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Short Communication

Determination of mineral and toxic heavy elements in different brands of black tea of Pakistan

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***Camellia sinensis* (Tea) has attracted attention of consumers and food manufacturers for its health benefits and physiological effects. Evidences are found that heavy metals are present in tea. Both metallic and non metallic elements are essential for human growth and development within certain permissible limits; harm to humans is expected due to change in this allowable limit. Twelve black tea samples (open and branded) were collected from market and subjected to analysis, using flame atomic absorption spectroscopy. The results showed that black tea available in market is made from leaves collected from different regions (different soil source), and have different capacity for accumulation of heavy metals.**

Key words: Black tea, heavy metals, flame atomic absorption spectrometry (FAAS), toxicity.

INTRODUCTION

For so long herbs are utilized for the treatment of different kind of disease. Tea which is used as refreshing drinks has been widely used in the past and also in the present, all over the world. It can be easily prepared from fresh or dried herbs by putting hot water in it. Depending on the chemical constituents present in herbal tea, it is utilized for nutritional as well as therapeutic purposes. It is evident from botanical study that tea is the most largely consumed beverage in the world. Different investigation showed that tea particularly green is useful for prevention of cancer, use as a stimulant, astringent, diuretic, regulate body temperature and blood sugar, promoting digestion and increase mental activity. Some toxic heavy metals are described in literature from herbs (Samali et al., 2012). Saponin isolated from tea has been found to decrease blood pressure (Nworgu et al., 2008). A heavy metal is a member of an ill-defined subset of elements that exhibit metallic properties, which would mainly include the transition metals, some metalloids, lanthanides and actinides. Living organisms require varying amounts of heavy metals (iron, cobalt, copper, manganese, molybdenum and zinc). Excessive levels of these metals can damage the organisms. Certain elements like vanadium, tungsten and even cadmium are normally toxic for organisms. However, motivations for controlling heavy metal concentrations in gas streams are diverse. Some of them are dangerous to health and environment (for example, Hg, Cd, As, Pb and Cr), while some may cause corrosion (for example, Zn and Pb) and some are harmful in other ways (for example, that which pollutes catalysts) (Hussain et al., 2011).

This study is aimed at determination of these heavy metals, which became possible by using analytical techniques such as flame atomic absorption spectroscopy. The general assessment of analytical

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Table 1. Standard range of heavy metals.

Elements	Zn (mg kg^{-1})	Fe (mg kg^{-1})	Mn (mg kg^{-1})	Cu (mg kg^{-1})	Ni (mg kg^{-1})	Pb (mg kg^{-1})	Cd (mg kg^{-1})
Standard calibration range	0.6,1.2, 1.8, 2.4	0.6, 1.2, 2.4, 4.8, 9.6, 19.2	0.6, 1.2, 1.8, 2.4, 3, 3.6	0.4, 0.8, 1.2, 1.6, 2.0	0.6, 1.2, 1.8, 2.4, 3, 3.6, 4.2, 4.8, 5.4	0.6, 1.2, 1.8, 2.4, 3, 3.6, 4.2, 4.8, 5.4	0.4, 0.8, 1.2

results for different samples (brands of tea collected from local market) is likely to illustrate individual specificity of each studied brand and diversity of each product.

MATERIALS AND METHODS

Sample collection

Ten marked black tea brands and two open teas (twelve samples total), commonly consumed in Pakistan were collected from local markets and study was then carried out on them in the instrumental laboratory, Department of Chemistry, Kohat University of Science and Technology. The tea samples included Lipton yellow Label, Brook Bond Supreme, Tetley, Tapal Daneder, Hill Top, Zaiqa, Alkozay, Kenya, Lali, Shaheen, Open sample I and Open sample II. These different brands were subjected to analysis using FAAS.

Sample preparation

Pretreatment of crucibles and tea

The crucibles and glassware used in experiment were washed with distilled water and dried in oven. The crucibles used for digestion of tea leaves (ash test) were kept in furnace at constant temperature of 550℃ fo r 4 h in a desiccator and later were weighted. This was done for the purpose to removing all the moisture. Then 2 g of each tea sample was weighted and kept in crucible, and were further heated in furnace until they were converted to white ash (powder).

