A COMPARATIVE STUDY OF TRACE ELEMENTS IN SOME FOODSTUFFS AVAILABLE IN PAKISTAN; REFERENCE TO WORLD HEALTH ORGANIZATION STANDARDS

Manzoor Iqbal Khattak* and Asif Khan
Chemistry Department , Balochistan University, Quetta, Pakistan
manzoor_iqbal@yahoo.com

***ABSTRACT**: The main objective of this research work is to present the concentrations of trace elements (Ca, Cu, Cr, Fe, K and Pb) in wheat, rice, tea and dry milk (branded and unbanded) available in Pakistan and also some samples of imported Australian wheat were analyzed too. Flame Emission Spectroscopy and Atomic Absorption Spectroscopy were utilized to find the levels of Ca, Cu, Cr, Fe, K and Pb. The results were compared to the reported results of other countries. The weekly human intakes of toxic trace element Pb from wheat and rice samples collected in Pakistan and samples of imported Australian wheat were estimated. These calculations were then compared to the World Health Organization (WHO) which has been suggested weekly tolerance levels of lead (Pb).*

Keywords; Trace elements; Foodstuffs

INTRODUCTION

Trace elements are the minerals which are required in minute quantities from millionth of a gram (microgram) to thousands of a gram (mg) per day. The role of inorganic micronutrients and the impact of toxic heavy metals enhanced the head of the international organizations of many countries and spurred national institutions to help the sufficiency of trace elements and the safety measurements of human food chain resources.

Generally speaking , B, Cr, Mn , Ni , Ti , V, Mo , As , Li , Al , Sr , Ce and Si were recently evidenced as pollutants in diverse food chains. These toxic elements are reported to be found in human foods and animal foods, too. Some of these trace elements are important ingredients for animal foods but not for human. For example, ruminants feeding followed in meadows for animals show abnormally high molybdenum levels of copper deficiency. Many of the above mentioned trace elements like manganese causes nutrients problems in human population due to high dietary intake. Other elements like cadmium, lead and mercury are poisonous contaminants in the food chain of many countries and as a consequence of which the intake levels for such elements are mentioned for safeguarding in many of the World Health Organization (WHO) research papers [1-4].

Wheat is the vital constitution of the human diet and its production. Wheat is the basic food throughout the World; its consumption is increasing to satisfy human requirements for carbohydrates, protein and other macro minerals in the diets. Wheat also supplies certain inorganic micro nutrients that are life for general growing and maintaining of health while unbalance of these trace elements in different organs and body fluids can cause a wide variety of diseases.

Rice is the most important crop in the world production. Rice is the staple food about half of the human race, providing over one-fifth of the total food calories consumed by the people of the World.

Reference to chemical analysis , the ingredients in tea are very complicated which may be due to soil chemistry or processing with tanning substances like flavonols, alkaloids, protein, amino acids, enzymes, aroma, vitamins and trace elements [5-8]. The choice of the processing of tea that may be offer several benefits [9-10] even that traces of insecticides , herbicides and fertilizers may be present due to their spray during growth. However, the contents of heavy and toxic metals in tea leaves offer a challenge to reducing these components[12-13]. The objective analysis tells us that the main source of trace elements in plants, including tea are due to nutrient solutions and soil chemistry, respectively [11-12].

Also, tea is one of the most significant and least expensive beverages in the World, contributing a valuable source of income to many producer countries . The two main types of tea, Black and Green are made by different methods from the same type of leaves. The main chemical constituents of tea include amino acids chlorophylls and carronades, lipids, certain volatile compounds, enzymes and minerals.

Milk is always considered as nutritionally balanced food as it contains vitamins, proteins and metals in edible form. It is the one food for which these seem to be no adequate substitute. It is rich source minerals, particularly calcium. There are large numbers of elements in milk at concentrations of less than 1mg/l . Elements in milk that are important in human nutrition include Chromium (Glucose Tolerance), Cobalt (In Vitamin B_{12}), Copper (enzyme cofactor and hemoglobin formation), Iodine (In Thyroxin hormone), Manganese, (enzyme cofactor), Zinc (In insulin, enzyme cofactor).

In the context, systematic study was carried out to measure and define the baseline value of essential and toxic trace elements in individual foodstuff like tea, wheat, rice and dry milk. Data can be used to desire a balanced diet and to identify pollution levels. The annual consumption of wheat, rice, tea and dry milk is higher than other foodstuffs in Pakistan. Because trace elements composed a minute fraction of these foodstuffs.

