



Assessment of heavy metals in vegetables at Savar in Bangladesh

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ABSTRACT

Vegetables are essential for human health. All vegetables are source of all kinds of essential minerals and trace elements. Presence of some selected heavy metals such as Cr, Cd, Zn, Cu and Pb in different vegetable samples were investigated, which were collected from various locations (Genda Bazar, Sadapur and Savar thana bazar) of Savar at Dhaka, Bangladesh from December 2019 to May 2020. Samples were digested by acid digestion and heavy metals were determined by Analytik JenaovAA 400P Atomic Absorption Spectrophotometer. Total 24 samples were collected from these places. Heavy metal concentrations in the samples were found to be in the range of 1.0-2.14 mg/kg of Cr, 0.03-0.49 mg/kg of Cd, 0.01-2.99 mg/kg of Pb, 0.40-1.30 mg/kg of Cu and 0.14-4.40 mg/kg of Zn. In all samples, Pb was found in high concentrations and Cd was found high only in bottle gourd. The World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) suggested the maximum permissible values of Cr (2.3mg/kg), Cd (0.2 mg/kg), Pb (0.3 mg/kg), Zn (99.4 mg/kg) and Ni (67.9 mg/kg) in vegetables. Although not all heavy metals exceed WHO/FAO's specified value, the amount obtained is a significant threat to us.

Key Words: Vegetable, Heavy metal, Savar and Bangladesh.

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I. Introduction

Vegetables are an essential part of daily diets and a great source of vitamins and minerals. Vegetables are rich sources of essential nutrients such as carotene, protein, vitamins, calcium, iron, ascorbic acid,

fibre and palpable concentration of minerals (Jimoh and Oladiji, 2005). All are essential for human body. There are two groups of these materials, one group is Carbohydrates and another group is Minerals. Minerals are inorganic substances and are present in the whole body. Minerals may be broadly classified as macro (major) or micro (trace) elements. The macro (need greater than 100 mg/dl)-minerals include calcium, phosphorus, sodium and chloride, while the micro (Need less than 100 mg/dl)-elements include iron, copper, cobalt, potassium, magnesium, iodine, zinc, manganese, molybdenum, fluoride, chromium, selenium and sulfur (Eruvbetine, 2003). The presence of minerals in vegetables depends on various factors like inherent (varieties, maturity, genetics and age) and environmental (soils, geographical locations, season, water source and use of fertilizers), conditions of plants and animals and methods of handling and processing (Pennington and Calloway, 1973).

Although these vegetables contain essential elements, sometimes they bear heavy metals also. Heavy metals are too much toxic for human body. Heavy metals are exceptionally harmful in their non-biodegradable nature, long biological half-lives, and their ability to accumulate in various body parts. Heavy metal contamination of the food products is one of the major factors of food quality assurance (Marshall, 2004; Radwan and Salama, 2006). Emissions of heavy metals from the industries and vehicles may be deposited on the vegetables surface during their production, transport and marketing. Several industrial activities emit these heavy metals in soil, plants and even residents along roads with heavy traffic loads are subjected to increasing contamination levels with heavy metals (Ghrefat and Yusuf, 2006). Human exposure to heavy metals has increased significantly due to continuously using these metals as starting materials in different industrial processes (Al-Thagafi et al., 2014). Nowadays, various factories have been set up in Savar. Various heavy metals are emitted as waste materials from those factories, mixing with water or soil. Different crops are being produced using that soil and water. Considering that aspect, this study has been done in the Savar area. So in the present work, an attempt has been made to assess different heavy metals of winter vegetables at Saver in Bangladesh.

II. Materials and Methods

The experiment was conducted in the Department of Agricultural Chemistry laboratory, Sher-e-Bangla Agricultural University, Dhaka-1207, from December 2019 to May 2020. Various vegetable samples (Red amaranth, radish, radish spinach, carrot, tomato, brinjal, spinach, bottle gourd, turnip and spinach were collected from areas of Savar thana such as Sadapur kazi para, Savar thana stand bazar and Genda bazar under Dhaka district and these vegetables were collected at harvesting stage from farmer's filed and local market and a total 24 samples were collected from these places Three types of vegetables were used as sample materials such as (1) Leafy vegetables (red amaranth, spinach, radish leaves etc); (2) Fruity vegetables (brinjal, tomato, bottle gourd); (3) Roots and Tuber vegetables (radish, carrot, turnip) and these all are winter vegetables (Table 01).

