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Evaluation of Trace Metal Contents in Food Products Within the Network of Shops and Local Markets of Agra, India

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Minerals and trace elements occur in a number of chemical forms, such as inorganic ions and salts or as constituents of organic molecules, e.g., proteins, fats, carbohydrates and nucleic acids. The minerals (Goyer 1994)) that are considered essential in the human diet are Na, K, Cl, Mg, P, Fe, Cu, Zn, Mn, Se, I, Cr, Co, Mo, F, As, Ni, Si and B. A number of other chemical elements occur in food are Al, Sr, Pb, Sn, Hg, Cd and many of them toxic. As certain heavy metals such as Pb, Cd, As and Hg have been recognized to be a considerable potential hazard exists for human nutrition. Toxic metals (Coultate 1990; Popa et al. 1986) may reach our food from a number of sources such as (i) the soil in which human or animal feedstuffs are grown; (ii) sewage sludge, fertilizers, and other chemicals applied to agricultural land; (iii) the water used in food processing or cooking; (iv) contaminated dirt (e.g., soil on unwashed vegetables) and (v) the equipments, containers and utensils used for food processing storage or cooking. Studies on different foodstuffs for heavy metals like Pb, Cd, Fe, Cu, Zn etc. have been done by various investigators (Karavoltsos et al. 2002; Yuzbasi et al. 2003). According to their nutritional role (Goyer 1995; Underwood 1977), metals from the food products can be divided in to two categories: essential metals like Na, K, Ca, Cu, Zn and Mn (their absence or even their insufficient amount in human diet induce some modifications of metabolic process which will lead to some diseases after a period of time) and unessential metals like Pb, Hg, Al, Sn and Ag. For both categories, increasing of metal concentration in food over the maximum permissible limits can cause toxic effects (Guicherit 1973) for consumers of these products. The gravity of toxic effect (Vinas et al. 1993) depends on nature, quality and chemical forms of metals from the food product and it depends on metal concentration in food, on body resistance and on synergetic or antagonistic effects of other chemical contaminants.

Severity of toxic effects of all elements increases with dose. On the basis of mean concentrations of Hg in cereals, vegetables, pulses, milk and fish, the average intake of Hg through normal diet of an adult is estimated to be 7.3 μg/day. The estimated daily intake of Cd in different countries ranges from 25-60 μg/day while the tolerable daily intake of Cd is about 57-72 μg/day. Water, food and smoking are the major sources of Cd. Among the most important food possible contaminated with Cd are pork meat, fish, milk, beer and vegetables. The main

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sources of Pb contamination are lead piping and lead lined tanks in domestic water supplies. canning. hair dyes. storage batteries. paints. pigments and using the pottery glaze for storage the beverages. Leafy vegetables. potatoes and beans are likely to absorb more Pb than fruiting crops like tomatoes. beats. etc. The WHO suggests a provisional tolerance of 7.0 μg/kg body weight per day for adults. The richest sources of Cu are oysters. and the organ meats (liver. kidney and brain) followed by nuts. dried legumes. dried vine and cocoa. These contain Cu in the range 20-400 mg/kg. The poorest sources of Cu are milk. butter. cheese. white sugar and honey. which consist of about 0.5 mg/kg of Cu. The non-leafy vegetables. fresh fruits. refined cereals. including white flour and bread contains about 2.0 mg/kg of Cu. The daily intake from normal adult diets is between 1 and 3 mg. which roughly corresponds to the intake level recommended by most authorities. The distribution of Zn in our foodstuffs has much in common with Cu. The concentration of Zn in cow's milk lies between 3.0 and 5.0 μg/mL. Wheat germ and bran and oysters are the richest sources of Zn and contain about 40-120 mg/kg and 1000 mg/kg of Zn. respectively. White sugar. pome and citrus fruits are among the lowest in Zn. which hardly contain 1.0 mg of fresh edible portion. Adult human diets supply 5.0-22 mg Zn per day. Dietary intake of Ni is about 300-66 μg/day. Only 1-10 % of the dietary nickel ingested is absorbed. Nickel is found in tea. cocoa. peanuts and several other foodstuffs. Cow's milk contains about 0.03 mg of Ni. Copper and nickel are commonly used as a protectant and eradicant against blister blight. a fungus disorder that affects tea.

In our present research study. the metals Pb. Cu. Cd. Ni and Zn were investigated in different brands of food products viz.. milk. fruit juices. and tea and alcoholic beverages.

METHODS AND MATERIALS

The samples were collected from open market of Agra city. The concentrations of Pb. Cu. Cd. Ni and Zn metals from different brands of tea samples were determined. To determine the metals content from food products originated from animals. we analysed 12 samples of cow's milk. 12 samples of buffalo's milk. 10 samples of goat's milk. 13 samples each from two local dairies supplying milk in Agra. To check the heavy metal contents in alcoholic beverages and different brands of beer. wine and whiskey samples were analysed. Six different brands of fruit juices were also checked to determine the metal contents.

