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QUANTITATIVE DETERMINATION AND VALIDATION OF HEAVY METALS ARSENIC, LEAD AND CHROMIUM FROM CARDIOL VATI BY ICP-MS

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ABSTRACT

Cardiol vati is one of the most popular herbal medicines in Indian market for Cardiac patients. The rapid development of metropolitan cities in developing as well as in developed countries it causes adverse life style effects like unhealthy food, pollutions and a sedentary job, and transportation mode are likely to be risk factors for cardiac diseases. Due to the minimum side effects and easily available in market people are preferred herbal medicines than allopathy medicines. Herbal medicines required standardization with implementation and constant review of technical standards of herbal product and effective quality control methods. Therefore it is thought necessary about the efficacy and standardization of Cardiol vati. Hence in present study Cardiol vati was scanned for the analysis of Heavy metals like Arsenic (As), Lead (Pb), Chromium (Cr) etc. These metals can bind several physiological and health effects. These metals can determine by quantitatively and validated by using modern technique such as ICP-MS.

KEYWORDS: Cardiol vati, Standardization, Herbal medicine, validation, Icp-ms.

INTRODUCTION

World health organization states that around 85-95% of the world population uses traditional medicines.[1] Indian traditional herbal medicines is the oldest health practice by ancient Aryans which is based on the oldest scripture of Hindus about 6000 years old. In the preparation of herbal medicines various parts of the plants are used as a raw material. After passing through many process they are converted in to finished herbal products. Herbs

include crude plant materials such as leaves, flowers, fruit, seeds, stems, wood, bark, roots, rhizomes or other plant parts, which may be whole, fragmented or powdered. Herbal materials include, in addition to herbs, fresh juices, gums, fixed oils, essential oils, resins and dry powders of herbs.[2] Arsenic is known to cause arsenicosis. Inorganic arsenic compounds causes cancer, inorganic oxides of arsenic may develop cancer.[3] But patients are not aware about their content, standards and validation. World health Organization gives some guidelines[4] for the preparation of herbal medicines and listed some methods for the standardization of herbal medicines[5] and also give maximum permissible limit of heavy metal[6] and quality controlled norms. It is important to follows the quality control norms to standardize the herbal medicines. Varies instrumental methods like HPLC -high – performance chromatographic techniques[7], GC-gas chromatography[8], electrophoresis and TLC -thin layer chromatography.[9] However those methods cater to mostly organic active ingredients. Therefore XRPD-Ray diffraction[10] and ICP methods are developed for the quality control from inorganic prospective such as Arsenic (As), lead (Pb) and Chromium (Cr) elements. Standardized herbal medicines maintained the quality and containing well defined constituents are required for reliable, beneficial therapeutic effects without any toxic effects.

MATERIALS AND METHODS

Chemicals

Yttrium as internal standard, de-ionized 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 Cardiol vati, was selected for the analysis. The brand names of the medicines, license number and the plants used as per company's label are included (Table 1).

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

Sr. No	Brand and Company Name	Medicines Name	Plants as per label *
1	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,

***Data as per container labelled.**

Experimental design

Methods

Samples: Cardiol vati, taking five tablets code number was given A, B, C, D and E. By taking the weight of each tablet on digital balance. Tablet of each sample is gently ground to fine powder using mortar and pestle and packed in butter paper until analysis. Quantitative multi-elemental analysis by inductively coupled plasma (ICP) Icap-Q spectrometry depends on a complete digestion of solid samples. However, fast and thorough sample digestion is a challenging analytical task in modern multi-elemental analysis. To determine each heavy metal concentration, 0.125 mL internal standard and 4.675 mL of diluent added in to 0.2 mL sample solution. De-ionzed water solution of 0.5% nitric acid and 2 ppm gold was used as a diluent.

Instrument configuration

Thermo – fisher ICP-MS icap model was used for all measurements. The instrument was operated in a single collision cell mode with kinetic energy discrimination (KED), using pure He as collision gas. The general analytical condition set for the ICP-MS are given in table number 2.

Table: 2. General analytical condition.

