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Evaluation of Heavy Metals in Indian Herbal Teas

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Tea holds an exalted place among beverages all around the World. Next to water, it is the most consumed beverage in the World. In recent times herbal teas have gained popularity due to their health promoting campaign. Herbal teas are made from different medicinal herbs and make a health promoting drink full of medicinal properties such as support in blood circulation (black pepper), digestive aid (ginger), antistress and antiviral (Basil), kidney protection (cardamon), antiseptic (cloves) etc. (Brown et al. 1999). Accumulation of heavy metals in our body is known to cause various ailments e.g : Arsenic is known to cause skin cancers, hypertention and peripheral arteriosclerosis also known as black-foot disease (Lee et al. 2002; Lee et al. 2003; Cabrera and Gomez 2003); mercury is known to cause neurological disorders (e.g. Minamata disease) and kidney damage (Anonymous 1997a); lead causes brain neurotoxicity and behavioral diseases (Mateo et al. 2003; Marchetti, 2003); cadmium causes lung cancers, pulmonary edema, pneumonitis, respiratory distress, liver and kidney damage and skeletal deformities commonly known as "Itai-itai" disease (Anonymous 1997b). A lot of work has been done to check the presence of these heavy metals in air, water, sediment, soil, animals and human beings (Abdulla et al. 1993; Kabata-Pendias and Pendias 2000; Adriano 2001; Iskander 2001) but comparatively less work has been done on the presence of these heavy metals in herbal teas especially Indian herbal teas. Recently our research group has been involved in exploring the presence of heavy metals in some therapeutically important medicinal plants (Haider et al. 2004). Adverse effects of heavy metal contamination on cash crops has also been studied by us (Shukla et al. 2002, 2003). In the present study, attempts have been made to study the presence of heavy metals in some Indian herbal teas.

MATERIALS AND METHODS

Eight different popular herbal teas commercially available in the local markets, were procured for the study. The major ingredients of these herbal teas are given in Table 1. All chemicals used in the study were of analytical grade (E.Merck) Deionised water was used throughout the study, including rinsing of the glasswares. A digestion mixture comprising of conc. HNO_3 and perchloric acid (ultrapure grade) in the ratio of 6:1 was used for wet digestion of the samples. Mixed working standard (1 and 10 μg/ml) solutions were freshly prepared

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Table 1. Herbal teas and their ingredients.

Sr. No.	Herbal tea	No. of ingredients	Ingredients
1	A	2	*Ocimum sanctum and Ocimum gratissimum*
2	B	1	*Cymbopogon citratus*
3	C	13	*Ocimum sanctum, Cinnamomum tamala, Viola odorata, Foeniculum vulgare,Cinnamomum zeylanicum, Zingiber officinale, Syzygium aromaticum, Myristica fragrance, Elettaria cardamomum, Piper nigrum, Cyperus rotundus, Tinospora cordifolia and Adhatoda vasica*
4	D	9	*Ocimum sanctum, Viola odorata, Rubia cordifolia, Zingiber officinale, Piper nigrum, Syzygium aromaticum, Elettaria cardamomum, Myristica fragrance and Cymbopogon citratus*
5	E	35	*Cassia senna, Hypericum perforatum, Taxus baccata, Ocimum sanctum, Acacia arabica, Aloe vera, Valeriana wallichi, Coriandrum sativum, Nelumbo nucifera, Convolvulus pluricaulis, Rosa damascena, Myristica fragrance, Asparagus racemosus, Zingiber officinale, Elettaria cardamomum, Cinnamomum zeylanicum, Syzygium aromaticum, Piper nigrum, Glycyrrhiza glabra, Calotropis procera, Centella asiatica, Withania somnifera, Tribulus terrestris, Foeniculum vulgare, Cuminum cyminum, Althaea officinalis, Azadirachta indica, Cyperus rotundus, Santalum album, Terminalia arjuna, Piper longum, Catharanthus roseus, Acorus calamus, Pimpenella anisum and Crocus sativus*
6	F	17	*Foeniculum vulgare, Cinnamomum zeylanicum, Trachyspermum ammi, Ocimum sanctum, Piper nigrum, Viola odorata, Mentha arvensis, Syzygium aromaticum, Zingiber officinale, Cinnamomum tamala, Bacopa monnieri, Glycyrrhiza glabra, Elettaria cardamomum, Withania somnifera, Rosa damascena, Santalum album and Terminalia arjuna*
7	G	9	*Ocimum sanctum, Viola odorata, Zingiber officinale, Glycyrrhiza glabra, Cinnamomum zeylanicum, Syzygium aromaticum, Foeniculum vulgare, Pterocarpus santalum and Rosa damascena*
8	H	10	*Foeniculum vulgare, Zingiber officinale, Bacopa monnieri, Glycyrrhiza glabra, Elettaria cardamomum, Terminalia arjuna, Cymbopogon flexuosus, Piper nigrum, Pterocarpus santalum and Cinnamomum zeylanicum*