Table 01. Description of collected and analyzed vegetable samples

Sl. No	Name	Scientific name	Edible part	Types of vegetables	Parts used for analysis	Collected location
01.	Red amaranth	<i>Amaranthus crventus</i>	All parts	Leafy	Leaves & Stem	Genda, Sadapur, Savar thana Bazar
02.	Radish spinach	<i>Raphanus sativus</i>	Leaves	Leafy	Leaves	Genda, Sadapur, Savar thana Bazar
03.	Radish	<i>Raphanus sativus</i>	Root	Root	Root	Genda, Sadapur, Savar thana Bazar
04.	Carrot	<i>Daucus carota</i>	Root	Root	Root	Genda, Savar thana Bazar
05.	Spinach	<i>Spinacia oleracea</i>	Leaves	Leafy	Leaves	Genda, Sadapur, Savar thana Bazar
06.	Tomato	<i>Solanum lycopersicum</i>	Fruit	Fruit	Fruit	Genda, Savar thana Bazar
07.	Brinjal	<i>Solanum melongena</i>	Fruit	Fruit	Fruit	Genda, Sadapur, Savar thana Bazar
08.	Bottle gourd	<i>Lagenaria siceraria</i>	Fruit	Fruit	Fruit	Genda, Sadapur, Savar thana Bazar
09.	Turnip	<i>Brassica rapa</i>	Root	Root	Root	Genda, Savar thana Bazar

After collecting sample materials, roots and shoots were separated. To get a constant weight, these samples were dried at 70°C in an oven. Then the samples were ground in a Wiley Hammer Mill, passed through 40 mesh screens, mixed well and stored in vials. After that, 1gm of each sample was taken for

digestion. Digestion solution was Diacid mixture (HClO_4 and $\text{HNO}_3 = 2:1$). After digestion, the solutions were filtered using Whatman no. 40 filter paper and made all sample solution volumes 100ml. By these solutions, heavy metals present in these vegetables were determined. Analytik JenanovAA 400P Atomic Absorption Spectrophotometer was used to determine Cadmium, Chromium, Lead, Zinc and Copper. Then the desired data were collected and arranged in tabulated form. SPSS 15.0 software was used for getting statistical data like Analysis of variance, Standard Deviation, Mean and Range etc.

III. Results and Discussion

Nine vegetable samples were collected from Genda bazar. Red amaranth has Cr content of 2.10-2.14 mg/kg, Pb content of 3.68-3.74 mg/kg, Cu content of 1.28-1.30 mg/kg and Zn content of 1.51-1.65 mg/kg. Radish spinach has 0.50-0.52 mg/kg Cr, 3.85-3.93 mg/kg Pb and 1.08-1.16 mg/kg Zn. Pb, Cu was not found in radish that contained 0.55-0.59 mg/kg of Cr, 0.41-0.51 mg/kg of Zn and Cd, and 0.41-0.51 mg/kg of Zn and Cd. Spinach contained 0.04-0.08 mg/kg Cr and 3.41-3.48 mg/kg Zn and Cd, but no Pb or Cu. Cd, Pb and Cu were not found in tomatoes while containing 0.54-0.58 of Zn and Cr. Brinjal has Pb content of 0.48-0.54 mg/kg and Zn content of 0.71-0.79 mg/kg. Cr, Cd and Cu were not available in this location. Cr, Pb and Cu were unavailable in bottle gourd, leaving only Cd (0.16-0.20 mg/kg). Zn concentration was 3.01-3.09 mg/kg. All heavy metals were absent in turnip, with the exception of Zn (3.01-3.09 mg/kg). Carrot, on the other hand, was found to be deficient in all of the selected heavy metals. From [Table 02](#), maximum Cr was found in Red amaranth (2.12 ± 0.02 mg/kg), maximum Cd found in Bottle gourd (0.18 ± 0.02 mg/kg), maximum Pb found in Radish spinach (3.89 ± 0.04 mg/kg), maximum Cu found in Red amaranth (1.29 ± 0.01 mg/kg), maximum Zn found in Spinach (3.45 ± 0.03). [Amin et al. \(2020\)](#) found that the Pb, Cd, Cr and Co range in analyzed vegetables was 0.643-3.362, 0.041-0.049, 1.681-2.431 and 1.612-2.492 mg/kg, respectively. Those vegetables were grown in industrial areas at Savar. [Arora et al. \(2009\)](#) found wastewater irrigated plants as 216-378 mg/kg, 12-69 mg/kg, 5.2-16.8 mg/kg and 22-46 mg/kg for Fe, Mn, Cu and Zn, respectively. Cu and Zn were found highest in carrots.

