



## RESEARCH ARTICLE

### STUDY ON SOME HEAVY METAL INTAKE THROUGH THE RECOMMENDED MEDICATION DOSAGE OF SOME AYURVEDIC HERBS AND FORMULATIONS

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#### ABSTRACT

Eight herbal medicines (Six herbal extracts-Yastimadhu, Aloevera, Haritaki, Ashwagandha, Rasna, Nirgundi and two herbal formulations- Arogyavardhini Vati and Chanderprabha vati) were tested for levels of heavy metals (Lead, copper, cadmium, iron, chromium, manganese, nickel and zinc). Both herbal extracts and herbal formulations showed presence varying quantities of heavy metals. However, concentrations of heavy metals were greater in the herbal formulations as compared to herbal extracts. Iron was found in maximum quantities as compared to other heavy metals. Very high quantities of Iron were detected in the two Ayurvedic formulations. The paper discusses the significance of these quantities in terms of Daily Limit given by various international food and drug administration agencies. The intake of the heavy metals has been calculated by taking into account the recommended daily dose of the given Ayurvedic medicines. Intake of heavy metals through medication is compared with the daily maximum dose given by the various agencies. It was observed that the quantity of all the heavy metals daily intake as per recommended medicinal dose are within the prescribed limits. Iron, Zinc and copper are classified as micronutrients, the minimum level of these are required for good health. However, these metals have been reported to be deficient in the diet. The prescribed medication of tested Ayurvedic medicines provides the required intake of these micronutrients. The study concludes that the eight ayurvedic medicines tested have safe limits of heavy metals and in addition provide for required micronutrient.

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## INTRODUCTION

Ayurveda is a system of medicine of Indian origin. Ayurvedic medicines originated in India more than 2000 years ago and rely heavily on herbs and their formulations. It is known to be an upveda of Atharva Veda. Ayurvedic medicines being prepared from herbs are usually considered safe and free from side effects. WHO (world health organization) estimates that 80% of world's population relies on these 'Alternative' plant based medicines as their primary medical intervention (Chan, K., 2003; Robert *et al.*, 2004). Approximately 80% of India's population use Ayurveda through more than one-half million Ayurvedic practitioners working in 860 Ayurvedic hospitals and 22100 clinics (Gogtay *et al.*, 2007). Considering the complexity of these drugs, their inherent biological variation it becomes necessary to evaluate their efficacy, safety and quality (Maria *et al.*, 2007). Due to heavy demand for herbal medicines natural resources of these herbs have depleted, so to meet the increasing demand, the medicinal herbs are cultivated on farms using standard agronomic practices which require the input of fertilizers, pesticides, fungicides etc to provide

nutrients, protection from pests and diseases and to maintain high productive level. It's well documented that chemical fertilizers and pesticides contain toxic substances which are taken up and accumulated in the various parts of the medicinal herbs. One such group of toxic substances is heavy metals. Ayurvedic formulations prepared using such herbs are likely to contain heavy metals taken up from the rooting media. Heavy metal concentration in Ayurvedic medicines is of special concern in today's time as use of Ayurvedic medicines is increasing and one of the most important reasons for heavy metal contamination is pollution from various sources. The heavy metals can be absorbed by plants as they grow. In addition, air born heavy metals may be sources of foliar contamination, at least for lead (Anon, 2001.a) and cadmium (Anon, 2001.b). Contamination of herbs with heavy metals cannot be totally avoided as heavy metals are naturally present in the soil media as well as additional contamination from anthropogenic sources. And as these heavy metals cannot be removed from the herbal preparations and also as some of the Ayurvedic formulations are constituted with heavy metals they can be said to be an unavoidable evil. Since 1978 at least 55 cases of heavy metal intoxication associated with Ayurvedic HMP (herbal medicinal preparations) in adults and children have been reported in the USA and abroad (Saper *et al.*, 2004).

