Volume : 3 | Issue : 6 | June 2014 ISSN - 2250-1991

Research Paper Chemistry

A Quantitative Analysis of Heavy Metals in Vegetables Grown At Kakching-Wabagai Area, Thoubal District Manipur

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ABSTRACT

Present study compares the potentially toxic heavy metals present in some seasonal vegetables grown along the sites of the Sekmai River and its tributorial sites at the Kakching-Wabagai areas. Potentially toxic elements are non-biodegradable and their presence in small amounts can cause toxicity to human and animal lives. Heavy metals like Iron(Fe),Copper(Cu),Zinc(Zn) and Lead(Pb) can pose threat to the human live if their presence exceed the maximum permissible limits, when the vegetables are taken as a livelihood foodstuff. Four seasonal vegetables namely Mustard (Brassica Campestris-local name Hangam–yela), Cauliflower (Brassica Oleracea Botrytis-local name Kobi thamchet-manbi), Cabbage (Brassica Oleracea Capitata-local name Kobiful-kabi) and Spinach (Spinacea Oleracea-local name Palang-sak) were collected from the Kakching-Wabagai area. Atomic Absorption Spectroscopic method was used for the quantification of Fe, Cu, Zn and Pb in these vegetables. Concentration of Fe and Zn were more than the permissible limit however, Cu was less with no appreciable amount of Pb in all the vegetables. Heavy metal content was found highest in unwashed sample than washed sample.

KEYWORDS Atomic Absorption Spectroscopy, Vegetables, Kakching -Wabagai.

INTRODUCTION

Presence of potentially toxic non-biodegradable heavy metals in small amounts in the vegetables that forms the main component of our diet can lead to toxicity to human and animal lives. Vegetables take up heavy metals by absorbing or adsorbing on the plant surfaces, either from the soil or deposition from the polluted environments, or from the agricultural input like pesticides and fertilizers etc. [1] and accumulate them in their edible parts [2] resulting in a wide range of concentrations of both the essential as well as or non-essential elements. Vegetables cultivated in soils polluted with toxic metals may cause clinical problems to both animals and human being leading to various kinds of health hazards. High concentrations of trace elements like Cu, Cd and Pb in vegetables and fruits have been associated with high prevalence of upper gastrointestinal cancer [3]. Several factors such as the climate, atmospheric deposition, nature of the soil, degree of maturity of the plant species plays a vital role in the absorbance of these heavy metals by plants/vegetables [4-7]. Many of the published works attributes the increase in the heavy metal accumulation in plants, across the world to rapid growth of industrialization [8-9], urbanization, high traffic intensities [10], use of polluted water [11-12], fertilizers [13], and use of dump compost [14-15].

The quantification of various heavy metals were performed and examined in the fruits and vegetables sold in the local markets of Egypt [16], Kolkata [17], Delhi [18] and Rajasthan [19]. Water, soil and crop plants have been analyzed for different toxic metals in the contaminated/affected areas of the Bellandur lake in Bangalore [20], Varanashi [21] and Samata village of Bangladesh [22]. It is also reported that at least 20 million hectares of agricultural land in Africa, America, Europe and Asia have been affected by the heavy metals [23].

The purpose of the present research work was to determine the concentrations of the heavy metals like Iron (Fe), Copper (Cu), Zinc (Zn) and Lead (Pb) in some selected seasonal vegetables grown in the areas of the Kakching-Wabagai, Thoubal District, Manipur during the consecutive periods of 2008-2009 and 2009-2010.

MATERIALS AND METHODS

(1) Area of Study

We choose the Kakching-Wabagai locality along the banks of Sekmai River in Manipur (India) that lies between 24027.504/ N to 24032.252/ N and 94001.154/ E to 93056.142/ E with a population of around 45000 (as per 2011 census). Seasonal vegetables particularly Mustard, Cabbage and Cauliflower were grown on a large scale in the fields after the harvesting of paddy crops. The vegetables were grown some 500 m - 1000 m away from the residential areas. However, Spinach was grown at random at several places, especially at Kakching. No market survey for collecting the vegetables were performed, instead the samples were collected directly from their sites during its season.

