Research Paper Chemistry

Heavy Metals (Fe, Cu, Zn and Pb) Analysis in Mustard, Cauliflower, Cabbage and Spinach Grown At Kakching-Wabagai Area, Thoubal District, Manipur, India

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ABSTRACT

Potentially toxic heavy metals 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 common foodstuff for the sake of living. Vegetables like the Mustard (Brassica Campestris-local name Hangam–yela), Cauliflower (Brassica Oleracae Botrytis-local name Kobi thamchet-manbi), Cabbage (Brassica Oleracae Capitata-local name Kobiful-kabi) and Spinach (Spinacea Oleracae-local name Palang-sak) were collected from the Kakching-Wabagai area. Atomic Absorption Spectroscopic method were used for the quantification of the Iron, Copper, Zinc and Lead and the obtained results of Iron and Zinc were higher than the WHO/FAO and Indian Standard (Awasthi 2000) but Copper was less and no appreciable amount of Lead was detected, in critical toxic levels.

KEYWORDS | Atomic Absorption Spectroscopy, Vegetables, Kakching -Wabagai.

INTRODUCTION

Vegetables are the main components of the diet, which contribute the vitamins, minerals, essential elements and other micronutrients, which are in short supply [1]. Vegetables act as the buffering agents for substances, obtain during the digestion process. However, plants may contain both the essential as well as toxic or non-essential elements over a wide range of concentrations.

Chronicle low level intake of heavy metals have damaging effect on animal and more particularly on the human lives, since, the heavy metal are non-biodegradable. Vegetables take up the heavy metals by absorbing or adsorbing on the plant surfaces or either from the soil or deposition from the polluted environments, air etc. [2] or from the agricultural input like pesticides and fertilizers etc [3,4]. Many factors such as the climate, atmospheric deposition, nature of the soil, degree of maturity of the plant species have important role for absorbing the heavy metals by plants/vegetables [5-8]. Different research work has reported that the influence of rapid growth of industrialization [9-11], urbanization, high traffic intensities [12-14], use of polluted water [15-18], fertilizers [19] and use of dump compost [20-24] can increase the levels of the heavy metal accumulation in plants, in many parts of the world.

It is a common practice for the people, who lives in their own and gain the livelihood by means of agricultural products, and they gain the welfare of the living standards from the agricultural sources of small incomes. Generally, from the time immemorial, man look for settlement near the river banks sites and they cultivate numerous kinds of vegetables in the type of kitchen garden in small scales, while in the large scales, usually they grow vegetables at a far place away from the residential areas.

The purpose of the present research work was to determine the concentrations of the heavy metals namely Iron, Copper, Zinc and Lead in some selected seasonal vegetables grown in the areas of the Kakching-Wabagai, (Thoubal District, Manipur) India.

MATERIALS AND METHODS

(1) Area of Study

The study area covered from 24027.504/N to 24032.252/N and 94001.154/E to93056.142/E of the areas of the Kakching-Wabagai, which lies along the Sekmai River bank sites of Thoubal district, Manipur, India in the Indo-Myanmar border. Here in the study, the plant Spinach was grown at random in the areas of the Kakching and the Mustard plant was also grown at a large scale in the vast areas of fields of this area. No such type of vegetables was grown in the areas of the Wabagai but, there grown plenty of Cauliflower and Cabbage on a large scale production. In both the places such vegetables were grown some 500m-1000m far away from the residential areas. These vegetables were grown after the harvesting of the paddy crops. In this research work, no market survey type of collection was done, however samples were collected directly from the fields where it was grown.

(2) Sampling and Pretreatments

Vegetables were collected from the respective sites in previously washed polythene bags (10% HNO_3) and brought to the laboratory. The plants so collected were of the same size, grown at the same period of cultivation and picked up in a random manner. The vegetables were divided into two parts: (i) Unwashed and (ii) Washed. Washing was done with tap water, followed by double-distilled water; and then trapped inside a tray so as to remove the adhering water in the vegetables. Such vegetables were dried inside a hot air oven at a constant temperature of 75^{0}C-85^{0}C for 48 hours until a constant weight was obtained. Dried vegetables were turned into fine powder with mortar and pestle. The vegetables in its powdered form were stored inside previously cleaned labeled (10% HNO_3) poly plastic tubes.