Table 02. Estimation of Cr, Cd, Pb, Zn and Cu from Genda bazar in Savar thana

Name of vegetables		Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Red amaranth	Mean±SD	2.12±0.02	0	3.71±0.03	1.29±0.01	1.57±0.07
	Range	2.10-2.14	0	3.68-3.74	1.28-1.30	1.51-1.65
Radish spinach	Mean±SD	0.51±0.01	0	3.89±0.04	0	1.12±0.04
	Range	0.50-0.52	0	3.85-3.93	0	1.08-1.16
Radish	Mean±SD	0.57±0.02	0	0	0	0.45±0.05
	Range	0.55-0.59	0	0	0	0.41-0.51
Carrot	Mean±SD	0	0	0	0	0
	Range	0	0	0	0	0
Spinach	Mean±SD	0.06±0.02	0	0	0	3.45±0.03
	Range	0.04-0.08	0	0	0	3.41-3.48
Tomato	Mean±SD	0	0	0	0	0.56±0.02
	Range	0	0	0	0	0.54-0.58
Brinjal	Mean±SD	0	0	0.51±0.03	0	0.75±0.04
	Range	0	0	0.48-0.54	0	0.71-0.79
Bottle gourd	Mean±SD	0	0.18±0.02	0	0	1.51±0.02
	Range	0	0.16-0.20	0	0	1.49-1.53
Turnip	Mean±SD	0	0	0	0	3.05±0.04
	Range	0	0	0	0	3.01-3.09

From Sadapur, six vegetable samples were collected. In Red amaranth contain 1.0-1.04 mg/kg of Cr, 1.66-1.80 mg/kg of Pb, 0.40-0.45 mg/kg of Cu and 1.13-1.33 mg/kg of Zn. In Radish spinach contain 1.97-2.0 mg/kg of Cr, 1.17-1.21 mg/kg of Zn and Cd, Pb, Cu were not found. All heavy metals in Radish were absent except Zn (0.24-0.28 mg/kg). In Brinjal contain 0.06-0.08 mg/kg of Cd and 1.04-1.08 mg/kg of Zn. Here Cr, Pb and Cu were unavailable. In Bottle gourd Cr, Pb, Cu were unavailable and contained 0.41-0.49 mg/kg of Cd, 1.70-2.10 mg/kg of Zn. From [Table 03](#), maximum Cr found in Radish spinach (1.98 ± 0.01 mg/kg), maximum Cd found in Bottle Gourd (0.42 ± 0.01 mg/kg), maximum Pb found in Red amaranth (1.74 ± 0.07 mg/kg), maximum Cu found in Red amaranth (0.42 ± 0.02 mg/kg), maximum Zn found in Spinach (3.26 ± 0.01). [Hasan et al \(2022\)](#) found 36.12 mg / kg Cu, 121.6 mg / kg Zn, 1.43 mg / kg Cd, 1.21 mg / kg Pb, 19.8 mg / kg Cr, 12.08 mg/kg Co and 0.75 mg/kg As among the

rice cultivated in the Savar industrial area. [Islam and Hoque \(2014\)](#) found Cr, Ni, Cu, Zn, As, Cd and Pb in vegetables 0.61-3.0 mg/kg, 1.6-12 mg/kg, 8.3-34 mg/kg, 16-119 mg/kg, 0.007-0.24 mg/kg, 0.009-1.0 mg/kg and 0.06-3.5 mg/kg respectively.

Table 03. Estimation of Cr, Cd, Pb, Zn and Cu from Sadapur in Savar thana

Name of vegetables		Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Red amaranth	Mean±SD	1.01±0.02	0	1.74±0.07	0.42±0.02	1.23±0.1
	Range	1.0-1.04	0	1.66-1.80	0.40-0.45	1.13-1.33
Radish spinach	Mean±SD	1.98±0.01	0	0.48±0.02	0	1.19±0.02
	Range	1.97-2.0	0	0.46-0.50	0	1.17-1.21
Radish	Mean±SD	0	0	0	0	0.26±0.02
	Range	0	0	0	0	0.24-0.28
Spinach	Mean±SD	0	0.04±0.01	0	0	3.26±0.01
	Range	0	0.03-0.06	0	0	3.16-3.36
Brinjal	Mean±SD	0	0.07±0.01	0	0	1.06±0.01
	Range	0	0.06-0.08	0	0	1.04-1.08
Bottle gourd	Mean±SD	0	0.42±0.01	0	0	1.90±0.20
	Range	0	0.41-0.49	0	0	1.7-2.1