Sr. No	Parameter	Value
1	Spray Chamber Temperature	2.7
2	Cool Flow	14
3	Sampling Depth	5
4	Plasma Power	1550
5	Auxiliary Flow	0.8
6	Nebulizer Flow	1.0079
7	Spray Chamber Temperature	2.7
8	Peristaltic Pump Speed	25

Table -3. Standard Preparation. Stock Standards Available of 10 ppm 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

ARSENIC

1. Elemental arsenic and arsenic compounds are toxic and dangerous for environment and subsequently for human life.
2. Arsenic is highly toxic in its inorganic form.
3. Arsenic is naturally present at high level in the ground water of a number of countries.
4. Contaminated water used for drinking, food preparation and irrigation of food crops possess the greatest threat to public health from Arsenic.
5. Long –term exposure to arsenic from drinking water can cause cancer and skin lesion. It has also been associated with developmental effects, cardiovascular diseases, neurotoxicity and diabetes.[11]

Lead

Lead is particularly dangerous to children because their growing bodies absorb more lead than adult and it can effect on their brain and nervous system. Adult may be exposed to lead by eating and drinking food or water containing lead or from dishes or glasses that contain lead.[12] Lead can cause several effects like, Rise in BP, Kidney damage.[13]

RESULTS AND DISCUSSION

Diluted samples of Cardiol vati were used for the further analysis on ICP-MS Icap Q model. As a heavy metals Arsenic (As), Lead (Pb) and Chromium (Cr). are great importance for life. Detected accuracy of Heavy metal concentration in selected samples by ICP-MS are given in Table 4.

Table: 4. Accuracy of elemental concentration per Tablet.

Sr. No	Tablet code	Concentration of Elements in ppm		
1	A	0.00099	0.02749	0.0101311
2	B	0.00121	0.020412	0.0106504
3	C	0.00101	0.02532	0.01042
4	D	0.00132	0.02166	0.01101
5	E	0.00104	0.02345	0.01085

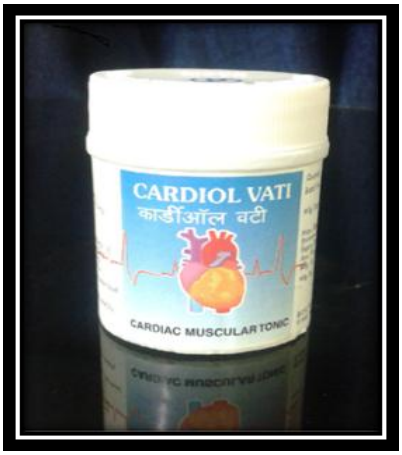

Figure-1A. Cardiol vati Sample.

Figure-1B. Cardiol vati.

Cardiol Vati- Application

Heart is the most important organ of the circulatory system which nourishes the whole body by supplying pure blood .Obviously abnormal heart function lead to serious problems. Heart is made up of muscle fibers. Any abnormality in the constitution of heart and the other factors like blood, mind and Oja give rise to diseases related to heart. Cardiol vati helps to reduce cholesterol and triglyceride level in blood. It also tones the cardiac muscles and improves the function of heart. (Information collected from the leaflet provided with sample).

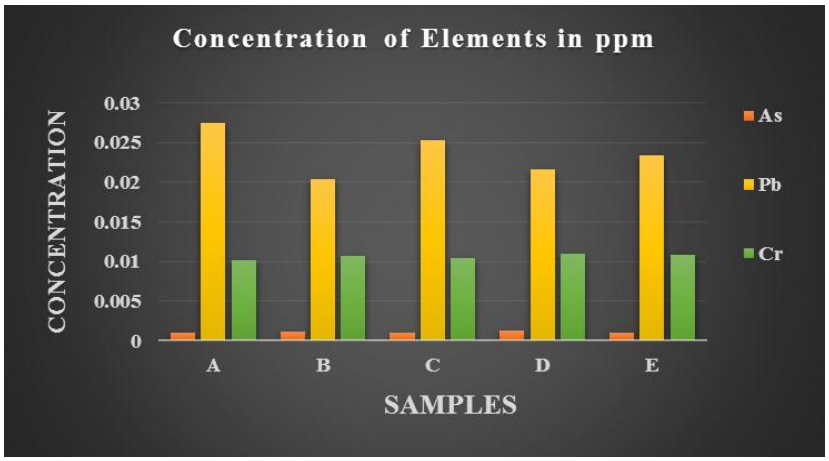

Fig: 2. Graphical representation of Elements present in different samples

LD 50 FROM MERCK INDEX - 11TH EDITION AND ACGIH Threshold limit Value

Sr. No	Elements	Compounds	LD50	TLV (Airborne Threshold Limit Value)
1	As	Arsenic acid	06 mg/kg iv in rabbit	0.01mg/m^3
2	Pb	Lead acetate	200 mg /kg ip ion rat	0.05 mg/m^3
3	Cr	Chromium carbonyl	100 mg/kg iv in mice	5.0 µg/m^3

Table: 6. Standard deviation, standard errors and Coefficient variance of Heavy Metals Calculated in Cardiol Vati.

