

## **SHORT NOTES**

### **ANALYSIS OF LEAD AND CADMIUM IN SELECTED INDIAN AYURVEDIC MEDICINES BY ICP-AES**

#### **ABSTRACT**

Herbal drugs used in treatment of diabetes, require long-term usage and the patient might be at risk of heavy metal poisoning. This study has been conducted to determine the concentration of heavy metals Pb and Cd in ten (10) commonly used anti-diabetic medicines of different brands. 6 out of 10 medicines were purchased from different medical stores in Mumbai and the other four were purchased from online ayurvedic medicine selling store, Rajasthan. The samples were digested using microwave digester and finally analyzed using Inductively Coupled Plasma- Atomic Emission Spectroscopy. The results revealed the concentration of cadmium in the range of 0.061 to 18731.940 ppm. The concentration of lead was detected which ranged from 0.37 to 1965172.97 ppm. Pb and Cd concentration levels in most of the medicines were higher than the maximum permissible limit as found, on their comparison with the safety standards given by World Health Organization (WHO). Based on the results obtained in the present work, it is concluded that the present technique is suitable for the determination of heavy metals concentration in anti-diabetic granules and tablets at the ppb level.

#### **INTRODUCTION**

Ayurveda is an intricate system of healing that originated in India thousands of years ago<sup>1</sup>. Ayurvedic medicines are primarily composed of herbs, minerals metals and/or animal products. Herbal medicines in recent years, are used to treat many conditions such as asthma, eczema, premenstrual syndrome, rheumatoid arthritis, migraine, menopausal systems, chronic fatigue and irritable bowel syndrome among others<sup>3</sup>. Heavy metal contamination in traditional medicines may occur due to polluted environment in which the medicinal plants grow, the polluted conditions in which the plants are dried and processed, the storage conditions or during manufacturing of the final dosage form<sup>4</sup>. If these metals present in water and soil are in significant amounts, they can accumulate in the food chain and cause serious health problem to humans and can affect the rest of the organisms<sup>5</sup>.

Herbal formulations, especially those used in the treatment of diseases such as hypertension diabetes and weight loss, may require long-term usage and the patient might be at risk of heavy metal poisoning<sup>6</sup>. The World Health Organization (WHO) has developed guidelines for the quality control of herbal medicines<sup>7</sup>. Lead and cadmium are among the most common heavy metals found in an environment. Lead poisoning causes symptoms of muscle cramp, constipation, frailty, stomach-ache and memory problem, while cadmium poisoning causes symptoms of dizziness, cough, dryness, nausea, severe vomiting and diarrhoea. There are several poisoning cases reported

in India due to heavy metal contamination in herbal medicines. Most of the population in India relies on the use of herbal medicines. Therefore, it is essential to maintain the quantity of such heavy metals within the prescribed maximum permissible limits given by WHO. The WHO mentions maximum permissible limit in raw materials for arsenic, cadmium, and lead, which amount to 1.0, 0.3, and 10 ppm, respectively<sup>8</sup>.

Different digestion methods such as wet digestion, dry digestion and microwave digestion are used to bring the herbal medicines to their elemental form<sup>3,6,10</sup>. In order to evaluate the heavy or toxic metals from herbal medicines, different techniques like atomic absorption spectroscopy, X-ray fluorescence spectroscopy, inductively coupled plasma- atomic emission spectroscopy and inductively coupled plasma-mass spectroscopy are used<sup>10-13</sup>. ICP-AES, combined with the microwave digestion technology has tremendous advantages in terms of saving time and effort, reducing environmental pollution, as well as fast and accurate determination of results in determining major and minor trace elements<sup>10</sup>. The objectives of the present work were to determine the presence and concentration of lead and cadmium in some ayurvedic medicines in India using ICP-AES after microwave digestion.

#### **MATERIAL AND METHODS**

##### **Materials**

The chemicals used for the study were supra grade, nitric acid (HNO<sub>3</sub>) (69-71%), lead and cadmium atomic