Nine vegetable samples were collected from the Savar thana bazar. Cr, Cu, and Zn concentrations in Red amaranth are 1.75-1.79 mg/kg, 1.29-1.30 mg/kg, and 1.78-1.80 mg/kg, respectively. 2.20-2.28 mg/kg Cr, 1.70-1.80 mg/kg Pb, and 0.30-0.36 mg/kg Zn are found in Radish spinach. Radish contains 0.20-0.60 mg/kg Cr, 0.75-0.85 mg/kg Zn, Cd, Pb, and Cu, but no Pb or Cu. Cr, Pb, and Zn concentrations in carrots are 1.0-1.20 mg/kg, 3.15-3.19 mg/kg, and 0.14-0.20 mg/kg, respectively. Spinach contains 4.34-4.40 mg/kg Zn and Cr, but no Cd, Pb, or Cu. Tomato contains 0.33-0.35 Zn and Cr but no Cd, Pb, or Cu. Brinjal has a lead content of 2.97-2.99 mg/kg and zinc content of 0.91-0.97 mg/kg. Cr, Cd and Cu were not available in this location. Cr and Cu were unavailable in bottle gourd, but they contained Cd (0.30-0.36 mg/kg) and Zn (1.21-1.25 mg/kg). Cr, Pb, and Cu were not found in Turnip, which contains 0.05-0.09 mg/kg of Cr and 1.04-1.08 mg/kg of Zn. The highest levels of Cr were found in Radish spinach (2.240.04 mg/kg), the highest levels of Cd were found in Bottle gourd (0.330.3 mg/kg), the highest levels of Pb were found in Carrot (3.170.02 mg/kg), the highest levels of Cu were found in Red amaranth (1.290.03 mg/kg) and the highest levels of Zn were found in Spinach (4.370.03) ([Table 04](#)). When [Nahar et al. \(2021\)](#) examined the vegetables grown in the tannery area, they found Pb, Cd, Cr, Cu and Ni concentrations of 6.42-8.90, 0.22-0.44, 0.46-0.84, and 1.14-2.14 mg/kg, respectively [Chowdhury et al. \(2003\)](#) found that different concentrations of Cu, Ni, Mn and Zn in food samples varied from 0.33-14.1 µg/g, 0.0002-7.68 µg/g, 0.22-101 µg/g and 0.84-64.9 µg/g respectively at Murshidabad, India.

Table 04. Estimation of Cr, Cd, Pb, Zn and Cu from Savar thana bazar

Name of vegetables		Cr (mg/kg)	Cd (mg/kg)	Pb (mg/kg)	Cu (mg/kg)	Zn (mg/kg)
Red amaranth	Mean±SD	1.77±0.02	0	0	1.29±0.03	1.79±0.01
	Range	1.75-1.79	0	0	1.29-1.30	1.78-1.80
Radish spinach	Mean±SD	2.24±0.04	0	1.75±0.50	0	0.33±0.03
	Range	2.20-2.28	0	1.70-1.80	0	0.30-0.36
Radish	Mean±SD	0.40±0.20	0	0	0	0.80±0.05
	Range	0.20-0.60	0	0	0	0.75-0.85
Carrot	Mean±SD	1.10±0.01	0	3.17±0.02	0	0.16±0.04
	Range	1.00-1.20	0	3.15-3.19	0	0.14-0.20
Spinach	Mean±SD	0	0	0	0	4.37±0.03
	Range	0	0	0	0	4.34-4.40
Tomato	Mean±SD	0	0	0	0	0.34±0.01
	Range	0	0	0	0	0.33-0.35
Brinjal	Mean±SD	0	0	2.98±0.01	0	0.94±0.03
	Range	0	0	2.97-2.99	0	0.91-0.97
Bottle gourd	Mean±SD	0	0.33±0.3	0.32±0.02	0	1.23±0.02
	Range	0	0.30-0.36	0.30-0.34	0	1.21-1.25
Turnip	Mean±SD	0	0.07±0.02	0	0	1.06±0.02
	Range	0	0.05-0.09	0	0	1.04-1.08

IV. Conclusion

This study found that a lot of vegetables had a lot of heavy metals in them. Except for Cd, red amaranth was full of heavy metals (Cr, Pb, Cu & Zn). Bottle gourd is only contaminated by Cd in three places. Heavy metals were found in many vegetables in the area where the study took place. So, vegetables should not be grown or made near an industrial area like Savar. Otherwise, it could have a big impact on the health of people in and around these places.

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