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Hence various international agencies have come out with limits of dietary daily intake for the various heavy metals. The US EPA (Environment Protection Agency), ASTDR (Agency for Toxic Substances and Disease Registry) has compiled priority list in 2001 called as "TOP 20 Hazardous Substances". The heavy metals arsenic, lead, mercury and cadmium are ranked 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> respectively (Das *et al.*, 2011). The various agencies like EPA, ATSDR, FDA (Food and Drug Administration) have made different criteria's. EPA has established a Reference Dose (RfD) for inorganic arsenic, cadmium and methyl mercury. ATSDR within the U.S. Department of Health and Human services also has established and maintains "minimal risk levels" (MRL) for oral consumption of arsenic, cadmium and methyl mercury (Gogtay *et al.*, 2002). FDA has stated allowable level for Arsenic, Cadmium, Lead and Mercury in bottled drinking water. The present study has been undertaken to determine the level of various heavy metals in six herbal extracts and two Ayurvedic formulations and to discuss the results in terms of toxicity levels in the prescribed dosage of test material and compare with the Daily Limit set by various international agencies.

## MATERIALS AND METHODS

In the present study, six herbs (Nonrasa Shastra) and two ayurvedic formulations (Rasa Shastra) were procured from the local market. Their uses are listed as per classical ayurvedic texts.

- Yastimadhu (*Glycyrrhiza glabra*) mentioned in Bhavprakash nighantu in Haritkyadi varg Shalok. 229-230. It's indicated for piles, ulcer (Vran), edema (Shoth), mitigates poisoning (Vishagn), vomiting (Chardi), thirst (Trisha), nausea (Glanni). (Dev, S., 2006.a)
- Kumari (*Aloe vera*) mentioned in Bhavprakash nighantu in Guduchyadi Varg Sh.229-230, it is indicated for Splenomegaly (Plihavridhhi), fever, burns, blisters, skin diseases (Dev, S., 2006.b)
- Haritaki (*Terminalia chebula*) mentioned in Bhavprakash nighantu in Haritkyadi varg sh.19, 20, 21, 22 indicated for asthma (Shwas),cough (Kas),Piles(Arsh),leprosy (kusth), jaundice(Dev, S., 2006.c)
- Ashwagandha (*Withania somnifera*) in Bhavprakash nighantu in Guduchyadi varg Sh.190 indicated for leucoderma, inflammation (Shoth), Rasayan (Rejuvinator). (Dev, S., 2006.d)
- Rasna (*Pluchea lacneolata*) indicated in arthritis, neuritis, cough, asthma, obesity, diabetes.

- Nirgundi (*Vitex Negundo*) Guduchyadi varg Sh.114 is indicated for hair problems, eyes, pain of abdomen (Udar shool), worm infestation (Krimighan), anorexia. (Dev, S., 2006.e)
- Arogyavardhini vati (Ras Ratansamuchhaya) has the following ingredients- kajjali, lauh bhasm, abhrak bhasm, tamr bhasm, triphala, shilajeet, gugglu, chitrakmool, kutki, nimb patr. It is indicated for yakrit rog, jalodar, pandu, medorog, mandagni. (Mishra, S.N., 2011.a)
- Chanderprabha vati (Sidhyogsangrah) Has the following ingredients- Kapurkachri, nagarmotha, chirayta, giloy, devdaru, haldi, atissa, daruhaldi, chitrakmool, dhaniya, triphala, chavya, vidang, gajpippal, trikatu, swarnmakshik bhasm, sajjikashar, yavakshar, sendhalavan, sonchar lavan,sambhar lavan, choti elaichi, kabab chini, gokshur, shwetchandan, nisoth, dantimool, dalchini ,vanshlochan, lauh bhasm, shilajeet, gugglu, bhawna giloy swaras. It is indicated for urinary tract infestations, Madhumeha. (Mishra, S.N., 2011.b)

## Estimation of heavy metals

Samples were dried in a hot air oven at 60 degree centigrade for 4 hours. Dried samples were ground and 1gram of sample was digested in an acid mixture of nitric acid and hydrochloric acid in ratio of 1:3 (Aquaregia). The digested samples were cooled and filtered through glass fiber filter. The final volume made to 25ml with distilled water. The filtered samples were subjected to analysis for heavy metals using a double beam Atomic Absorption Spectrophotometer (Electronic Corporation of India Ltd (ECIL), model AAS4141). Calibration curves of each metal were prepared by dilution of 1000mg /L standard stock solution of the metals.