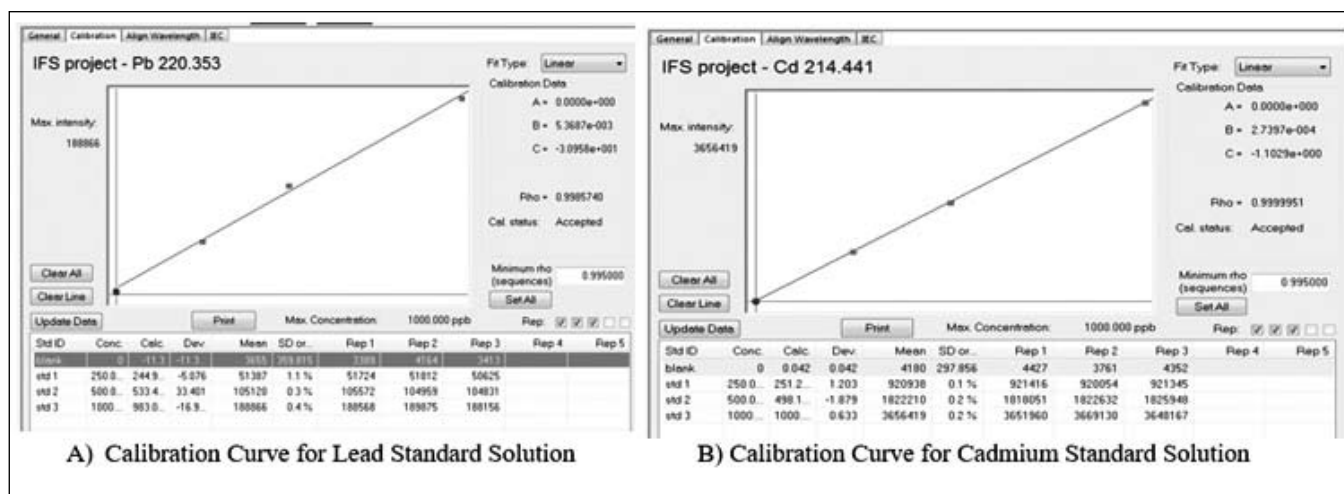


Fig. 1: Calibration curve for lead standard solution and cadmium standard solution

absorption standard solutions (990-1010 mg/L) and double de-ionized water which was obtained from Milli-Q water system. Microwave digestion system-CEM Corporation (model Mars 6 One Touch Technology) and Teledyne Leeman Labs-Prodigy 7 ICP-AES system with CMOS array detector were used for the analysis.

### Method

Study comprised of total 10 anti-diabetic ayurvedic medicines from 10 different brands. All 10 medicine samples were labelled from S-1 to S-10. A sample was taken and homogenized using mortar and pestle and dried at 80°C. For microwave digestion 0.2 kg of dried powder sample was taken in 100 mL Teflon reaction vessel. 10 mL concentrated HNO<sub>3</sub> was added and allowed to stand at 150°C for 30 min in fume hood. Further, microwave digestion was performed with the following conditions, ramp time 20 min, hold time-20 min, temperature- 190°C, power-1000 W and cooling time-15 min. After that, 20 mL of double de-ionized water was added to each vessel and made up to 50 mL and further analysed with ICP-AES. For calibration purpose, the lead and cadmium standard solutions were prepared from lead and cadmium (990-1010 mg/L) atomic absorption standard stock solution of concentrations 0.25, 0.5, 0.75 and 1 ppm and further analysed with ICP-AES. The relative standard deviation was automatically calculated, which was found <1.5% and the correlation coefficient was > 0.995000.

### RESULTS AND DISCUSSION

The present study was focused on the analysis of anti-diabetic granules, tablets and Bhasma, which was similar to the study carried out by S. K. Bias et. al.<sup>8</sup> on

Table I: Concentrations of Pb And Cd by ICP-AES

SAMPLE ID	CONCENTRATION IN PPM	
	LEAD	CADMIUM
S-1	16.75*	-
S-2	4.80	0.061
S-3	0.37	0.089
S-4	36.12*	0.348*
S-5	6.09	0.344*
S-6	3.75	0.401*
S-7	-	0.112
S-8	5.93	-
S-9	9.35	-
S-10	1965172.97*	18731.940*

anti-diabetic ayurvedic Churna samples. The previous studies done by Muhammad Saeed *et.al.*<sup>4</sup> and A. B. M. Helal Uddin *et.al.*<sup>7</sup> were based on wet acid digestion method. All these methods were based on open digestion systems which had disadvantages like, time-consuming process, limited to boiling points of acids, excess use of acid, low extraction efficiency, loss of volatile elements, greater risk of contamination from external sources and reducing environmental pollution.

In the present study, microwave digestion was performed, similar process for digestion was also used by Yan Qing Hua *et.al.*<sup>10</sup>, Eng Shi Ong *et.al.*<sup>14</sup> and Ibrahim A. Maghrabi<sup>15</sup>. This technique had given high digestion efficiency. Hence, in the present study new method had been developed in which samples were digested with concentrated nitric acid in microwave digestion system

at given conditions. Similar studies were also performed using Atomic Absorption Spectroscopy by Zahra Mousavi *et.al.*<sup>16</sup> in which the concentrations of metals in drugs were found in the range of 0.19 to 1.75 µg/g for Cd and 9.61 to 52.74 µg/g for Pb. In the study of Sanjay K Baiser *et.al.*<sup>8</sup>, the concentration of cadmium in anti-diabetic churn samples ranged from 0.34 to 0.8 ppm and Lead concentration ranged from 11.8 to 13.5 ppm. In the study of Adepoju-Bello *et.al.*<sup>9</sup>, the concentration of cadmium ranged from 0.000 to 40.288µg/g and lead was undetectable in the samples. In the study of Yogesh B. Pakade *et. al.*<sup>6</sup>, the concentration of cadmium was found in the range of 0.11 to 0.48 mg/kg and lead was found in the range of 2.5 to 6.0 mg/kg.