Digestion of black tea

The standard procedure described in AOAC (2000) was followed for the preparation of samples for analysis of heavy metals. To prepare a clear colorless sample solution that is suitable for the analysis using FAAS, different black tea leaves digestion procedures were assessed; the dry technique was used in this study. Exactly 2 g of ash formed (white powder, mentioned previously) was digested by 2.5 ml of 6 M HNO_3 solution, then was diluted to 25 ml using distilled water after filtration. In this way 12 clear solutions of all 12 samples were formed.

Calibration and determination of metals

Calibration curves were prepared to determine the concentration of the metals in the sample solution. These calibration standard ranges are shown in Table 1. Calibration curves for each of the metals were made from diluted solutions prepared from stock standard solutions containing 1000 mg/L, in 2% HNO_3, of the metals Ni, Mn, Fe, Zn, Cu, Cd and Pb. Determination of the metals in the black tea samples was made by FAAS. For each of the black samples, three repeat measurements were performed. Therefore, for each sample, the results were obtained from the mean of measurements (Perkin-Elmer, 2000).

RESULTS AND DISCUSSION

The levels of metals in commercially available different tea brands were determined by flame atomic absorption spectrometry (FAAS). The results for determination of mineral metals (Zn, Fe, Mn and Cu) and toxic metals (Pb, Ni and Cd) are shown in Tables 2 and 3, respectively.

The most abundant metal in tea is found to be Mn; it has maximum value of 3.72 (mg kg^{-1}) in open tea and minimum of 1.27 (mg kg-1) in Zaiqa Tea, values of other brands (samples) range between them. Cu has moderate values, highest in open samples 1.00 (mg kg^{-1}) and 2.4 (mg kg^{-1}) whereas very low in Lipton yellow label, that is, 0.02 (mg kg^{-1}). Zn values vary moderately, highest in Zaiqa tea, Open samples, while fairly low in Lipton, Tapal and Hilltop. All the samples collected were found to be enriched with Fe; Lipton has 8.41 (mg kg^{-1}) while Alkozay has 5.47 (mg kg^{-1}). The results shows that black tea available in market is made from leaves collected from different regions (different soil source) and thus have different capacity for accumulation of heavy metals. Among these heavy metals, Fe and Mn have highest values, whereas toxic metals (Pb, Ni) have low values, however the amount of Cd is almost negligible. For toxic heavy metals (non-nutrients), Pb has maximum value of 1.25 (mg kg^{-1}) in Alkozay and have lowest value of 0.26 (mg kg^{-1}) in Tetley Tea. Kenya tea has greatest value of Ni (0.64 mg kg^{-1}) and Lipton has lowest content of Ni (0.07 mg kg^{-1}). Cd is in very minor quantity; ranges between 0.01 mg kg^{-1} in Lipton to 0.06 mg kg^{-1} in Alkozay Tea. The values of mineral heavy metals (Zn, Fe, Mn and Cu) in almost all brands are high, whereas those of Pb, Ni and Cd are relatively low. The contents of mineral heavy metals found in black tea can be arranged as Fe>Mn>Zn>Cu and those of toxic heavy metals is arranged as Pb>Ni>Cd.

The mineral metal contents of the black tea were found to be higher than those of toxic heavy metals. The present study reveals that tea being a rich source of dietary element intake could be a major concern for toxicity in healthy individual that consumes tea. Intention of our study is limited

Table 2. Mineral heavy metals present in different black tea samples (Unit: mg kg^{-1}).

Elements	Zn	Fe	Mn	Cu
Lipton	1.30	8.41	1.30	0.01
Supreme	1.34	7.03	2.37	0.76
Tetley	2.19	7.00	1.80	0.68
Kenya	2.89	6.69	2.37	0.57
Alkozay	3.21	5.47	1.63	0.93
Zaiqa	3.16	7.61	1.61	0.65
Shaheen	2.81	8.30	1.27	0.85
Lali	1.11	6.76	2.73	0.48
Tapal	1.35	7.43	2.46	0.74
Hilltop	1.05	7.30	1.37	0.71
Open sample I	1.33	11.63	3.72	1.0
Open sample II	2.93	7.01	2.08	2.40

Table 3. Toxic heavy metals present in different black tea samples (Unit: mg kg^{-1}).