(2) Sampling and Pretreatments

The plants of the same size with same period of growth were collected in a random manner for each kind, put into previously washed polythene bags (with10% HNO3) and brought in the laboratory. It is then grouped into – (i) Unwashed and (ii) Washed. Washing was done first with tap water followed by double-distilled water; then trapped inside a tray so as to remove the adhering water in the vegetables. Such samples were dried inside a hot air oven at a constant temperature of 750-850C for 48 hours until a constant weight was obtained. Dried vegetables were made into fine powder with mortar and pestle and stored inside previously cleaned (with10%HNO3) poly plastic tubes.

(3) Analytical Procedure for Heavy Metal Analysis

By taking 1.0000 g of the dried and powdered vegetables in 100mL beaker, added 15mL of tri-acid (HNO3:HClO4:H2SO4=5:1:1) following the method of Allen et.al. (1986) and kept covered with watch glass undisturbed for 24 hours. It was then heated inside the hot air oven for 48 hours with a constant reading temperatures of 750-850C until the solution becomes transparent. After cooling for 1hour, added 20 mL of double-distilled water, stirred well until the solution becomes cold. The solution is then diluted with 10 mL double-distilled water and stirred well. After cooling for a while, the solution is centrifuged through 5000 rpm and filtered through Whatman filter No.42. It was then washed with double-distilled

water inside a 50 mL volumetric flask. The solution obtained were sent for taking the Atomic Absorption Spectroscopic results.

(4) Quality Assurance

All the chemicals used were Merck Analytical Grade and for quality assurance, the result of each was corrected by subtracting the value of the blank (tri-acid). For every three determinations of the samples, standards were run to make sure that the obtained results were within the range. Acetylene flame was used for taking the AAS results. Precision and accuracy of the analysis were ensured through replicates of three (3) and were found to be ±2% of the certified value.

RESULTS AND DISCUSSIONS

The concentrations of the heavy metals - Fe, Cu Zn and Pb in the vegetables under study obtained through AAS are shown in Tables 2 and 3, and graphically represented in Fig. 1. Table 4 is the permissible limit as per FAO/WHO and Indian atandrds. The determinations were based on the vegetable dry weight. Nine samples per vegetable category were analyzed. It was observed that the concentration of Fe and Zn exceed the permissible limits, Cu was relatively less while no appreciable amount of Pb was found in all the vegetables. The variations in the content of the heavy metals observed in these vegetables depend on the physical and chemical nature of the soil, absorption capacity of metals by plants, also by enumerable environmental and anthropogenic factors.

Multiple correlation coefficients ($R^2_{1.23}$) were done to study the influence of the presence of one metal on another in a particular vegetable (1=Fe, 2=Cu, 3=Zn). For Spinach, a multiple correlation coefficient of 1 ($R^2_{1.23}$ =1) shows a perfect correlation amongst the metals during the seasons of 2008-09 and 2009-10. In case of mustard, $R^2_{1.23}$ = 1 for the period 2008-09, while that of the period 2009-10 is $R^2_{1.23}$ =0.9998. Similarly, for cauliflower, the value of $R^2_{1.23}$ = 1 during the period 2008-09 and $R^2_{1.23}$ = 0.9998 during 2009-10. However, in the case of the cabbage no good correlation was obtained during the period 2008-09, but showed a coefficient $R^2_{1.23}$ =0.9998 during 2009-10.

Table 1: Standard conditions for Atomic Absorption Spectroscopy

Elements	Wavelengths(nm)
Iron (Fe)	309.3
Copper (Cu)	324.8
Zinc (Zn)	228.8
Lead (Pb)	217.0

[Courtesy: Manual Methods of Analysis of Food-Metals(MMAF)2005, Directorate General of Health Services, Ministry of Health & Family Welfare, Govt. of India, New Delhi]

Table 2: Concentration of Fe, Cu, Zn and Pb in four different vegetables (mg/kg dry weight) - Washed

Vegetables	Yr	Fe	Cu	Zn	Pb
Spinach	2008-09 2009-10	543.75 639.82	15.15 udl	54.71 60.23	udl
Mustard	2008-09 2009-10	241.14 315.08	13.3 udl	71.34 63.28	udl
Cauliflower	2008-09 2009-10	91.9 79.58	2.81 udl	36.2 42.41	udl
Cabbage	2008-09 2009-10	84.43 117.35	Udl udl	27.51 34.21	udl

