 5 ml of 60% concentrated nitric acid was added and kept on hot plate at 85° C for 15 mins. Subsequently it was cooled and then made to 50 ml with the help of distilled water. Blank samples were also processed and analyzed simultaneously. The solutions were then analyzed with an inductively coupled plasma atomic emission spectrometer.

Elemental Analysis of Plant Leaf Extracts

The Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) instrument model used was Arcos from M/S. Spectro, Germany. The software used was Smart Analyzer Vision 5.01.0921. The detector was charge coupled device (CCD). The instrumental parameters and operating conditions are given in Table 1. All the samples were analyzed in triplicate and mean values of concentrations for each element are given along with standard deviation in Table 2.

Table 1: The instrumental parameters and operating conditions for ICP-AES.

ICP-AES parameter	Value
R.F. Generator	1.6 KW, 27.12 MHz
Plasma Power	1400 W
Pump Speed	30 rpm
Coolant Flow	12.00 l/min
Auxiliary Flow	1.00 l/min
Nebulizer Flow	0.80 l/ml

Table2:Elemental concentrations in methanolic soxhlet leaf extracts of *Semecarpus anacardium* by the ICP-AES technique.

Elements	Wavelength Selected in nm	Concentrations in ppm Mean ± SD
Na	589.592	47.016 ± 1.088
Mg	279.079	44.55 ± 0.529
Si	251.612	26.65 ± 16.301
Cl	134.724	ND
K	766.491	587.716 ± 5.768
Ca	422.673	8.766 ± 0.453
Cr	267.716	ND
Mn	257.611	0.616 ± 0.028
Fe	259.941	ND
Ni	231.604	0.4 ± 0.0
Cu	324.754	0.916 ± 0.028
Zn	213.856	0.616 ± 0.028
Co	230.786	ND
Cd	214.438	ND
Se	196.09	ND
Al	176.641	ND
S	180.731	17.266 ± 0.652
Pb	220.353	ND
Ba	455.404	ND
Hg	184.95	ND
As	189.042	ND
B	208.959	5.533 ± 0.791
P	177.495	10.4 ± 0.0
Sr	460.733	ND
Br	154.065	ND
Ti	132.171	ND
Bi	223.061	ND
Ge	164.919	ND
In	230.606	ND
La	408.672	ND
Mo	202.095	ND
Pd	340.458	ND
Sb	206.833	ND
Sc	361.384	ND
Sn	189.991	ND
Te	170	ND
V	292.464	ND
W	239.709	ND
Th	401.913	ND
I	178.276	ND
Li	670.780	ND

Mean concentration ± standard deviation (n=3); ND= Not Detected means less than 0.01 ppm.

RESULTS

The leaves of medicinal plants play an important role both in lore and ayurvedic medicines[23, 24]. The medicinal plants are found to be rich in one or more individual elements, which pertain their therapeutic value for treatment of different diseases delicately, either singly or in combination[25]. Elemental analysis has revealed the presence in order of K> Na> Mg> Si> S> P> Ca> B> Cu> Zn, Mn> Ni. The results show higher concentration of potassium. Elements such as Cl, Cr, Fe, Co, Cd, Se, Al, Pb, Ba, Hg, As, Sr, Br, Ti, Bi, Ge, In, La, Mo, Pd, Sb, Sc, Sn, Te, V, W, Th, I, Li were not detected. Elemental

concentrations in methanolic soxhlet leaf extracts of *Semecarpus anacardium* by the ICP-AES technique are given in Table 2.

Elements such as iron, copper, zinc, manganese, etc. have immunomodulatory functions and thus influence the susceptibility to the course and the outcome of a variety of viral infections[26]. Even though certain essential elements can be toxic at high levels, the WHO limits for these metals have not yet been established[27]. It is seen that the concentrations of the elements varies in the plant sample. The differences in the concentration of these elements is due to the factors such as preferential absorption of a particular plant for the corresponding elements, the age of the plant, the mineral composition of the soil and the ambient climatological conditions[28].

DISCUSSION

Heavy metals are present in the biological cycle in very low concentrations. So even at minimal increases, they could cause severe damages to human and other living organisms, thus systematic investigations and control are required[29]. Also the monitoring of metals in these plants is of some therapeutic and prophylactic importance.

