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RESEARCH ARTICLE

Elemental Analysis of Herbal Tablets by ICP-MS

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Abstract

Popularity of herbal medicines is growing worldwide because of their minimal side-effects. Herbal medicines required standardization, with implementation and constant review of technical standards of production and effective quality control methods. It is necessary to promote this study in the view of the importance of results of both individual and social field. Heavy metals are very toxic, as ions or in compound form. They are soluble in water and may be readily absorbed into living organisms. After absorption, these metals can bind to vital cellular components such as structural proteins, enzymes and nucleic acid and interfere with their functions. In human, these metal can cause severe physiological and health effects. Hence, in the present study, some important herbal medicines are scanned for the analysis of essential elements. Herbal medicines contain metals like Mn, Zn, Cr, Fe and Cu etc. and these metals are determined quantitatively by using Inductively coupled plasma mass spectrometry (ICP-MS) technique which can be incorporated in routine quality control parameters.

Keywords: Herbal medicines, heavy metals, elemental analysis, inductively coupled plasma mass spectrometry.

Introduction

'Ayurveda' derived from 'Ayur' means life and 'Veda' means science and it means science of life. World health Organisation states that around 85-95% of the world population uses traditional herbal medicines (WHO, 2007). Due to the increase in population, most of the people use herbal products which are now available in different forms like tablets, elixirs and powders. Therefore, it is thought necessary to study the levels of essential elements being consumed by patient per tablet so that their repercussions can be evaluated. It is one of the most noted systems of medicine in the world. Ayurveda is based on the hypothesis that everything in the universe is composed of five basic elements viz. Earth, air, energy, light and space and they exists in the human body in combined form like vata, pitta, kapha system of diagnosis and treatments. In the preparation of herbal medicines, varies parts of plants like roots, leaves, barks, seeds, flowers, fruits, stems are used as a raw material. After passing through many processes, they are converted into finished herbal product, but patients are not aware about their standards. World Health Organisation gives some guidelines (2007) for the preparation of herbal medicines and listed some methods for the standardisation of herbal medicines (WHO, 2011) and also give maximum permissible limit of heavy metal (The Merck index, 1989) and quality controlled norms. It is important to follow the quality control norms to standardise the herbal medicines. Varies instrumental methods like High performance chromatographic techniques (Nilesh, 2005-06), GC-gas chromatography (Frank, 1966), XRPD-Ray diffraction (Sunil 2009-10), electrophoresis and thin layer chromatography (Amol, 2005-06). Standardised herbal medicines maintained the quality and contain well defined constituents required for reliable beneficial therapeutic effects. Most of the herbal medicinal products are not labeled appropriately in their contents. Keeping above points in view, the determination of metals in the herbal medicines was done by ICP-MS method which has high degree of sensitivity and specificity.

Materials and methods

Chemicals: Yttrium as internal standard, deionized water solution of 0.5% nitric acid and 2 ppm gold (Thermo- fisher ICP-MS icap model).

Sampling: In the present study, the marketed herbal tablets Sarpagandha, Cardiol vati, Hemiplus vati, Medomine vati, Arthowin vati and B.P.C capsules are selected for the analysis. The brand names of the products, license number and the plants used as per company's label are included (Table 1).

Experimental design: Code numbers namely A to F was assigned for Sarpagandha, Cardiol vati, Hemiplus vati, Medomine vati, Arthowin vati and B.P.C capsules. By taking the weight of each tablet on digital balance, each tablet sample was gently ground to fine powder using mortar and pestle and packed in butter paper until analysis. The dilution is given in Table 2. Quantitative multi-elemental analysis by inductively coupled plasma (ICP) [Icap-Q] mass spectrometry depends on complete digestion of solid samples. However, fast and thorough sample digestion is a challenging analytical task in modern multi-elemental analysis.

Table 1. Tablet name with the company name and plants as per label.

Code	Brand and company name	Product name	Plants as per label*
A	Baidyanath (Mfg. Lic. No. ND/AYU/4)	Sarpagandha	Sarpagandha powder
B	Safe life (Mfg. Lic. No. NKD/AYU 82)	Cardiol vati	Suthi, Arjun ghan, Punarnava, Bringrajn, Abhrak bhasma, shuddha shiljit, Amalki ghan, Guduch ghan, Gokshur ghan, Akik pisti.
C	Safe life (Mfg. Lic. No. NKD/AYU 82)	Hemiplus vati	Amalaki, Haritaki, Bibhitaki, Sunthi, Pipali, marich, Vidang, Suvarna makshik bhasma, kasis bhasma.
D	Safe life (Mfg. Lic. No. NKD/AYU 82)	Medomine vati	Pipali, Marich, Amalki ghan, Haritaki ghan, Bibhitaki ghan, Trmad churn, Loha bhasma, Shuddha shilajit, Kitatika, Guduchi, Gugul, Sunthi.
E	Safe life (Mfg. Lic. No. NKD/AYU 82)	Arthowin vati	Rasna mool, Sunthi, Gokshur, Erand mool, Ashwagandha, Guggul, Guduchi.
F	Peekay pharma (Mfg. Lic. No. 25D/10/88)	B.P.C capsule	Sarpgandha, Lahasun, Arjun chhal Ex, Guggul Ashwag Jatamansi, Naandha, Isabgol, Brahmi, Jatamansi, Nagarmotha, Shankpushi, Kapoor kachri, Badi ilaichi.