Sr. No	Observations	Concentration of Elements in ppm		
		As	Pb	Cr
1	1	0.00099	0.02749	0.0101311
2	2	0.00121	0.020412	0.0106504
3	3	0.00101	0.02532	0.01042
4	4	0.00132	0.02166	0.01101
5	5	0.00104	0.02345	0.01085
6	Mean	0.001114	0.0236664	0.0106123
7	SD	± 0.000144222	± 0.002828427	± 0.000347851
8	SE	± 6.44981E-05	± 0.001264911	± 0.000155563
9	CV	0.129463241	0.119512352	0.032778054

Table: 7 Calibration correlation coefficient R and BEC (ppb) data.

Sr. No	Isotope	R	BEC (ppb)
1	^{75}As	0.996	0.0113
2	^{207}Pb	0.993	0.121
3	^{52}Cr	0.994	0.071

Table: 8. JECFA (and EU as indicated) heavy metal limits[14]

Sr. No	Element	Stated Limit (PTWI - weekly)	Calculated Daily Limit (Adult 70 kg)	EU Status
1	Arsenic	15 µg inorganic arsenic/kg bw	150 µg	No information found
2	Lead	25 µg lead/kg bw	250 µg	Endorsed 6/19/1992

Heavy metals namely (As), Lead (Pb) and Chromium (Cr) are great importance in life. The detected accuracy of heavy metals concentration in selected samples by ICP-MS is given in Table 4. In Cardiol vati sample A to E, most abundant element was Lead (Pb) whereas Arsenic (As) was found in lowest concentration. The Standard deviation (SD), standard error (SE) and coefficient variance (CV) calculated from the different observations of all samples are given in table number 6 and table number 7 shows that for most of the target elements, low ppt BEC (background equivalent concentration). Table number 8 shows the heavy metal PTWI-weekly stated limit and calculated daily limit for adult by the Joint Expert Committee on Food Additives.

The CV for the Arsenic (As) calculated from the different observation was 0.129463241 and the SE was found ± 6.44981E-05.

The CV for the Lead (Pb) calculated from the different observation was 0.119512352 and the SE was found ± 0.001264911.

The CV for the Chromium (Cr) calculated from the different observation was 0.032778054 and the SE was found ± 0.000155563.

From the above observation and calculation of CV and SE for the heavy metals Arsenic (As), Lead (Pb) and Chromium (Cr) was found in very low concentration and it was found in below toxic limit in all samples.

Figure 3, 4 and 5 shows the standard calibration graph for the elements Arsenic (As), Lead (Pb) and Chromium (Cr) by ICP-MS.

