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Micronutrient concentration in some leafy vegetables collected from local market of Raigarh city, Chhattisgarh, India

Milan Hait*, Husana Banoo, Priyanka Salhotra, Ashutosh Patel
Department of Chemistry, Dr. C.V. Raman University, Kota, Bilaspur, Chhattisgarh, India

Abstract
The micronutrients levels as heavy metal like Iron (Fe), copper (Cu) and Zinc (Zn) were determined using Digital spectrometer in three different samples of leafy vegetables, collected from Raigarh market of Chhattisgarh. The maximum concentration of Fe, Cu and Zn were found, in Karmata Bhaji (24.12 mg/kg), Chunchunia Bhaji (1.62 mg/kg) and Chunchunia Bhaji 14.27 mg/kg) respectively. The minimum concentration of Fe (24.12 mg/kg), Cu (24.12 mg/kg) and Zn (24.12 mg/kg) were found in Chunchunia Bhaji, Karmata Bhaji and Sarson Bhaji. The relative abundance of heavy metals in these leafy vegetables followed the sequence Cu (1.51 mg/kg) < Zn (11.20 mg/kg) < Fe (19.05 mg/kg). The levels of Fe, Cu and Zn were below the FAO/WHO recommended limits for heavy metals in vegetables. Low concentrations of Cu, Fe and Zn in all the samples are indications that these plants contribute no toxic effects of metals. The daily human intakes of metals have also been calculated which were observed below recommended values by the FAO/WHO.

Keywords: heavy metals, micronutrients, leafy vegetable, analysis and public health

Introduction

Plant form the basis of most food chain on the planate. Vegetables are an essential constituent of human beings and animal diet that contains important nutrients and trace elements. They are very significant protective food and useful for the maintenance of health and the prevention and treatment of various diseases. Vegetables are rich sources of vitamins, fibers, and minerals, and also have beneficial anti-oxidative effects [1-3].

Leafy vegetables have greater potential of accumulating heavy metals in their edible parts than grain or fruit crops. Studies on the uptake of heavy metals by plants have shown that heavy metals can be transported passively from roots to shoots through the xylem vessels [4-5]. Vegetables takes up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments. The essential metals can also produce toxic effects when the metal intake is excessively elevated. However, intake of heavy metal contaminated vegetables may pose a direct threat to human health. This is because, heavy metals have the ability to accumulate in living organisms and at elevated levels they can be toxic [6-7].

Environmental pollution has caused the contamination of soils, on the other hand waste water irrigation results in the significant mixing of heavy metal content of the agricultural land. Crops and vegetables grown in soils contaminated with heavy metals have greater accumulation of heavy metals than those grown in uncontaminated soils. Heavy metals that are tolerated by plants and are toxic to humans and animals are easily transferred to consumers through food supply and consequently cause health problems [8-9]. It is necessary to assess the levels of heavy metals in daily edible vegetable and to report possible contamination that would represent a health hazard. The main aim of this research work was to determine the concentration of heavy metals in different green leafy vegetables collected from the local market of Raigarh city in Chhattisgarh and to compare safety level of heavy metals in those vegetables what was recommended by the international organization.

Material and Method

The entire chemicals used in the analysis were Chemicals of analytical grade procured from E marks, Germany, Qualigens, Mumbai India and Loba Cheme of high purity and distilled deionized water were used in all the solution preparation. All glass wares and plastic containers used were washed with detergent solution followed by (20% v/v) nitric acid and then rinsed with tap water and finally with distilled deionized water. Also, standard solutions of the metal salts and other reagents were prepared.

Study Area

The study area covered in this research was Raigarh market of Raigarh district in the state of Chhattisgarh, India. Raigarh is a prominent city and a district headquarters in Raigarh District. It is located on 250 KM from State capital Raipur towards east. Raigarh is located at 21.9°N to 83.4°E. It has an average elevation of 215 m (705 ft) with a urban population 246, 281 [10-12].

Sample and Sampling

We have selected three different sample of leafy vegetables namely, Karmota Bhaji (*Ipomoea aquatica Frosk*), Sarson Bhaji (*Brassica comprestris L.*) and Chunchunia Bhaji (*Marsilea vestita*). The vegetable samples were collected from

Raigarh market in the month of March' 2018. The details of these vegetables are given in the Table1.