Potassium (K)

Potassium ions are the most abundant cations in the human body[30]. It is extremely important for the cells in the body[31]. It is essential for smooth flow of communication signals from cell to cell and its deficiency can contribute to diseases like stroke, heart problem, diabetes and hypertension. It acts in the intercellular fluid as the primary ion. Potassium together with sodium helps to regulate the water balance within the body. It regulates the transfer of nutrients to the cell, transmits electrochemical impulses and is necessary for normal growth and enzymatic reactions[32]. The average human consumes potassium up to 7 gm a day and has a store of some 140 gm in the human body, mainly in the muscles. Normal diets contains enough potassium, but some foods such as instant coffee, sardines, nuts, raisins, potatoes and chocolate have more than average potassium[33,34]. The concentration of potassium was highest than the other reported elements present in methanolic leaf extract of *Semecarpus anacardium*, 587.716 ± 5.768 ppm.

Calcium (Ca)

Calcium ions are the most resourceful and common signalling agent in the human body[35]. It is important for strong bones, teeth, maintains proper blood pressure and also for blood clotting. Its deficiency can lead to very serious problems like arthritis. It plays important function in nerve transmission, hormonal functions and metabolism of vitamin D. The average human contains about 1 kg of calcium in our bodies. Children and pregnant women are encouraged to eat foods rich in calcium, such as cheese, milk and white bread[33,34]. In this plant extract the concentration of calcium was found to be 8.766 ± 0.453 ppm.

Magnesium (Mg)

Magnesium is the fourth most abundant element in the human body and is essential for good health[36]. It prevents some heart disorders and high blood pressure and is associated with improved lung functions. It helps in absorbing calcium and phosphorus. It controls insulin levels in blood. It is injected in veins in acute heart or asthma attack situations. Its supply is located in the bones together with calcium and phosphorus, while it is found in cellular fluids and some soft tissue. It is involved with energy production of glucose, protein and nucleic acid synthesis, the formation of urea, muscle impulse transmission and neurotransmission. It plays an important role in enzyme activity. Its deficiency interferes with the transmission of nerve and muscle impulses, causing irritability and nervousness[32]. Chlorophylls are magnesium-centred porphyrins. Humans take in 250-350 mg each day (about 100 gm a year), and we each have about 20 gm in our bodies. Magnesium hydoxide (Milk of Magnesia), Sulphate (Epsom salts), Chloride and Citrate are used in medicines[33,34]. In this plant extract the concentration of magnesium was found to be 44.55 ± 0.529 ppm.

Phosphorus (P)

Phosphorus is one of the most abundant minerals in human body and it is required for healthy formation of bones and teeth. It forms calcium phosphate with calcium in the bones & teeth in the ratio 2:1. It helps in maintaining healthy blood sugar levels. It is important in the utilization of carbohydrates, fats, and proteins for the growth and maintenance in the body. Phosphorous is estrogenic, immuno stimulant and anti-osteoporotic[32]. Many fertilisers contain a high proportion of phosphorus and are manufactured from concentrated phosphoric acids. Phosphorus is the basis of life as part of the DNA molecule. We take in about 1 gm of phosphate a day and we store about 750 gm in our bodies, since our bones are mainly calcium phosphate[33,34]. The concentration of phosphorus was found to be 10.4 ± 0.0 ppm in this plant extract.

Chlorine (Cl)

Chlorine is found throughout the body, in the blood, in fluids inside cells and in fluids between cells. It helps to regulate acid alkali balance, stimulate production of hydrochloric acid, stimulate the liver to function as a filter for wastes and helps to distribute hormones[32]. Chloride is the chief anion of extracellular fluid which is responsible for muscular irritability[1]. Our daily intake is about 6 gm, mainly as salt, but we could manage with half this amount[33,34]. Chlorine was not detected in this plant extract.

Iron (Fe)

Iron is used to make tendons and ligaments and is important for maintaining healthy immune system. It is an essential part of haemoglobin. Its deficiency causes anaemia. But accumulation of iron in the body typically damages cells in the heart and liver which can cause cancer, coma, metabolic acidosis, liver failure, circulatory shock and long-term organ damages. For medicinal plants the WHO (2005) limits have not yet been established for iron[37]. The average human contains about 4 gm. If the diet does not contain the 10 - 18 mg of iron needed each day, anaemia will eventually develop. Molasses, brewer's yeast, cocoa and liquorice contain a lot of iron[33,34]. Iron was not detected in this plant extract.