*Data collected from the labelled contain with the tablets.

Table 2. Sample weight and dilution.

Samples	Weight (g)	Dilution
Sarpagandha	0.37287	100 mL in 1% HNO_3
Cardiol vati	0.45548	100 mL in 1% HNO_3
Hemiplus vati	0.2527	100 mL in 1% HNO_3
Medomin vati	0.47809	100 mL in 1% HNO_3
Arthowin vati	0.41698	100 mL in 1% HNO_3
B.P.C capsule	0.11798	100 mL in 1% HNO_3

Table 3. Multi-Elemental standards and mercury analysis.

Concentration	Yttrium (1 ppm)	MES	MES + Hg (20 ppb)	Final volume (mL)
Std .05 ppb	750 µL	-	75 µL	30
Std 0.5 ppb	750 µL	-	750 µL	30
Std 1.0 ppb	750 µL	-	1500 µL	30
Std 2.0 ppb	750 µL	-	3000 µL	30
Std 5.0 ppb	750 µL	150 µL	-	30
Std 20 ppb	750 µL	600 µL	-	30
Std 50 ppb	750 µL	1500 µL	-	30
Std 100 ppb	750 µL	3000 µL	-	30
Std 200 ppb	750 µL	6000 µL	-	30

To determine each heavy metal concentration as essential elements, 0.125 mL internal standard and 4.675 mL of diluent was added in to 0.2 mL sample solution. Deionzed water solution of 0.5% nitric acid and 2 ppm gold was used as a diluent.

Statistical analysis: The obtained values were properly validated with standard deviation, standard error and coefficient variance.

Results and discussion

Essential elements namely Cu, Zn, Cr, Mn and Fe are great importance for life. The detected accuracy of essential elemental concentration in selected samples by ICP-MS is given in Table 4.

Sarpagandha: In Sarpagandha sample, most abundant element was Fe-0.5113 ppm, whereas, Cr was found in lowest concentration (0.00102 ppm) and Zn was not detected.

Cardiol vati: In Cardiol vati sample, most abundant element was Fe-2.4213 ppm, whereas Cr was found in lowest concentration (0.00532 ppm) and Zn was not detected.

Hemiplus vati: In Hemiplus vati sample, most abundant element was Fe-20.1723 ppm whereas Cr was found in lowest concentration (0.00961 ppm) and Zn was not detected.

Medomine vati: In Medomine vati sample, most abundant element was Fe-0.68723 ppm whereas, Cr was found in lowest concentration (0.00125 ppm) and Zn was not detected.

Table 4. Accuracy of essential elemental concentration in ppm by ICP-MS.

Samples	Elements in ppm				
	Cu	Zn	Cr	Mn	Fe
Sarpagandha	0.07065	ND	0.00102	0.09875	0.5113
Cardiol vati	0.0384	ND	0.00532	0.21466	2.4213
Hemiplus vati	0.07236	ND	0.00961	0.61231	20.1723
Medomin vati	0.04236	ND	0.00125	0.07535	0.68723
Arthowin vati	0.03121	ND	0.00365	0.13623	2.1231
B.P.C capsule	0.05987	ND	0.00261	0.17031	1.478

ND: Not detected.

Table 5. LD50 of the elements (The Merck Index, 1989).

Elements	Compounds	LD 50
Copper (Cr)	Cupric acetate	0.71 g/kg orally in rats
Zinc (Zn)	Zinc acetate	2.46 g/kg orally in rats
	Zinc phosphide	40.5-46.7 mg/kg orally in rats
Chromium (Cr)	Chromium carbonyl	100 mg/kg in mice
Manganese (Mn)	Manganese dioxide	45 mg/kg in rabbit
	Manganese chloride	180-250 mg/kg in mice
Iron (Fe)	Iron pentacarbonyl	02.19 mg/L in mice 0.91 mg/L in rat

Arthowin vati: In Arthowin vati sample, most abundant element was Fe-2.1231 ppm whereas Cr was found in lowest concentration (0.00365 ppm) and zinc was not detected.

BPC capsules: In BPC capsules sample, most abundant element was Fe-1.478 ppm whereas, Cr was found in lowest concentration (0.00261 ppm) and Zn was not detected.

Conclusion

Results obtained from ICP-MS analysis of tablet samples detected the accurate values of essential element concentration in ppm. All these values of essential elements showed less toxicity in herbal medicines and detected below LD50. The content of essential elements is not indicated on their label. Elemental analysis by ICP-MS is a recent technique which gives more accurate concentration of essential elements contain in the samples which is not previously reported by researchers. Quantitative estimation of metals is done by atomic absorption spectrophotometer in bhasma only, not in tablets, therefore, the concentration of the essential elements are below the hazardous levels to the patient**.**

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