The analytical chemistry followed by technology offer precise instrumentation for data collection . Diverse techniques are employed like Inductively Coupled Plasma Mass Spectroscopy (ICP-MS), proton induced X-Rays fluorescence Spectroscopy and Neutron Activation Analyzer (NAA) to determining heavy trace elements in various foods. These toxic and heavy metals are referred to as trace elements in diverse chain foods. But AAS and FES (Flame Emission Spectroscopy) were used in our study.

MATERIALS AND METHOD

Different samples of wheat, rice, tea and dry milk were collected for the analysis of different metals. All samples were purchased from the local markets where as some samples of wheat from seaport (Imported from Australia). Wheat and rice grains were ground in a mechanical grinding machine before digestion.

For ASS/FES, Wheat and rice samples were digested by wet aching method. In this method, 2 gm of each sample and 10 ml H_2SO_4 were added and shaked vigorously, ensuring that no dry lumps remain. After that 5-ml of concentrated HNO_3 were added drop wise and mixed well. Heated the solution cautiously until the initial vigorous reaction had subsided. Solution was heated more strongly until most of the nitrous fumes were removed and all organic matter was destroyed and white fumes of H_2SO_4 were evolved. The solution was cooled and filtered through a WHATMAN-542 filter paper.

But dry milk and tea were digested by wet ashing method. In this method, approximately 5-gm of dry milk of each sample was weighed in previously cleaned china dishes and were heated to remove the organic remnants . These organic remnants can be wiped on china dishes either with burning or with treatment of cryogenic temperatures (liquid Nitrogen) . The ash obtained after removal of organic matter was treated with 10 ml of 6N HCl and was carefully evaporated to dryness on a low temperature. Then 15-ml of 3N HCl was added and heated until the solution just boiled. The solution was cooled and filtered through a WHATMAN-542 filtered paper [14] .

For AAS/FES the calibration standards made by the stock solution (1000 ppm) and further were made up to desired concentration for each metal. [15-16]

Atomic Absorption Spectroscopy was used for the was used for the concentration determination of Calcium, Copper , Chromium, Iron & Lead in food samples while Flame Emission Spectroscopy [8] for the quantitative determination of Potassium (K) .

RESULTS AND DISCUSSION

It is observed that Ca, Cr, Cu, Fe, Pb can be determined by AAS whereas K can be determined by FES. The results show fairly good agreement with Standard Reference Materials (SRM). Optimal AAS experimental condition for the four trace elements analyzed by using AAS is given in Table-1. The concentrations for the each six elements found in wheat and rice are tabulated in Table -2 reference to their region from Pakistan or Australia and also show the concentration range of element in wheat collected from local market of Pakistan and imported from Australia which also shows the concentration of each six elements found in tea and dry milk too. Tea sample was not analyzed for Calcium because it does not contain Calcium

TABLE-1 Standard Conditions

S.NO.	Element	Wavelength (nm)	Absorption or emission	Limit of detection (ppm)	Working range (ppm)
1	Ca	422.7	AAS	0.085-0.092	4--30
2	Cr	357.9	AAS	0.041-0.072	0.1-10
3	Cu	324.8	AAS	0.032-0.077	0.1-10
4	Fe	248.3	AAS	0.039-0.10	0.5-8
5	K	Flame	FES	0.01	10-500
6	Pb	283.3	AAS	0.19-0.45	0.5-8

TABLE-2 Concentration of Trace Elements In Foodstuffs

S.NO.	Element	WHEAT (ppm)		RICE (ppm)	TEA (ppm)	DRY MILK (ppm)
		Australian	Pakistani			
1	Ca	56.38-140	62.25-126.28	27.62-64.88	ND	185-437
2	Cr	ND	ND	ND	0.019-0.362	0.009-0.037
3	Cu	0.0145-0.0769	0.031-0.076	0.018-0.054	0.122-0.541	.005-0.121
4	Fe	0.3185-1.8785	0.3755-1.037	0.196-0.562	1.57-7.49	0.099-1.912
5	K	310-370	310-430	100-170	0.014-0.14	.094-0.140
6	Pb	0.195-0.540	0.27-0.48	0.130-0.425	600-800	310-420

The results show that the concentration of nearly all of the essential or toxic elements is approximately similar among Pakistani and Australian wheat as well as toxic element in tea and dry milk is similar in the branded and unbranded sample. The percentage decreases in element contents in wheat and rice compared to NIST (National Institute for Standard and Technology) is probably occurring as a result of brand extraction and milling. Indeed, some increase in their concentration would have been exported as a result of the use of steel rollers and grinders in the mills. The concentration of elements in milk and tea show no difference in the quality standard as well as RDA (Recommended Daily Allowance) of branded and unbranded samples available in the local market. Actually, estimated intake of Lead (Pb) from wheat in Pakistan is 1244 μg/person WHO tolerance level ia 3000