Zinc (Zn)

Zinc has ability to occupy low symmetry site in enzymes and cause disturbances in enzymatic function. It plays a major role as catalyst in over 200 enzymes and is capable of influencing immune system[38-41]. It maintains various reactions of the body which help to construct and maintain DNA, required for the growth and repair of body tissues, important element of ligaments and tendons[32]. It has an anti-diarrhoea activity and regulates fertility. The WHO (2005) permissible limits for medicinal plants have not yet been established for zinc[37]. The average human body contains about 2.5 gm and takes in about 15 mg per day. Herring, beef, lamb, sunflower seeds and cheese have above average levels of zinc. Zinc can be carcinogenic in excess[33,34]. The concentration of zinc was found to be 0.616 ± 0.028 ppm in this plant extract.

Copper (Cu)

Copper is a major component of oxygen carrying part of blood cells. Along with vitamin C it is important for keeping blood vessels and skin elastic and flexible. It helps to form chemicals that regulate blood pressure, pulse and healing. Its deficiency leads to arthritis. It is an important component of many enzyme systems such as cytochrome oxidase, lysyl oxidase and ceruloplasmin an iron oxidizing enzyme in blood. Its deficiency has been associated with cardiac abnormalities in humans and animals, causing anemia and neutropenia. Adult human needs around 1.2 mg of copper a day to help enzymes produce energy in cells. Excess copper is toxic and genetic diseases such as Wilson's disease and Menke's disease are caused by the body's inability to utilise copper properly[33,34]. For medicinal plants, the WHO (2005) limits have not yet been established for copper[37]. The concentration of copper was found to be 0.916 ± 0.028 ppm in this plant extract.

Cobalt (Co)

Cobalt is an essential trace element and forms part of the active site of Vitamin B_{12}. The amount of cobalt required in the human body is very small and it contains only about 1 mg. Cobalt salts in small doses have been found to be effective in correcting mineral deficiencies in certain animals. But in large doses it is carcinogenic. The radioactive isotope Cobalt 60 is sometimes used in some countries to irradiate food to preserve it. There are no established criteria limits for cobalt in medicinal plants[37]. Cobalt was not detected in this plant extract.

Sulphur (S)

Sulphur is an important element that is used in small amounts to construct all parts of human body. There is plenty of sulphur in the food products and excess of it gained by the body is excreted[31]. It is essential as a component of fats, body fluids and bones. Sulfur is essential to all living things and there is a sulfur cycle in nature. The average human contains 140 gm and takes in about 1 gm a day[33,34]. The concentration of sulfur was found to be 17.266 ± 0.652 ppm in this plant extract.

Silicon (Si)

Silicon is common mineral required by our body along with calcium to grow and maintain strong bones, hair, skin and fingernails[31]. It is essential to plant and animal life. In humans, it is found in connective tissue and skin. It is non-toxic but some silicates, such as asbestos, are carcinogenic[33,34]. The concentration of silicon was found to be 26.65 ± 16.301 ppm in this plant extract.

Titanium (Ti)

Not much is known about biological role of titanium but it is reported to act as a stimulant[31]. Titanium is a suspected carcinogen. It was not detected in this plant extract.

Manganese (Mn)

Manganese is used to make the chemicals that helps in digestion. It also supports the immune system, regulates blood sugar levels and it works with vitamin K to support blood clotting. Not getting enough manganese can cause poor bone formation, affect fertility and ability of blood to clot. It is an antioxidant nutrient and is important in the breakdown of amino acids and production of energy[42]. It is essentially required for the metabolism of Vitamin B_1, C, E and for the activation of various enzymes which are important for proper digestion, utilization of foods and hence in regulating immune response of the body[25]. For medicinal plants the WHO (2005) limits has not yet been established for manganese[37]. Certain agricultural soils are deficient in it, and so manganese is added in form of fertilisersto the soil. It is also given as a food supplement to grazing animals. The average human body contains about 12 mg and takes in about 4 mg per day from foods such as nuts, bran, wholegrain cereals, tea and parsley[33,34]. The concentration of manganese was found to be 0.616 ± 0.028 ppm in this plant extract.