These samples require extensive sample pre-treatment prior to analysis. For milk analysis. 5 mL aliquot of sample were taken in 100 mL volumetric flask and 50 mL of 25% tricholoro acetic acid was added to it and diluted to volume with deionised water. The samples were shaken at 5 min. intervals for 30 min. and then filtered. 5 mL aliquot of the filtrate was transferred to 50 mL volumetric flask and 1 mL of 5% lanthanum solution was added to it and diluted the sample with deionised distilled water. Direct aspiration of samples was done in case of whiskey while in beer samples. few drops of octyl alcohol were added prior to analysis to control the foam if produced. For tea analysis. 3 g sample was taken in to 400 mL beaker and 100 mL concentrated nitric acid was added and contents were swirled and then the beaker containing this solution was put on the hot plate. The acid was evaporated nearly to dryness. cooled and 50 mL concentrated nitric acid and 10 mL per chloric acid were added to it. The solution was evaporated until fumes of per chloric acid were obtained. The solution was transferred to 50 mL volumetric flask and diluted to volume with deionised water. To analyse fruit juices. 20 mL of sample in 100 mL volumetric flask were taken. 10 mL concentrated hydrochloric acid added to it and diluted the sample with deionised double distilled water. The samples were shaken and filtered to remove solid particles.

All the chemicals were used of Merck AnalR grade quality. All the glasswares were rinsed with 10% nitric acid and then with deionised double distilled water before use. Metals. Pb. Cu. Cd. Zn and Ni have been determined by Flame Atomic Absorption Spectrometer (Perkin Elmer Aanalyst 100) using hollow cathode lamps and air-acetylene flame. The metals. Pb. Cu. Cd. Zn and Ni were analysed at 283.3. 324.8. 228.8. 213.9 and 232.0 nm wavelengths. respectively. Sample blank was also run during analysis for all brands of samples and all the samples have been analysed in duplicate and three replicate determinations were used for each sample.

RESULTS AND DISCUSSION

The mean values of all the results have been summarized in the Tables 2-6 and Figures 1-2. The obtained results were compared with the maximum limit allowed for each product. and these limits are shown in Table 1 as given by Banu et al. (1985).

Table 1. Maximum limits allowed in some food products (μg/g).

Food products	Pb	Cu	Cd	Zn
Fruit juice	0.1	1.0	0.02	5.0
Milk	0.1	0.5	0.01	5.0
Distilled alcoholic beverages	0.3	5.0	0.01	5.0
Industrial alcoholic beverages	0.01	1.0	0.01	5.0

N.D: under the limit of detection

Table 2. Heavy metal contents in various brands of fruit juices (μg/g).

Fruit juice	Pb	Cu	Cd	Zn	Ni
Frooti	N.D	N.D	0.011	N.D	0.199
Morton	N.D	0.072	0.044	N.D	0.449
Nestle	N.D	0.025	N.D	0.812	0.449
Real	N.D	0.206	N.D	0.130	0.414
Slice	N.D	0.073	0.014	N.D	0.307
Tropicana	N.D	0.305	N.D	0.24	0.062

N.D: under the limit of detection

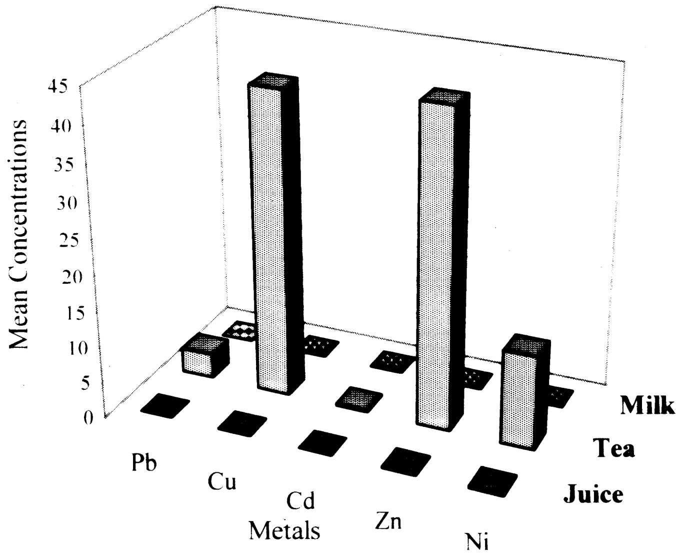

Figure 1. Heavy metal contents (μg /g) in some food products.

Table 3. Heavy metal contents in various brands of tea (μg/g).