by diluting the stock solutions of 1000 µg/ml (Merck India). Blanks and spiked samples were also processed and analysed simultaneously. One gram of each powdered sample was accurately weighed on an electronic balance (Shimadzu LIBROR AEX-200G).The samples were then put in a 100 ml digestion flask ; 5 ml of the digestion mixture was added to it and heated on a hot plate in the fuming chamber. The flasks were heated slowly first and then vigorously till one ml remained at the bottom. If the solution turned brownish, another 5 ml of digestion mixture was added and the process repeated till a white residue was obtained. The residue was dissolved and made up to 10 ml with 0.1N HNO_3 in a volumetric flask (grade one). The solutions were then analysed on Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) (8440 Plasma Labtam). All necessary precautions were adopted to avoid any possible contamination of the sample as per the AOAC guidelines (1998). The detection limit of the instrument for each metal was Cu 0.0054 µg/g, Cr 0.0061 µg/g, Mn 0.0014 µg/g, Ni 0.010 µg/g, Zn 0.0018 µg/g, Pb 0.042 µg/g and Cd 0.0025 µg/g.

RESULTS AND DISCUSSION

Level of heavy metals (Fig. 1) and micronutrients (Table 2a and 2b) were estimated in the eight brands of herbal tea and evaluated with respect to permissible limit and Allowable Daily Intake (ADI) as prescribed by WHO/FDA. The Acceptable Daily Intake (ADI) of Pb, Cr, Ni and Cd in foods is 0.45 mg/day, 0.2 mg/day, 0.40 mg/day and 0.21 mg/day respectively (Harper, 1976; IRIS, 1996; NRC, 1989). In terms of herbal tea, a person may consume extracts obtained from 25g/day. It means ADI for Pb would be 0.45 mg/25g, Cr (0.2 mg/25g, Ni (0.40 mg/25g) and Cd (0.21 mg/25g). In terms of mg/Kg, the ADI for Pb would be 18mg/Kg, Cr (8 mg/Kg), Ni (16 mg/Kg) and Cd (8.4 mg/Kg). Results show that Pb, Cr, Ni and Cd in all the Indian herbal teas is below the limit of ADI. According to WHO (1989), the Provisional Maximum Tolerable Daily Intake (PMTDI) of copper, zinc, iron and manganese (Essential micronutrients) is 0.5mg/Kg body weight, 1 mg/Kg body weight, 0.8 mg/Kg body weight and 0.14 mg/Kg body weight respectively. The PMTDI for copper is 30 mg/day for a 60 Kg person. Similarly PMTDI for zinc, iron and manganese is 60, 48 and 8.5 mg/day respectively. These essential micronutrients were found to be far below the PMTDI level in all the herbal teas studied indicating that they add to the micronutrient supply from other sources but do not have such high levels that may cause adverse effects (Table 2a and 2b). Herbal tea A with 2 ingredients showed Cd, Cr, Ni and Pb 0.26±0.03 µg/g, 0.83±0.03 µg/g, 3.46±0.12 µg/g and 4.25±0.19 µg/g respectively; Herbal tea B with a single ingredient showed lower level of these heavy metals as compared to A. 50% lesser load of Cd and Pb being 24% lesser than A (Fig. 1). Increase in the number of plant ingredients lead to increase in the level of heavy metal contamination as evident from the data for Ni and Cr in herbal tea E with 35 ingredients. It showed Cd, Cr, Ni and Pb as 0.10±0.02 µg/g, 3.29±0.13 µg/g, 5.43±0.21 µg/g and 4.09±0.76 µg/g respectively. Although possibility of contamination increases with higher number of ingredients, a positive correlation was not found in our study, for all the heavy metals tested. Cd

Table 2(a). Heavy metals in Indian herbal teas (μg/g)

Heavy Metal	Herbal Tea A	Herbal Tea B	Herbal Tea C	Herbal Tea D
Cu	9.90±1.13	6.45±0.29	4.25±0.17	4.83±0.02
Fe	36.50±6.95	853.60±28.0	122.00±6.08	654.00±9.17
Mn	25.60±1.99	80.56±0.95	83.46±3.90	66.90±6.12
Zn	26.86±0.32	24.40±0.46	17.23±3.45	16.93±2.50

Values are ±S.D. of three determinations in each case

Table 2(b). Heavy metals in Indian herbal teas (μg/g)

Heavy Metal	Herbal Tea E	Herbal Tea F	Herbal Tea G	Herbal Tea H
Cu	13.16±0.96	3.56±0.29	11.16±0.21	11.10±0.15
Fe	446.60±22.81	522.46±10.17	456.66±18.90	56.13±2.10
Mn	140.00±5.29	53.30±3.84	24.46±2.90	25.30±3.16
Zn	39.50±0.75	15.63±3.21	20.66±0.32	21.13±1.74