(3) Analytical Procedure for Heavy Metal Analysis

By taking 1.0g of the dried and powdered vegetables in 100mL beaker ,added 15mL of tri-acid (Con.HNO_3:$HClO_4$:H_2SO_4=5:1:1) as done by Allen et.al. (1986). It was kept covered with watch glass without any disturbance for 24 hours and then heated inside the hot air oven for 48 hours with a constant reading temperatures of 75^{0}C-85^{0}C until the solution becomes transparent. After cooling for 1hour, added 20mL of

double-distilled water, stirred well for 15 minutes to let the solution become cooler. It was then diluted again with 10mL double-distilled water and stirred well. After cooling it further, the solution was centrifuged through 5000rpm and filtered through Whatman filter No.42; and washed with double-distilled water inside a 50mL volumetric flask. The solutions so obtained were sent for taking the Atomic Absorption Spectroscopic results.

(4) Quality Assurance

All the chemicals used were Merck Analytical Grade. For quality assurance, the result of each was corrected by subtracting the value of the blank (tri-acid) and for every five 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 within ±2% of the certified value.

RESULTS AND DISCUSSIONS

The determination of the heavy metals Fe, Cu, Zn and Pb were based on the vegetable dry weight. Nine samples per vegetable category were analyzed which showed a high level of Fe and Zn in all the vegetables, but the amount of Cu was less; while no appreciable amount of Pb was found in the determination (Table 2). The amount of Fe ranged between 79.28mg/kg and 572.80mg/kg in the leafy vegetables of cabbage, cauliflower, mustard and spinach. For Cu, it ranged between 2.72mg/kg and 22.50mg/kg on dry weight in cauliflower, mustard and spinach but could not detect in cabbage. For Zn it ranged between 27.51mg/kg and 71.34mg/kg on dry weight basis from cabbage, cauliflower, spinach and mustard leaf. Figs. 1, 2 and 3 shows the quantity of various heavy metals found in the vegetables along with their percentage reduction on washing them.

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 the metals by plants, and also by enumerable environmental and anthropogenic factors that may be linked to the nature of the concerned plant species (2). The mean Fe concentrations varied from 84.43mg/kg to543.75mg/kg; Cu varied from 2.81mg/kg to 21.74mg/kg; Zn ranged from 27.51mg/kg to 71.34mg/kg in their mean values with their relative standard deviations less than 3%.

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]

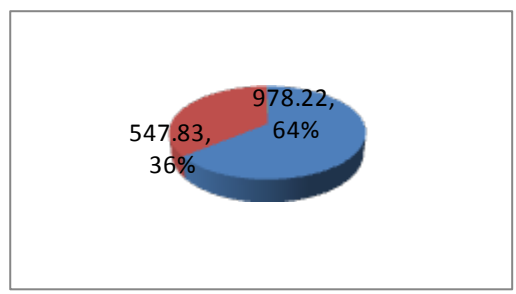
Table 2: Concentration of Fe, Cu, Zn and Pb in four different vegetables (mg/kg dry weight)

Vegetables	Fe	Cu	Zn	Pb
Spinach	543.75	15.15	54.71	udl
Mustard	241.14	13.3	71.34	udl
Cauliflower	91.9	2.81	36.2	udl
Cabbage	84.43	udl	27.51	udl

Table 3: 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]



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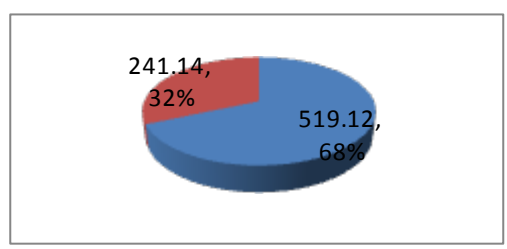

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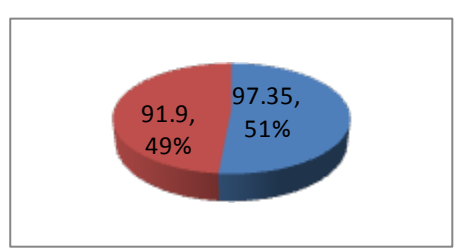