Table 3: : Concentration of Fe, Cu, Zn and Pb in four different vegetables (mg/kg dry weight) - Unwashed

Vegetables	Yr	Fe	Cu	Zn	Pb
Spinach	2008-09 2009-10	970.93 885.82	21.74 udl	55.95 72.61	udl
Mustard	2008-09 2009-10	519.92 370.88	19.36 udl	88.77 66.99	udl
Cauliflower	2008-09 2009-10	97.35 103.67	17.1 udl	41.19 73.0	udl
Cabbage	2008-09 2009-10	101.4 220.67	Udl udl	37.4 34.58	udl

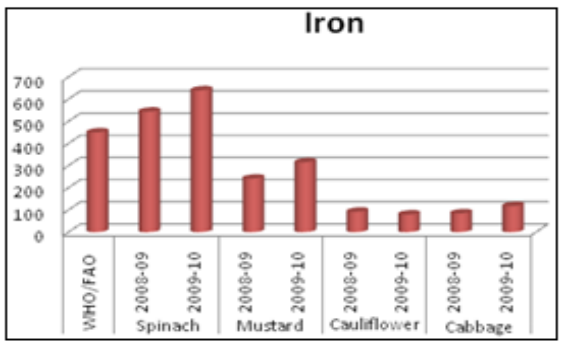
Table 4: Recommended levels of Fe, Cu, Zn and Pb in vegetables (mg/kg dry weight)

Vegetables	Fe	Cu	Zn	Pb
1.FAO/WHO	450.0	40.0	0.6	5.0
2.Indian Standard	------	30.0	50.0	2.5
3.FAO (mg/L)	5.0	0.2	2.0	5.0

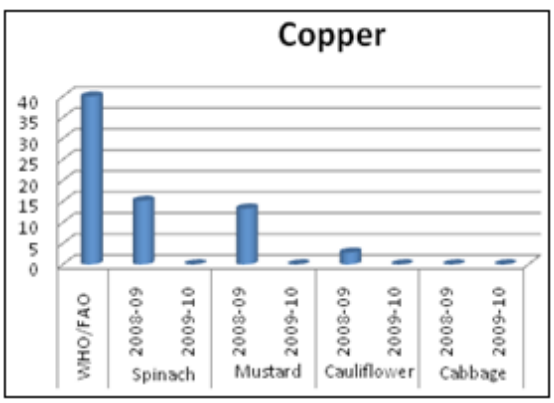
[1. Codex Alimentarius(1984); 2. Awasthi(2000); 3.Recommended max.conc. of trace metals for crop production 1985]

CONCLUSION

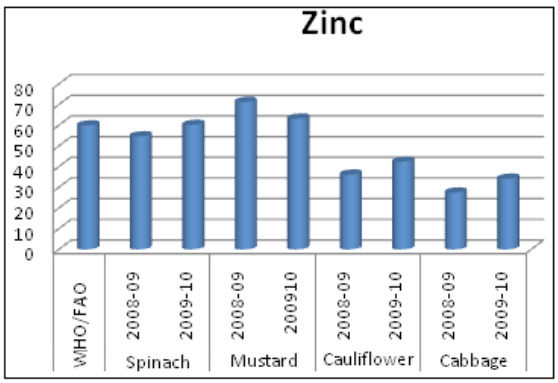
It is observed that on washing, the content of the heavy metals reduces the vegetables. A multiple correlation coefficient analysis showed varied correlations between the various heavy metals in the vegetables of the area under study. Also, the usual household washing before cooking for such vegetables is needed and recommended for reducing the intake of heavy metals. We still need to study more and do research, covering more seasons so as to come up with a noble conclusion to prevent consumption of toxic heavy metals through vegetables from time to time.



(a)



(b)



(c)

Fig. 1. Comparing the concentrations of (a) Iron, (b) Copper and (c) Zinc (in units of mg/kg dry weight) in the four vegetables sampled from the study area.

ACKNOWLEDGEMENTS

We sincerely thank Mr. R.K.Sharma, University of Delhi for taking AAS results and Department of Chemistry,Manipur University,Imphal for providing Laboratory facilities.

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