In present study, the concentration of lead and cadmium were determined using ICP-AES which was similar to the study conducted by Yan Qing Hua *et.al.*<sup>10</sup> and Ibrahim A. Maghrabi<sup>15</sup>. In the study of Yan Qing Hua *et.al.*<sup>10</sup>, the concentration of Pb was found in the range of 1.59 to 6.59 59 µg/g and cadmium was undetectable in the sample. In the study of Ibrahim A. Maghrabi<sup>15</sup>, the concentration of lead was found in the range of 0.345 to 1.59µg/g and Cd 0.030 to 0.180µg/g. The quantity of Pb and Cd, found in anti-diabetic medicines was compared with the maximum permissible limit (MPL) given by World Health Organization.

As per the Table I, 9 out of 10 samples have shown the presence of lead, whereas lead was undetected in sample number S-7. The concentration varied from minimum of 0.37 ppm in S-6 to a maximum of 1965172.97 ppm in the sample no. S-10. 3 (S-1, S-4 and S-10) out of 10 samples have shown lead content above their maximum permissible limit i.e. 16.75, 36.13 and 1965172.97 ppm respectively. Whereas, in the other samples S-2, S-3, S-5, S-6, S-8 and S-9, the lead concentration was found to be 4.80, 0.37, 6.09, 3.75, 5.93, 9.35 ppm, respectively, and these were present below the maximum permissible limit (10ppm) as per given by WHO. As per the Table I, 7 out of 10 samples i.e. S-2, S-3, S-4, S-5, S-6, S-6, and S-10 have shown the presence of cadmium, whereas 3 (S-1, S-8, S-9) out of 10 samples have shown the absence of cadmium. The concentration varied from a minimum of 0.061 ppm in S-2 to a maximum of 18731.940 ppm in S-10. 4 (S-4, S-5, S-6, S-10) out of 10 samples have shown cadmium content above their maximum permissible limit i.e. 0.348, 0.344, 0.401 and 18731.940 ppm respectively. Whereas, in the other samples S-2, S-3, and S-7, the cadmium concentration was found to be 0.061, 0.089 and 0.112 ppm, respectively, and these were found to be

present below the maximum permissible limit (0.3ppm) as per given by WHO.

The present study and the study given of by Zahra Mousavi *et.al.*<sup>16</sup> in Iranian market, Adepoju-Bello<sup>9</sup> in Nigeria and Moses A.G. Maobe<sup>17</sup> in Southwest Kenya proved that the heavy metals content varies depending on the country of origin, environmental pollution levels, parts of the plant, processing methods and instrumental methods used for the analysis.

## CONCLUSION

Based on the above results obtained, it was observed that most of the anti-diabetic medicines contained heavy metals like lead and cadmium above their maximum permissible limit given by the WHO. ICP-AES has the advantage of no chemical interference, is time saving has low detection limit, good precision, ability to analyze small sample size and good reliability. The technique is highly useful for fast and accurate determination of Pb and Cd. Further research work should be carried out on the presence of heavy metals with reference to geographical origin, environmental pollution and parts of the plant. The present study could be of relevance to the research laboratories involved in Ayurveda and herbal drug.

## ACKNOWLEDGEMENT

The author acknowledges Dr. Nitin Kulkarni (Manager-LabIndia Analytical Instruments Pvt. Ltd) for useful analytical assistance.

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<https://doi.org/10.53879/id.56.04.11298>

(Received 17 January 2018) (Accepted 02 April 2018)



## Indian Drug Manufacturers' Association (Event Calendar 2019-20)

Sr. No.	Day & Date	Organizer	Event	Venue
1.	Friday, 10 <sup>th</sup> May 2019	IDMA (Marketing Committee)	<b>IDMA Marketing and Sales Conference 2019: "Growing Brands to Level Next"</b>	Sunville Banquets, Worli, Mumbai
2.	Friday, 24 <sup>th</sup> May & Saturday, 25 <sup>th</sup> May 2019	IDMA-APA	<b>21<sup>st</sup> IDMA - APA Pharmaceutical Analysts' Convention (PAC) 2019</b>	At Hotel Holiday Inn, Andheri (E), Mumbai

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