Sodium (Na)

Sodium is a vital element to human life. A healthy human body contains 90 to 130 gm of sodium[43]. Potassium, Chlorine and Sodium together forms a part of blood plasma. Without sodium, cells will not get the nutrients to survive. Nervous system functioning depends on it. Loss of Sodium from body can leads to dehydration and weakness. The average person consumes about 10 gm of salt a day although all that is needed is about 3 gm. Any excess may contribute to high blood pressure. Sodium performs the transmission of electrical impulses and the regulation of water content in tissue and blood[33,34]. The concentration of sodium was found to be 47.016 ± 1.088 ppm in this plant extract.

Strontium (Sr)

It is the fifteenth most abundant element on earth. Its occurrence in plants is a due to the type and chemical composition of soil, rainfall, agricultural practice and kind of plant. Strontium has no known biological role and it is non-toxic. It replaces and mimics calcium[33,34]. It was not detected in this plant extract.

Lead (Pb)

It is a nonessential trace element having functions neither in humans nor plants. They induce toxic effects in humans even at low doses. Lead accumulation results in reduced functioning of kidney, liver and brain cells and later in complete breakdown of the tissues[44]. It is toxic in a cumulative way, teratogenic and carcinogenic[33,34]. It was not detected in this plant extract.

Cadmium (Cd)

Cadmium and its compounds are also toxic to humans. They produce acute and chronic symptoms varying in intensity from irritation to extensive metabolic disturbances. Although cadmium and lead have unknown role as nutrients, but plants readily accumulate them in their system. A well-documented incidence is that of Itai-Itai disease due to residue built up of Cd^{2+} in rice[45]. Cadmium is toxic, carcinogenic and teratogenic and accumulates in the body. The WHO (1998) recommends maximum permissible levels in raw materials for Cadmium and Lead which amount to 0.3 and 10 $mgkg^{-1}$, respectively[46]. It was not detected in this plant extract.

Arsenic (Ar)

Despite arsenic been known as highly toxic substance, it may actually be necessary for good health. It is thought to be necessary for the functioning of nervous system and for growth[31]. It was not detected in this plant extract.

Mercury (Hg)

Allopathic medical practitioners are skeptical about the use of mercury for therapy, a perception not supported by traditional medicine practitioners[47]. Mercury has no known biological role. It is a virulent poison, readily absorbed through the respiratory tract, the gastrointestinal tract or through the skin[33,34]. It was not detected in this plant extract.

Nickel (Ni)

As far as non-essential elements are concerned, nickel is known to cause cancer. Nickel and zinc, when present in low concentrations are important micronutrients, while in high concentrations, these two metals become toxic to plants[48]. For medicinal plants the WHO (2005) levels and limits are not yet been established for nickel[37]. Its toxicity in humans is not very common occurrence because its absorption by the body is very low[49]. Nickel is an essential element for plants such as the navy bean, which is used for baked beans[33,34]. The concentration of nickel was found to be 0.4 ± 0.0 ppm in this plant extract.

Aluminium (Al)

Alfrey *et al*. reported that orally administered aluminium compounds reduce the absorption of a number of other elements and compounds including strontium, iron, fluoride, phosphorus and to a lesser extent calcium[50]. Aluminium is now thought to be involved in action of a small number of enzymes. The body has hard time to get rid of excess aluminium[31]. It can be accumulated in the body from daily intake and at one time was suggested as a potential factor in Alzheimer's disease (Senile dementia), although some studies have disproved this theory. Only a small amount of what we take in with our food is absorbed by our bodies. Foods with above average amounts of aluminium are tea, processed cheese, lentils and sponge cakes. Some indigestion tablets are pure aluminium hydroxide[33,34]. It was not detected in this plant extract.

Chromium (Cr)

Chronic exposure to chromium may result in liver, kidney and lung damage[51]. However, in medicinal plants, the WHO (2005) limits had not yet been established for chromium[37]. We take in about 1 mg per day. Foods such as brewer's yeast, wheat germ are rich in chromium. However it is poisonous in excess. It was not detected in this plant extract.

Barium (Ba)

The best known use is in the form of barium sulfate, which can be drunk as a medical cocktail to outline the stomach and intestines for medical examination. Barium and all its compounds that are water or acid soluble are toxic[33,34]. It was not detected in this plant extract.

Selenium (Se)

Selenium is an essential trace element but is toxic in excess. It is carcinogenic and teratogenic. Hydrogen selenide and other selenium compounds are extremely toxic[33,34]. It was not detected in this plant extract.