## Daily ingestion of heavy metal through medication

Was calculated as follows:

$$A/B = C$$

A= Concentration of heavy metal in sample ( $\mu\text{g}/\text{gm}$ )

B= Capsule/ tablet weight in gram

C= Concentration of heavy metal in Capsule/ tablet ( $\mu\text{g}$ )

Daily ingestion of heavy metal = C x Prescribed number of capsules/ tablets per day

## RESULT AND DISCUSSION

Represented in Table 1 are the concentrations of the various heavy metals in the tested herbs and Ayurvedic preparations. In all the samples the heavy metals have been detected in varying quantities. The presence of heavy metals in Ayurvedic

**Table 1. Concentration of heavy metals in the Ayurvedic medicines**

Sample	Heavy metal concentration ( $\mu\text{g}/\text{gm}$ )							
	Zn	Cu	Ni	Mn	Pb	Cd	Cr	Fe
Yastimadhu	8.25	5.97	ND	2.50	13.29	3.30	ND	1131
Aloevera	2.07	ND	ND	3.25	3.70	2.82	ND	2274
Haritaki	0.87	ND	ND	3.15	16.92	2.80	ND	274
Ashwagandha	25.90	1.72	0.75	2.95	19.98	2.70	ND	416
Rasna	9.57	ND	ND	7.05	19.59	3.65	ND	95
Nirgundi	9.65	ND	ND	3.45	11.60	2.47	ND	345
Arogyavardhini	47.02	ND	28.78	10.40	15.36	0.00	62.73	19988
Chanderpraba	38.43	ND	0.43	59.24	14.93	0.00	1.17	36717

**Table 2. Heavy metal concentrations in the recommended medication dosage of the herbal extracts and formulations**

S.No	Samples	Per Capsule/Tablet concentration (µg) (Values in parenthesis denote concentration in the recommended daily dose)							
		Zn	Cu	Ni	Mn	Pb	Cd	Cr	Fe
1*	Yastimahdu	4.13	2.99	ND	1.25	6.65	1.65	ND	565.5
2*	Aloe vera	1.04	ND	ND	1.63	1.85	1.41	ND	1137
3*	Haritaki	0.44	ND	ND	1.58	8.46	1.40	ND	137
4*	Ashwagandha	12.95	0.86	0.38	1.48	9.99	1.35	ND	208
5*	Rasna	4.78	ND	ND	3.53	9.79	1.83	ND	47.50
6*	Nirgundi	4.82	ND	ND	1.72	5.80	1.24	ND	172.5
7**	Arogyavardhini vati	11.76	ND	7.20	2.60	7.68	ND	15.68	4997
8**	Chanderprabha Vati	9.60	ND	0.11	14.81	3.73	ND	0.29	9179.30

\*Serial number 1-6 capsule. bid- 500mg, \*\*Serial number 7-8 tablet. bid- 250mg

**Table 3. Current quantitative heavy metal limits of U.S. Agencies**

	Agency/ Scope	Stated limit	Calculated Daily Limit (Adult)
Arsenic	FDA/ Bottled drinking water	Allowable level=10 µg arsenic/liter	20 µg (calculated at 2 liters/day)
	EPA/Drinking water	MCL =10 µg arsenic/liter	20 µg (calculated at 2 liters/day)
	EPA/IRIS	RfD (Chronic effect ; non-cancer) =0.3 µg inorganic arsenic /kg bw	21µg (Calculated at 70 Kg)
	ATSDR	MRL(chronic oral consumption) =0.3 µg inorganic arsenic /kg bw	21µg (Calculated at 70 Kg)
Cadmium	FDA/ Bottled drinking water	Allowable level=5 µg cadmium/liter	10 µg (calculated at 2 liters/day)
	EPA/Drinking water	MCL = 5 µg cadmium/liter	10 µg (calculated at 2 liters/day)
	EPA/IRIS	RfD (Chronic effect ; noncancer) =1.0 µg cadmium/kg bw	70 µg (Calculated at 70 Kg)
	ATSDR	MRL (chronic oral consumption) =0.2 µg cadmium/kg bw	14 µg (Calculated at 70 Kg)
Lead	FDA/ Bottled drinking water	Allowable level= 5 µg lead/liter	10 µg (calculated at 2 liters/day)
	EPA/Drinking water	Action level= 15 µg/ liter	30 µg (calculated at 2 liters/day)
Mercury	FDA/ Bottled drinking water	Allowable level= 2 µg mercury/liter	4 µg (calculated at 2 liters/day)
	EPA/Drinking water	MCL = 2 µg mercury/liter	4 µg (calculated at 2 liters/day)
	EPA/IRIS	RfD (Chronic effect ; noncancer) = 0.1 ug methyl mercury/kg bw	7 µg (Calculated at 70 Kg)
	ATSDR	MRL (chronic oral consumption) = 0.3 ug methyl mercury/kg bw	21µg (Calculated at 70 Kg)