Values are ±S.D. of three determinations in each case

was highest in Herbal tea A (0.26±0.03 μg/g) and lowest in Herbal tea E (0.10±0.02 μg/g); Cr was highest in herbal tea E (3.29±0.13 μg/g) and lowest in Herbal tea A (0.83±0.03 μg/g); Ni was highest in herbal tea E (5.43±0.21 μg/g) and lowest in Herbal tea C (3.05±0.20 μg/g); Pb was highest in Herbal tea C (5.75±0.65 μg/g) and lowest in Herbal tea B (3.23±0.31 μg/g). According to WHO (1998), the permissible limit for Pb in medicinal herbs is 10 mg/Kg and Cd is 0.3 mg/Kg. Cd and Pb was found to be below the permissible limits in all the herbal teas as given in Table 2(a) and Table 2(b). Cu, Mn, Zn, Cr and Ni were found to be highest in Herbal tea e having highest number of ingredients i.e., 35. Iron content in herbal tea A and Herbal tea H is low as compared to other herbal teas which may be due to processing and storage of these teas. Levels of 5 out of eight heavy metals tested i.e, Cr, Ni, Cu, Mn and Zn were found to be highest in herbal tea E with highest number of ingredients i.e, 35 ingredients and comparatively low in other teas with less number of ingredients. This difference may be due to the fact that the possible sources of contamination are more in herbal tea E as compared to the others. Moreover, in herbal tea A and herbal tea B, only leaves are used whereas in herbal tea C, D, F, G and H, 2 root ingredients are present. In herbal tea E, 9 out of 35 plant ingredients are roots or rhizomes. As we know that the accumulation of heavy metals is higher in the root or rhizome portion as compared to the others (Liu et al, 2001) it is not surprising that, herbal

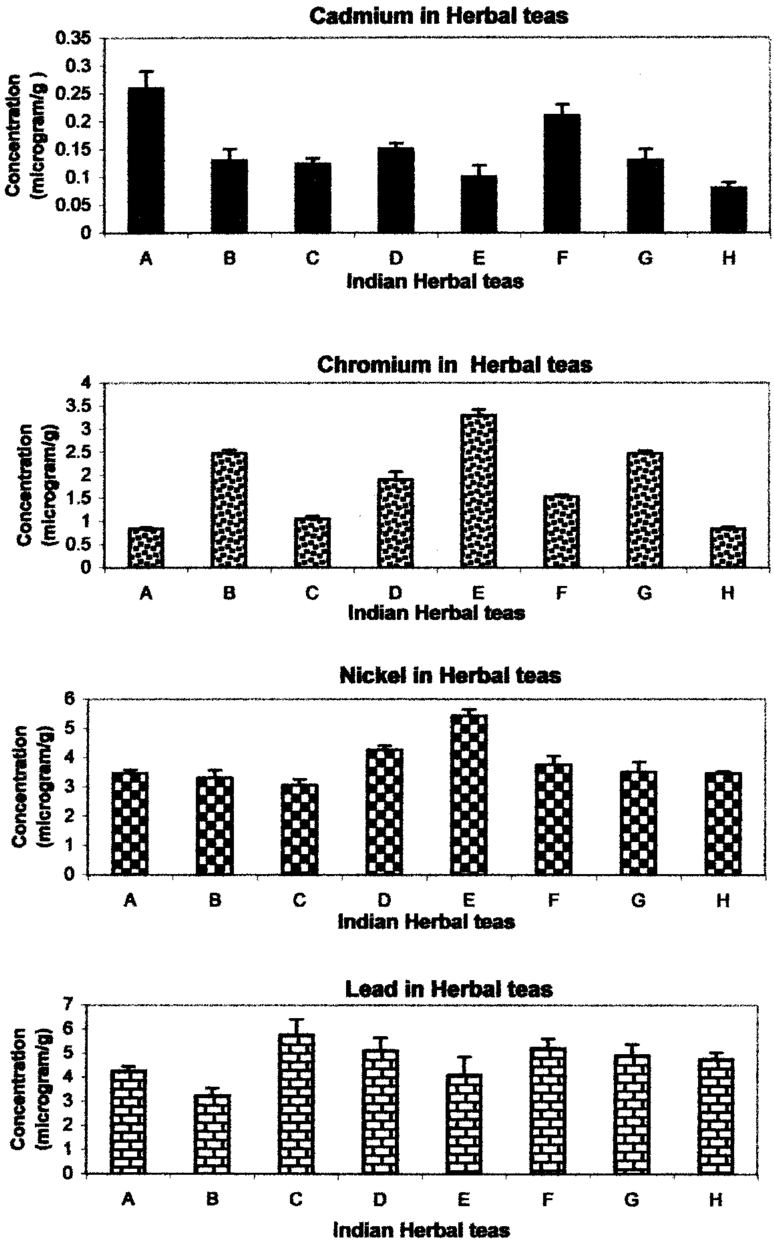

Figure 1. Cadmium, chromium, nickel and lead in herbal teas. Values are ±S.D. of three determinations in each case.

tea E contains more heavy metals as compared to the other teas as shown in Figure 1. Therefore, it may be concluded that it is safer to drink herbal tea with less number of ingredients as far as presence of heavy metals is concerned and possibility of contamination increases in polyherbal teas and all the herbal teas including polyherbal teas is safe to drink as far as metal contamination is concerned.

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