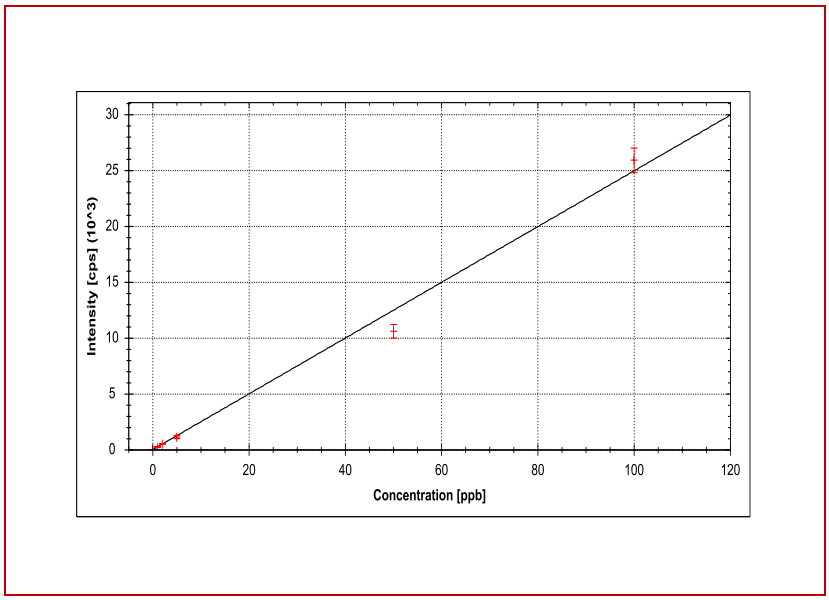

Fig-3 Calibration graph of Arsenic

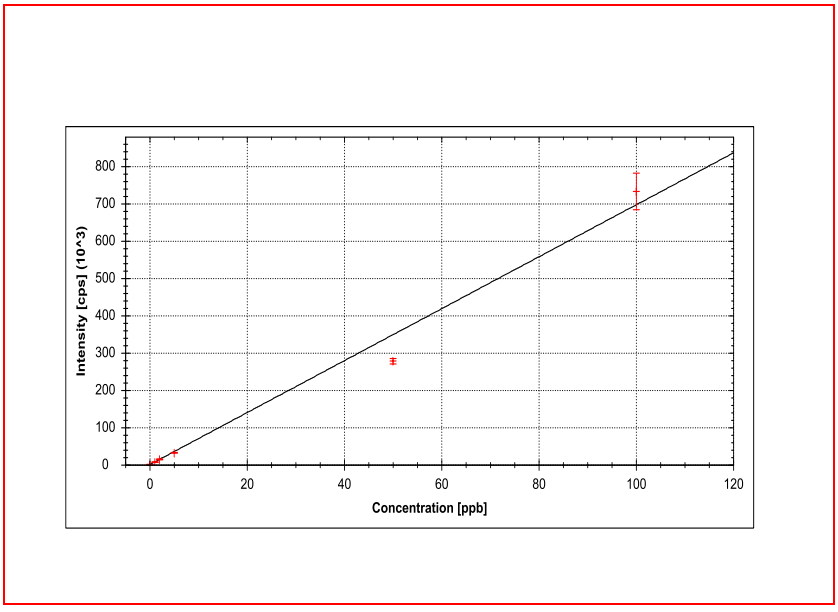

Fig: 4. Calibration graph of Lead

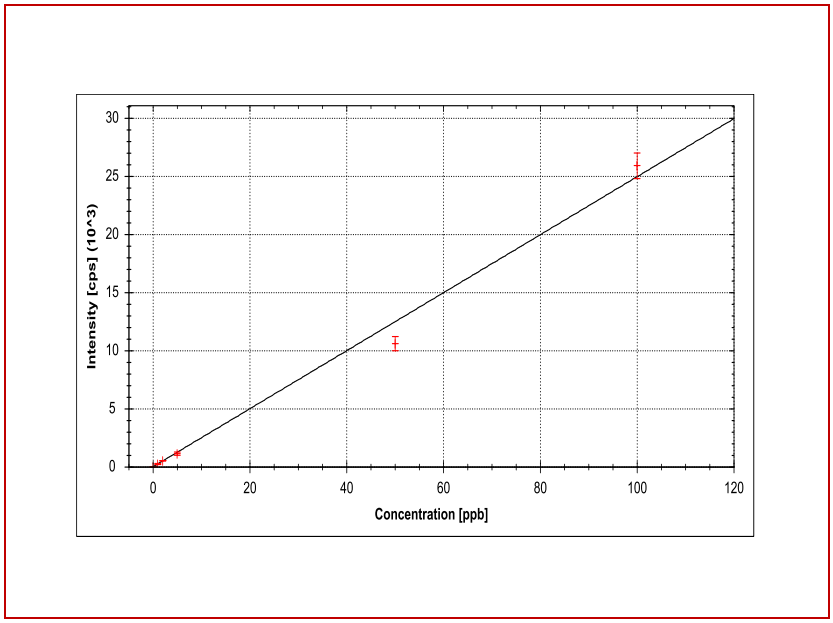

Fig: 5. Calibration graph of Chromium

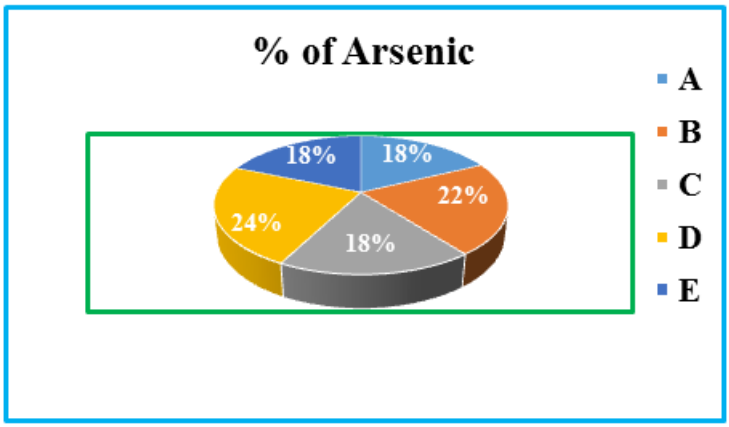

Fig: 6. Percentage of Arsenic per sample

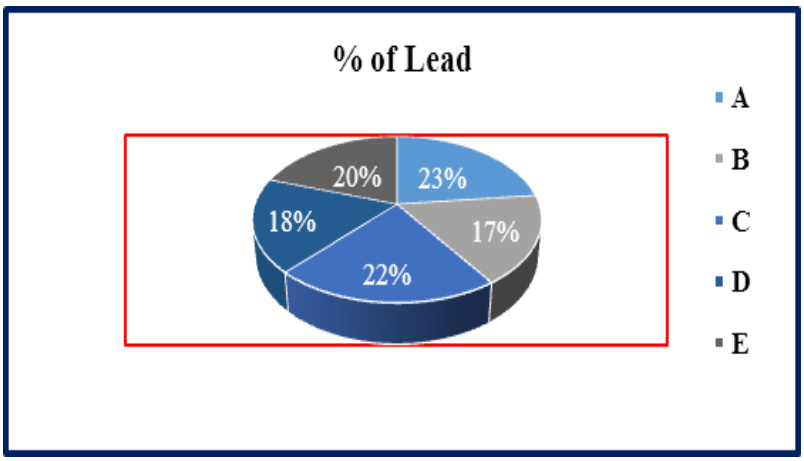

Fig: 7. Percentage of Lead per sample

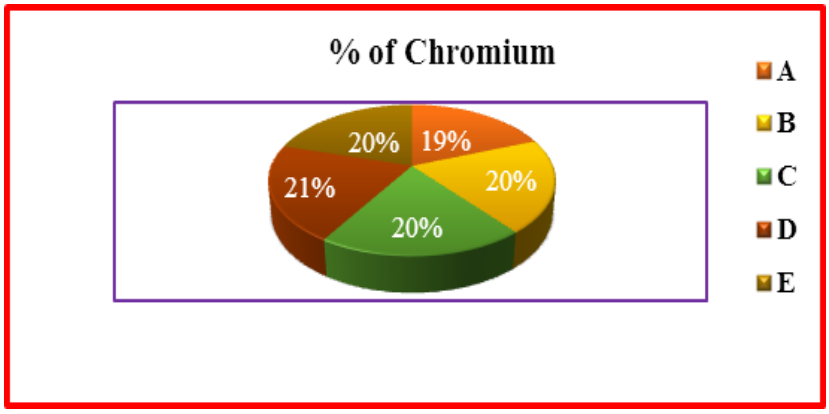

Fig: 8. Percentage of Chromium per sample

The above figure number six indicate that the 18%, 22%, 18%, 24%, and 18% of Arsenic (As) in A, B, C, D, E and F samples respectively.

Figure number seven indicates that the 23%, 17%, 22%, 18% and 20% of Lead (Pb) in A, B, C, D, E and F samples respectively.

Figure number eight indicates that the 19%, 20%, 20%, 21% and 20% of Chromium (Cr) in A, B, C, D, E and F samples respectively.

The above figure number 6 shows that the percentage of Arsenic (As) in all samples, figure number 7 shows that the percentage of Lead (Pb) in all samples and the figure number 8 shows that the percentage of Chromium (Cr) in all samples. It observed that the difference between each Heavy metals in all samples was very low concentration.

CONCLUSION

The CV of the samples are less than one are consider as low variance and CV is greater than one are consider as high variance in all samples very low CV was found. All these values of heavy metals showed less toxicity in herbal medicines, and are detected below LD50 and within permissible limit by WHO. A low SD means that the data is very closely related to the average thus very reliable. The sufficient quality controlled parameters and condition were followed during the manufacturing process. Results obtained from ICP-MS analysis of tablet samples detected the accurate values of Heavy metal concentration in ppm. The content of heavy metals is not indicated on their label. Elemental analysis by ICP-MS is a recent technique which gives more accurate concentration of heavy metal contain in the samples which is not previously reported by researchers. Quantitative estimation of metals is done by atomic absorption spectrophotometer in herbal powder only, not in tablets, therefore, the

concentration of the heavy metal are below the hazardous levels to the patient. The standardization and validation of herbal tablets should be mandatory for the preparation of herbal medicines for the more efficiency and accurate results.

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