Tea	Pb	Cu	Cd	Zn	Ni
Double diamond	4.66	37.22	0.97	56.91	15.78
Red label	3.50	66.68	N.D	51.76	24.03
Taj Mahal	3.16	36.38	N.D	38.31	7.63
Taja	2.33	33.11	0.18	34.99	6.90
Tata	3.83	41.40	N.D	37.37	10.83
Open tea	3.50	39.73	0.40	42.87	12.16

N.D: under the limit of detection

Table 4. Heavy metal contents in milk samples (μg/g).

Milk	Pb	Cu	Cd	Zn	Ni
Cow	N.D	0.04	0.08	N.D	N.D
Buffalo	N.D	0.01	0.11	0.17	N.D
Goat	N.D	0.05	0.03	N.D	N.D
Parag dairy	N.D	0.01	0.03	N.D	N.D
Singhal dairy (local)	N.D	N.D	N.D	N.D	N.D

N.D: under the limit of detection

Table 6. Heavy metal contents in whiskey samples (μg/mL).

Whiskey	Pb	Cu	Cd	Zn	Ni
Mc Dowell No.1	N.D	0.194	0.091	N.D	0.145
Old monk	N.D	3.271	0.071	N.D	0.196
Tango	N.D	0.098	0.100	N.D	0.272
Vodka	N.D	N.D	0.074	N.D	0.189

N.D: under the limit of detection

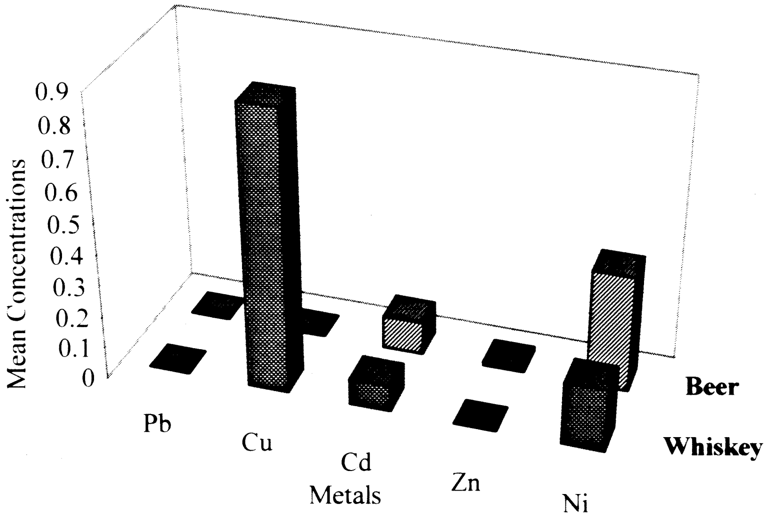

Figure 2. Heavy metal contents (μg/g) in alcoholic beverages.

Table 5. Heavy metal contents in beer samples (μg/mL)

Beer	Pb	Cu	Cd	Zn	Ni
Hayward 5000	N.D	N.D	0.087	N.D	0.462
Kingfisher	N.D	N.D	0.125	0.025	0.281

N.D: under the limit of detection

Table 2 shows the mean concentrations of metals in different brands of fruit juices. The levels for Pb were found in all brands of fruit juices under the limit of detection. Maximum Cu levels were recorded in tropicana juice and Cu levels were determined in frooti juice under the detection limit. For Cd metal, morton juice recorded maximum levels while Cd levels have been recorded below detection limit in nestle juice, real and Tropicana brands of juices. Zn levels were found below detection limit in frooti, morton and slice juices while nestle juice were recorded maximum Zn levels. Maximum Ni levels were found in morton and nestle juice and minimum Ni levels have been found in Tropicana juice. The metal concentrations recorded for all brands of juices have been found under the maximum permissible limits.

Table 3 shows the mean concentrations of metals in different brands of tea samples. Taja tea contains minimum concentrations for all metals except Cd and red label tea contains maximum levels for Cu and Ni metals. Minimum Cd levels have been observed in Taj mahal tea and maximum Cd values in double diamond tea. Double diamond tea contains maximum levels for Pb, Cd and Zn metals.

Table 4 shows the mean concentrations of metals in milk samples. Pb and Ni levels have been found in all the milk samples under the limit of detection. Zn levels were found only in buffalo's milk and local dairy milk of Agra city. Very low Cu and Cd levels have been observed in all the milk samples.

Table 5 and 6 shows the mean concentration of metals in different alcoholic beverages. Pb levels have been recorded below detection limit in all alcoholic beverages. Zn levels were found below detection limit in all different brands of whiskeys. Zn levels were found in kingfisher beer only. In case of Ni metal, the mean concentrations have been found higher in beers in comparison to whiskeys. Cu levels have been recorded in beers under detection limit and maximum Cu levels have been found in old monk whiskey, which was much higher in comparison to other brands of whiskeys.

Pb levels have been recorded only for tea samples and maximum values for all metals have been observed in different brands of tea samples. All the products analysed for heavy metals have been found within the maximum allowed limits.

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