Elements	Ni	Pb	Cd
Lipton	0.01	0.38	0.01
Supreme	0.02	0.28	0.01
Tetley	0.27	0.26	0.05
Kenya	0.64	0.26	0.05
Alkozay	0.34	1.25	0.06
Zaiqa	0.18	0.59	0.06
Shaheen	0.21	0.25	0.05
Lali	0.01	0.28	0.01
Tapal	0.01	0.35	0.01
Hilltop	0.01	0.31	0.01
Open sample I	0.04	0.60	0.01
Open sample II	0.39	0.28	0.05

only to determine heavy metals in tea, not to find source of heavy metals and their accretion in tea plant. However, heavy metals accumulate in tea plant due to soil pollution. Due to high content of manganese, tea can be considered important source of Mn (Aloud, 2003). Aloud (2003) also reported low values of toxic heavy metals (Pb, Ni and Cd) in tea leaves, whereas the results of Seenivasan et al. (2008) contradict our results, as his results showed comparatively high values, and toxic effects of Zn, Fe, Cu and Mn.

Owing to inadequate information for allowable intake level of heavy metals in tea, the conclusion of our results is comprehended to tolerable daily intake of metals considering exposure to air, food and drinking water (Ipeaiyedi and Dawodu, 2011). The values for Mn are much lesser than daily intake from drinking water according to US Environmental Protection Agency. The value of Pb, Ni and Cd were also lower than permissible levels for drinking water by WHO. Similarly values of Cu were much lower than those (7.8 and 1.2 mg/day) set by WHO (1996, 1998).

Conclusion

It is revealed that numbers of toxic metals present in tea is least. However, non branded open samples and few inferior brands have comparatively higher values than well-known brands like Lipton, Tapal. Therefore, Lipton may be preferred over others. This study can provide basis for further research work. The research can also help in making the manufacturers and consumers aware of the hazardous effects caused by heavy metals.

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REFERENCES

Aloud SS (2003). Heavy Metal Contents in Tea and Herb leaves, Pak. J. Biol. Sci., 6(3): 208-212.

AOAC, Official methods of analysis. (2000). AOAC International, 17th Eds.; USA: Maryland, pp. 13-16.

Hussain I, Riazullah, Khurram M, Ullah N, Baseer A, Khan FA, Khan N, Khattak MUR, Zahoor M, Khan J (2011). Heavy metals and inorganic constituents in medicinal plants of selected Districts of Khyber Pakhtoonkhwa Pakistan. Afr. J. Biotechnol., 10(42): 8517-8522.

Ipeaiyedi AR, Dawodu MO (2011). Leaching of Manganese, Iron, copper and zinc from tea in tea mugs. EJEAFChe., 10(5): 2240-2247.

Nworgu ZAM, Onwukaeme DN, Afolayan AJ, Ameachina FC, Ayinde BA (2008). Preliminary studies of blood pressure lowering effect of *Nauclea latifolia* in rats. Afr. J. Pharm. Pharmacol., 2(2): 037-041.

Perkin-Elmer (2000). Analytical methods for atomic absorption spectrometry, pp. 0303-0152.

Seenivasan S, Manikandan N, Muraleedharan NN, Selvasundaram R (2008). Heavy metal content of black teas from south India. Food Control., 19: 746-749.

Samali A, Rukaiyatu, Kirim A, Mustapha KB (2012). Qualitative and quantitative evaluation of some herbal teas commonly consumed in Nigeria. Afr. J. Pharm. Pharmacol., 6(6): 384-388

World Health Organization (WHO) (1996). Guidelines for drinking water quality. WorldHealth Organization, Geneva pp: 47-61

World Health Organization (WHO) (1998). Guidelines for drinking water quality. World Health Organization, Geneva, pp: 308-313-61.