Boron (B)

Elemental boron is not considered a poison and is essential to plants, but assimilation of its compounds has a cumulative toxic effect. We take in about 2 mg each day from our food about 60 gm in a lifetime. Some boron compounds show promise in treating arthritis[33,34]. The concentration of boron was found to be 5.533 ± 0.791 ppm in this plant extract.

Bromine (Br)

Bromine has no known biological role. It has an irritating effect on the eyes and throat, and produces painful sores when in contact with the skin[33,34]. It was not detected in this plant extract.

Bismuth (Bi)

Bismuth (III) chloride oxide (BiClO) is used in cosmetics to give a pearly effect. Bismuth has no known biological role and is non-toxic[33,34]. It was not detected in this plant extract.

Germanium (Ge)

Germanium has no known biological role. It is non-toxic. Certain germanium compounds have low mammalian toxicity but marked activity against some bacteria, which has stimulated interest in their use in pharmaceutical products[33,34]. It was not detected in this plant extract.

Indium (In)

Indium has no known biological role but has been shown to cause birth defects in unborn children[33,34]. It was not detected in this plant extract.

Lanthanum (La)

The ion La^{3+} is used as a biological tracer for Ca^{2+}, and radioactive lanthanum has been tested for use in treating cancer. Lanthanum has no known biological role, but both the element and its compounds are moderately toxic[33,34]. It was not detected in this plant extract.

Lithium (Li)

Lithium has no known natural biological role. It is non-toxic, teratogenic, stimulatory and an anti-depressant. Lithium carbonate therapy has become standard treatment for manic depression, although its action on the brain is still not fully understood[33,34]. It was not detected in this plant extract.

Molybdenum (Mo)

Molybdenum is an essential element for animals and plants. If soil lacks this element the land is barren. Leguminous plants use the nitrogen-fixing enzyme nitrogenase, which contains molybdenum[33,34]. It was not detected in this plant extract.

Palladium (Pd)

Palladium has no known biological role, and is non-toxic[33,34]. It was not detected in this plant extract.

Antimony (Sb)

Antimony and many of its compounds are toxic[33,34]. It was not detected in this plant extract.

Scandium (Sc)

Scandium has no known biological role, but is a suspected carcinogen[33,34]. It was not detected in this plant extract.

Tin (Sn)

Tin is non-toxic. Trialkyl and triaryl tin compounds are used as biocides and must be handled with care[33,34]. It was not detected in this plant extract.

Tellurium (Te)

Tellurium has no known biological role. It is very toxic and teratogenic[33,34]. It was not detected in this plant extract.

Vanadium (V)

Vanadium is essential to some species, including humans, although we require very little, less than the 0.04 mg, which we take in each day[33,34]. It was not detected in this plant extract.

Tungsten (W)

Tungsten has no known biological role, and has low toxicity[33,34]. It was not detected in this plant extract.

Thorium (Th)

Thorium has no known biological role. It is toxic due to its radioactivity[33,34]. It was not detected in this plant extract.

CONCLUSIONS

For ensuring the purity, safety and efficacy of herbal products, determination of the elemental contents in medicinal plants should be a part of the quality control process. More than 40 elements have been considered essential to life systems for the survival of both mammals and plants. Trace elements in medicinal plants are important because they are known to play an important role in plant metabolism and active constituents are metabolic products of the plant cells. Trace element concentrations in plants vary widely with the soil type, pH, fertilizer, organic content, climate, species, etc. If plants are used as raw materials for the manufacturing of health products, variations of nutrient levels should be closely monitored. The data on trace, minor, major and toxic elements in plants is of great importance to understand the pharmacological actions of the medicinal plants. Essential metals can also produce toxic effects when the metal intake is in high concentrations, whereas non-essential metals are toxic even in a very low concentration for human health and the environment. In the present work we found the Ni, Mn, Zn, Cu, B, Ca, P, S, Si, Mg, Na, K elements in varying concentrations. The nonessential toxic elements like Al, As, Cd, Pb and Hg were not detected in the present plant extract. For complete understanding about the relationship between elemental concentration and its curative action a thorough investigation is required. The results obtained in the ICP-AES analysis of methanolic soxhlet leaf extract of *Semecarpus anacardium* showed the presence of essential elements that could enhance the curative process of ill health and the potentially toxic elements were not detected in the present plant extract.

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