Table 1: Specification of leafy vegetable [13]

S. No	Common Name	Vernacular Name	Botanical Name	Family	Habit	Ethnobotanically important plant part
1	Karmota Bhaji	Water Spinach	*Ipomoea aquatica Frosk.*	Convolvulaceae	Weeds	Leaves
2	Sarson Bhaji	Sarsoon	*Brassica comprestris L.*	Brassicaceae	Cultivated	Leaves and seeds
3	Chunchunia Bhaji	Water Clover	*Marsilea vestita*	Marsileaceae	Weeds	Leaves

Sample Treatment

The vegetables were washed with fresh tap water and then rinsed with distilled deionized water. These samples were cut into pieces with knife and were air-dried in the laboratory for 4 days before oven-dried at 105°C for about 24 h. The samples were crushed into powder in a mortar with a pestle. The samples were then sieved through a 2 mm nylon sieve and transfer into a labeled polyethylene container for analysis [14-15].

Sample Digestion

1 gm vegetable samples were digested after adding 20 ml conc. HNO_3, 2 ml $HClO_4$ and HCl (10:1), left for 10 minutes and digest at 70 to 80ºC on hot plate. The solution was allowed to evaporate to dryness until all the tissue had been digested and raised the temperature 105ºC to reduce the volume to 0.5-1.0 ml and add 10 ml of distilled water, boil the residues. The mixture was cooled and filtered through a whatman no. 541 filter paper into a 100 ml volumetric flask and made up to mark with distilled deionized water [14-15].

Sample Analysis

A serial dilution method was used to prepare the working standards and the concentrations of the metals in each sample digest were determined using Digital spectrophotometer (Systronic, Model No.118) by preparing standard curve. Fe, Cu and Zinc were determined spectrophotometrically by 1, 10 phenonthroline method, Neocuproine method and dithiazone method at 510 nm, 457 nm and 620 nm respectively [16].

Daily intake of heavy metals from vegetables

The daily intake of heavy metals through the consumption of vegetables tested was calculated according to the equation [17]:

Daily intake of metals (DIM) = DVC × VMC

DVC = daily vegetable consumption; VMC = mean vegetable metal concentrations (mg/day, fresh weight).

Where daily vegetable consumption was taken as 98 g of vegetables per person per day as set by the FAO/WHO (1999), for heavy metal intake based on body weight for an average adult (60 kg body weight) [18].

Result and Discussion

The experimental results of the metal contents obtained from each leafy vegetable from the Raigarh market site are listed in Table 1 and graphical representation are shown in Fig 2. The Fe concentrations in different leafy vegetables like Karmota Bhaji, Sarson Bhaji and Chunchunia Bhaji were calculated 24.12 mg/kg, 18.4 mg/kg and 14.62 mg/kg respectively. The concentrations of Cu in Karmota Bhaji, Sarson Bhaji and Chunchunia Bhaji were calculated 1.34 mg/kg, 1.57 mg/kg and 1.62 mg/kg respectively. The concentrations of Zn were estimated 10.12 mg/kg, 9.22 mg/kg and 14.27 mg/kg in Karmota Bhaji, Sarson Bhaji and Chunchunia Bhaji respectively.

Table 2: Concentration of Fe & Zn in Leafy Vegetables (mg/kg)

S. No	Sample/ Metal Conc^n	Karmota Bhaji	Sarson Bhaji	Chunchunia Bhaji	FAO/WHO safe Limit
1	Fe	24.12	18.4	14.62	425
2	Cu	1.34	1.57	1.62	40
2	Zn	10.12	9.22	14.27	99.4

Table 3: Daily intake of heavy metal (DIM) through consumption of vegetables

S. No	Heavy metal	Mean Metal Concn (mg/kg)	Daily intake (µg/day)	FAO/WHO Limit or PTDI Limit
1	Fe	19.05	1526.51	48 mg
2	Cu	1.51	51.29	3 mg
3	Zn	11.20	424.67	60 mg

Fe has several functions in the body. It serves as a carrier of oxygen by haemoglobin from the lungs to the tissues, as a transport medium for electrons within cells, and as an integrated part of important enzyme systems in various tissues. Fe is essential for the synthesis of chlorophyll and activates a number of respiratory enzymes in plants [19]. The highest amount of Fe is found in Karmota Bhaji 24.12 mg/kg and the lowest amount of Fe was found in Chunchunia Bhaji 14.62 mg/kg. The Fe concentrations of were found among the vegetables in the order of Karmota Bhaji > Sarson Bhaji > Chunchunia Bhaji. The Fe contents of these plants are lower than the FAO/WHO (2001) [20] safe limit of 425.00 mg/kg. These vegetables could be good supplement for Fe.