**Table 4. Heavy metal limits for Canada's Natural Health Products**

Metal	Stated Limit	Calculated Daily Limit (Adult, 70 kg)
Arsenic	0.14µg "arsenic and its salts and derivatives"/ kg bw	10 µg
Cadmium	0.09 µg cadmium/ kg bw	6 µg
Lead	0.29 µg/kg bw	20 µg
Mercury	0.29 µg "mercury and its salts and derivatives"/ kg bw"	20 µg

**Table 5. Clinical implications of nutritional trace elements**

S.No.	Mineral	Recommended Daily Dose	Functions in body	Deficiency
1	Iron	Premenopausal:18mg day Postmenopausal female and male: 8mg/day	Component of hemoglobin, metalloprotein, oxygen transport	Iron deficiency anemia Hemosiderosis hemochromatosis
2	Zinc	F: 8mg/day, M:11 mg/day	Protein synthesis, zinc finger protein, component of enzymes	Ageusia Growth retardation Dermatitis Hypogonadism Acrodermatitis enteropathica Copper deficiency Nausea, vomiting
3	Copper	900 mg/day	Cellular respiration, collagen synthesis, component of enzymes, antioxidant	Menke's kinky hair syndrome Hypochromic anemia Skeletal defects Wilson's disease
4	Chromium	F: 25µg/day, M:35 µg/day	Glucose tolerance factor	Hyperglycemia, neuropathy, encephalopathy
5	Manganese	F:1.8 mg/day M:2.3 mg/day	Component of metalloenzymes, Manganese superoxide dismutase	Dermatitis, eczema, bronchogenic Carcinoma Hair and nail changes, impaired clotting factors Parkinsonism-like features
6	Nickel	Less than 100 micrograms /day		
7	Lead	-	-	-
8	Cadmium	7 micrograms/kg body weight per week		

substances has been reported in earlier works as well (Breeher, L., 2013; Saper *et al.*, 2004). Iron in the Ayurvedic preparations (rasa shastra) has been detected in larger quantity as compared to the herbal extracts (non rasa shastra), among the herbal extracts Yastimahdu and *Aloe vera* have the higher concentration of the heavy metal iron. Table 2 represents the calculated values of the heavy metals in the capsules and tablet standard presentation of the products. It also gives the concentration of heavy metal intake in the prescribed daily dose of the herbal extracts and Ayurvedic preparations. When

the daily intake of the heavy metals through the prescribed daily dose of these Ayurvedic medicines are compared with the Calculated Daily Limit in dietary intake given by the various American and Canadian agencies as given in Table 3 and 4. It is observed that the quantities ingested are within the limits prescribed by these agencies. Hence, these Ayurvedic medicines can be considered to be safe. Moreover, some of the heavy metals such as Iron, zinc copper, manganese, and chromium has been reported to be essential for good health (Table 5). These metals have been reported to be deficient in

the diet (WHO, 2008) and required to be made up through the use of mineral supplements. The tested herbal medicines contain these nutrients and consumption of these medicines makes up for the deficiency of these minerals in the diet.

### Conclusion

Hence it can be concluded from the presented results, that the tested Ayurvedic medicines are not only safe in terms of heavy metal intake but apart from their therapeutic use they are also beneficial as they supply some of the essential minerals most importantly iron which is usually deficient in the diet. It is also worth considering that these minerals may be having a synergetic effect on the activity of these Ayurvedic medicines.

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