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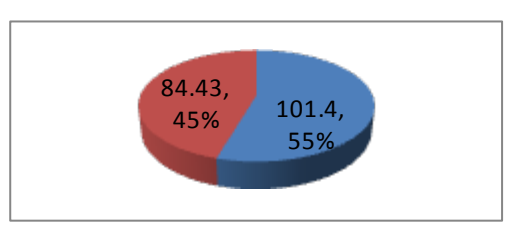

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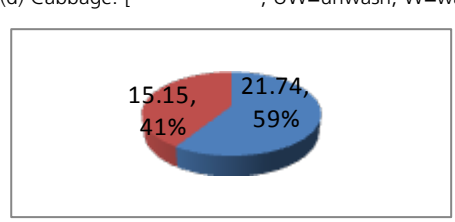
Fig. 1 Quantity of Iron in the vegetables with percentage reduction values: (a) Spinach (b) Mustard, (c) Cauliflower and (d) Cabbage. [UW W ; UW=unwash, W=wash]



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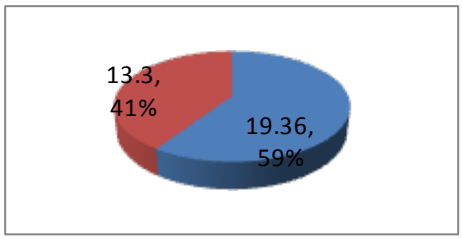

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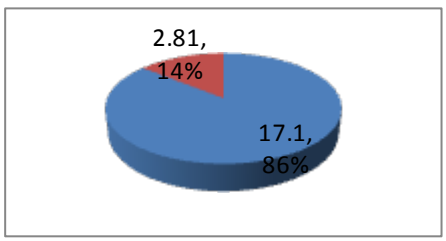

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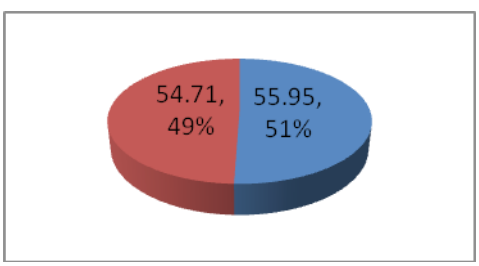
Fig. 1 Quantity of Copper vegetables with percentage reduction values: (a) Spinach, (b) Mustard, (c) Cauliflower. [UW W ; UW=unwash, W=wash]



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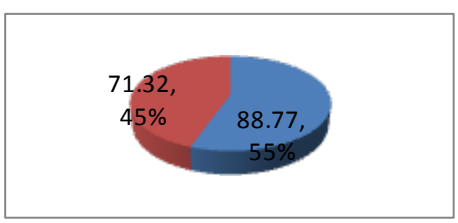

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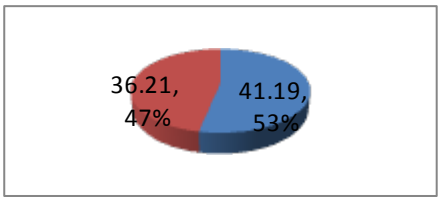

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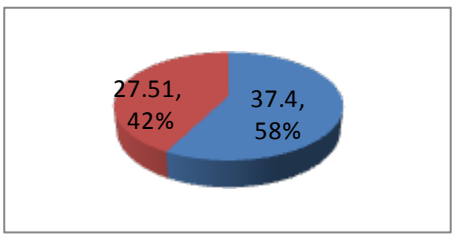

(d)

Fig. 3 Quantity of Zinc in the vegetables with percentage reduction values: (a) Spinach, (b) Mustard, (c) Cauliflower and (d) Cabbage. [UW W ; UW=unwash, W=wash]

CONCLUSION

On washing, the percentage of reduction was highest for Iron in cauliflower (56%) followed by mustard plant (54%), spinach (44%) and cabbage (17%). For Copper (Cu) 83.57% was reduced in cauliflower, 31% in mustard and 30% in spinach on washing. Again for the Zinc (Zn), cabbage (26%) exceeds mustard (20%), which also exceeds cauliflower (12%) and the spinach (2%). Hence, the usual household washing before cooking for such vegetables is needed and recommended for reducing the intake of heavy metals.

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