Cu is an essential metal for plant growth and activation of many enzymes, however most plants contain the amount of copper which is inadequate for normal growth that is usually ensured through artificial or organic fertilizer [21]. The highest concentration of Cu, 1.62 mg/kg in Chunchunia Bhaji and the least concentration of Cu, 1.34 mg/kg were recorded in the Karmota Bhaji. The Cu concentrations of were found among the vegetables in the order of Chunchunia Bhaji > Sarson Bhaji > Karmota Bhaji. The contents of Cu recorded in this study are lower than the permissible level by FAO/WHO in the leafy vegetable.

Zn is the least toxic and an essential element in human diet. It is distributed widely in plant and animal tissues and occurs in all living cells. It functions as a cofactor and is a constituent of many enzymes. The recommended dietary allowance for Zn is 15 mg/day for men and 12 mg/day for women by Agency for Toxic Substances and Disease Registry [22-23]. The highest amount of Zn was found in Chunchunia Bhaji 14.27 mg/kg and the lowest amount of Zn was found in Sarson Bhaji 9.22 mg/kg. The concentrations of Zn is found in the order of Chunchunia Bhaji > Karmota Bhaji > Sarson Bhaji. The contents of Zn in all the plants examined are generally lower than the permissible levels by the FAO/WHO (2001) [20] in leafy vegetables as shown in Table 2. Regular consumption of these vegetables may assist in preventing the adverse effect of zinc deficiency which results in retarded growth and delayed sexual maturation [24].

The exposure of consumers and the related health risks are usually expressed in terms of the provisional tolerable daily intake. The FAO/WHO (1999) [18] have set a limit for the heavy metal intake based on the body weight for an average adult, namely, 60 kg body weight. The average diet per person per day of vegetables is 98 g. If the mean levels of Fe (19.05 mg/kg), Cu (1.51 mg/kg) and Zn (11.20 mg/kg) found here are consumed daily, the contribution of heavy metal intake for an average human being from the vegetable diets were calculated and presented as shown in Table 3. The estimated daily intakes for heavy metals are reported by the FAO/WHO, which had set a PTDI limit for heavy metal intake based on body weight for an average adult (60 kg body weight) for heavy metals as shown in Table 3.

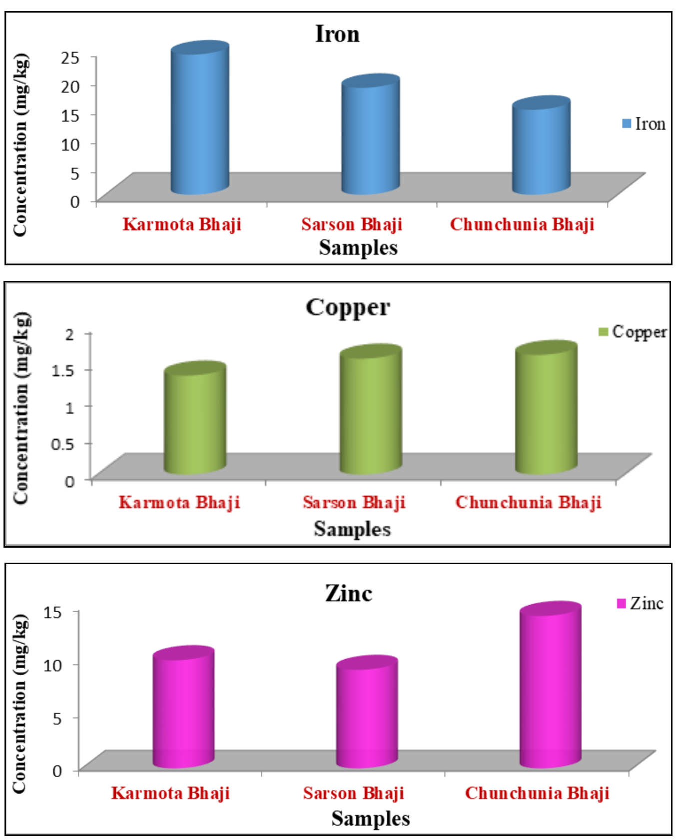

Fig 2: Concentrations of metals in leafy vegetables

Conclusion

Fe, Cu and Zn are chief dietary mineral supplements which have special role in important metabolic function in human and animal. The required concentration of Fe in diet for human body is 17 mg, Cu 2-3 mg and Zn 3-4 mg. in a standard body weight. Levels of the metals are found to be within the safe limits prescribed by the FAO/WHO. This is an important result as human health is directly affected by consumption of vegetables as diet. The monitoring of heavy metals in vegetables needs to be continued; because these are the main sources of food for humans and animals which are considered as bio indicators of environmental pollution.

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