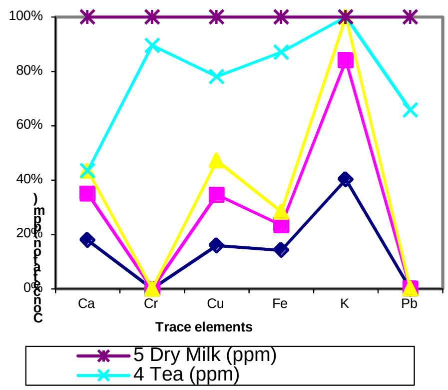

Figure-I ; Plot of Trace Elements Concentration in some foodstuff.

μg/person. So the concentration of lead in the samples is not alarming but it is still present. There is scarcity of scientific literature about dietary intake in diverse food chains. With such a high level intake of heavy and toxic elements in teas in diverse food chains, it would cause adverse effect on metabolism of animals and human population. Therefore, it is imperative to decide the intake dose limits of poisonous trace elements in various divers food chains.

CONCLUSION

This study revealed that the concentration of different elements detected in the wheat and rice samples were less than NIST certified values so it can be concluded that these studied commodities are not toxic for human consumption. The difference in concentration of a particular element in different samples of studied commodities can be explained in terms of soil structure, environmental condition, water used for irrigation, fertilizers and agro chemicals. In view of the concentration of studied elements in tea and dry milk further also it can be concluded that there is no difference in the quality standard of branded and unbranded samples available in the local market. The concentrations of the investigated metals ions studied are compared with concentrations in tea samples from other parts of the World and then found a higher concentration of iron (Fe) in tea samples may be due to contamination of iron during the processing of the tea. The contamination presents in milk include pesticide residues , fluorine and heavy metals in which most of the contamination are due to feeding or from water.

REFRENCES

1. **WHO.** *Environmental health criteria 85: lead.* Geneva, WHO. 1989a.
2. **WHO.**. *Environmental health criteria 86: mercury-environmental aspects.* Geneva, WHO. 1989b
3. **WHO.** 1989c. *Toxicological evaluation of certain food additives and contaminants.*
4. WHO Food Additives Ser. No. 24. Geneva, WHO. *Environmental health criteria 101: methylmercury.* Geneva, WHO. 1990.
5. A.Jha, R.S. Mann, R. Balachachandran, Tea: a refreshing beverage, Indian, Indian Food Ind. 15, 22-29 (1996).
6. A Kumar, A.G.C. Nair, A.V.R. Reddy , A.N. Garg, Availabilty of essentials elements in Indian and US tea brands, Food Chem.89, 441-448 (2005).
7. S.R. Sahito, T.G. Kazi, M.A Jakarani, G.H. Kazi, Q.G. Shar, S,Shaikh, The contents of fifteen essentials, trace and tocxic elements in some green tea samples and in their infusion, J.Chem. Soc.Pak.27, 43-48 (2005).
8. H.L.Li,L.Z. Wang, W.Y. Wang, Determination of nine life elements in brick tea by ICP-AES, Spectroscopc. Spectral Anal. 25 , 1344-1346 (2005).
9. V. Naithani, P. Kakkar, Evaluation of heavy metals in Indian herbal teas, Bull. Environ. Contam. Toxicol.75 , 197-203 (2005).
10. A. Morda-Piniro, A. Fisher, S,J.Hill, The classification of tea according to region of origin using pattern recognition technique and trace metals data, j.Food Comp. Anal.16, 195-211(2003).
11. E. Somer, Toxic Potentials of Trace metals in foods. A review, J. Food Sci.39, 215-216 (1974).
12. I. Narin , H. Colak, O. Turkoglu, M. Soylak, M. Dogan, Heavy metals in black tea samples produced in Turkey, Bull. Environ. Contam. Toxical.72 , 844-849 (2004).
13. H. Colak, , M. Soylak, O. Turkoglu, Dtermination of trace metals contents in various herbal and fruit teas produced and marketed in Turkey, Trace elements electrolytes 22, 192-195 (2005) .
14. Standards for Grade of Dry Milk including method of analysis. Bulletin 916 (Revised). American Dairy Products Institute.
15. Stooff Wetal. Integrated Criteria Document Chromium. Bilthoven, Netherlands, National Institute of Public Health & Environmental Protection 1989(Report No. 758474009).
16. Hollemen, A.F., Wiberg, E. Lehrbuch der anarganischen chemic. [Textbook of Inorganic Chemistry] Berlin, Walter de Gruyter, 1985.