



Health Risk Assessment Based on the Trace Elements in the Fruits and Vegetables Grown in an Industrial Area in Dhaka City, Bangladesh

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ABSTRACT

Background: Food security is an alarming issue to researchers. This study aimed to evaluate the trace metals in fruits and vegetables and their impact on human health in Konabari industrial area (Gazipur, Dhaka, Bangladesh) during 2016-2017.

Methods: Wet acid digestion determined the concentrations of eight trace elements (aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc) in 28 samples of 10 fruits and vegetables (papaya, guava, banana, Malabar spinach, eggplant, jute tender leaves, watercress, water spinach, gourd leaves, and cauliflower) using a microwave and inductively coupled plasma optical emission spectrometry. To assess the human health risk, the target hazard quotient (THQ) was calculated only for iron, manganese, and zinc in Microsoft Excel.

Results: The mean concentrations of aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc were 764.2, 6664.6, 556.2, 3551.14, 4479.4, 1034, 1559.8, and 128.6 mg/kg, respectively, which decreased as Ca>Mg>K>Na>Mn>Al>Fe>Zn. Most values exceeded the total nutritional levels for these fruits and vegetables, while the estimated daily intake of the elements was acceptable. The THQ of the fruits and vegetables consumed by the adult population was <1.

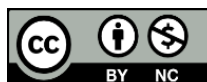
Conclusion: As the THQ was <1, the consumption of the samples posed no major health risks in terms of the trace elements.

1. Introduction

Food is the basic human need to maintain the primary functions of the body. Today, food security has become a major health concern across the world, attracting the attention of researchers due to the increased risk of food contamination by insecticides, heavy metals, and other

chemicals [1]. Increasing dietary diversification is the most important factor in providing a wide range of micronutrients and this requires an adequate supply, access to and consumption of a variety of foods [2].

Fruits and vegetables constitute a major portion of the essential nutrients and vitamins for the human body. However, the average daily intake of fruits and vegetables in an adult aged 31-60 years and weighing 60 kilograms on



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average has been estimated at 44.7 and 130 grams, respectively [3,4]. WHO/FAO report recommends a minimum of 400g of fruit and vegetables per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases such as heart disease, cancer, diabetes and obesity, as well as for the prevention and alleviation of several micronutrient deficiencies, especially in less developed countries on the other hand, vegetables are abundant sources of essential vitamins, elements such as iron, protein, calcium, ascorbic acid, and carotene, and palpable minerals [5].

Macronutrients and micro-minerals are present in all the body tissues and fluids and are considered essential to the nourishment of living organisms as they maintain certain physicochemical processes in the body [6]. For the proper functions of the body, the number of macro-minerals and micro-minerals should be above 100 mg/dl and less than 100 mg/dl, respectively [7]. Depending on environmental conditions (soil, geographical location, season, water source, and fertilizer use), the inherent variations in plants (e.g., age, varieties, maturity, and genetics) and handling and processing methods, the concentrations of these trace minerals may vary in different vegetables.

Diverse species of fruits and vegetables are grown at different times of year, and there are scarce data regarding their concentrated metal contents [8]. In order to accumulate more information about nutrients, we measured the concentrations of essential elements in fruits and vegetables using the wet acid digestion method, a microwave, and inductively coupled plasma optical emission spectrometry (ICP-OES; Hitachi, Japan).

For the construction and maintenance of the bones, relatively large quantities of calcium and phosphorus are essential to humans, as well as other vertebrate species. Calcium is also essential for the regular functioning of the nerves and muscles. Iron is an important element of the cytochromes, which is involved in the functions of cellular respiration, hemoglobin, and oxygen-binding protein of the red blood cells. Magnesium, manganese, and zinc are the cofactors that are built into the structure of certain enzymes. Sodium and potassium play a pivotal role in the nervous system function. A healthful diet must be a source of sufficient calories for energy requirements, carbon chains, and organic nitrogen, while also providing ample quantities of the essential nutrients [9]. A small deficiency in iron could cause anemia (fatigue/weakness), and a chronic deficiency could give rise to organ failure as excessive iron leads to the production of free radicals, thereby interfering with the metabolism and causing damage to organs such as the heart and liver. According to the Government Dietary Recommendations (2016), the required daily iron intake for men aged more than 18 years is 8.7 milligrams, while it is 14.8 milligrams for women aged 19-50 years, and 8.7 milligrams for woman aged more than 50 years.

Magnesium contributes to protein synthesis, energy production, and healthy bone formation and maintains proper cardiac function [10] (Anna S *et al.* 2016). As kidneys eliminate excessive magnesium through urine, the excessive levels of this element do not pose a health risk although they may give rise to diarrhea, accompanied by nausea and abdominal cramps due to the high doses noted by the Office of Dietary Supplements. The required daily intake of magnesium has been estimated to be 300

milligrams for men aged 19-64 years and 270 milligrams for women aged 19-64 years. Manganese is involved in proper enzyme functions, nutrient absorption, wound healing, and bone development [11]. Poor bone health, joint pain, and fertility problems could be attributed to manganese deficiency, while the overconsumption of this element may adversely affect the neurological system [12].

The excessive intake of sodium could coagulate the fluids in the body, particularly around the heart and lungs. Uncontrolled hypertension and shortness of breath are among the common indications of excessive fluids in the body [13]. Zinc is involved in various aspects of cellular metabolism and regular growth and development, while it also plays a key role in the strengthening of the immune system. However, the overconsumption of zinc may suppress the immune function as zinc restricts copper absorption, thereby leading to copper deficiency, anemia, changes in the red and white blood cells, and decreased immunity [14]. The standard daily intake of zinc has been determined to be 9.5 milligrams for men aged 19-64 years and seven milligrams for women of the same age range. In addition, 3,500 milligrams of potassium is required for an adult aged 19-64 years, and the regular dietary intake of this element could provide the required potassium supplement for the human body.

Although vitamin and mineral supplements are essential, their excessive use could negate their health benefits and even pose major health risks. Therefore, the probabilistic health risks associated with the consumption of various food stuffs should be thoroughly investigated. Health risk assessment has been performed by numerous researchers across the world. For instance, Muhib *et al.* (2016) carried out the health risk assessment of heavy metal consumption through the intake of cow milk in Bangladesh [15]. Furthermore, Rahman *et al.* (2017) reported the health risk assessment based on hazard quotient (HQ) for various metals in drinking water in Bangladesh [16]. The health risks associated with the consumption of contaminated food stuffs have also been reported by Islam *et al.* (2015) in Bangladesh [17], while Bortey-Sam *et al.* (2015) measured the HQ associated with the consumption of animal foods contaminated with metals [18].

Most of the previous studies have findout health impact of heavy metal in fruits and vegetables, where this study has conducted to evaluate the concentration and impacts of trace elements.

The present study was conducted during 2016-2017, aimed to measure the concentrations of some essential elements in the fruits and vegetables of a selected industrial area and compare the values with the recommended nutritional levels, estimated daily intake, and inoffensive upper level of intake in order to identify the possible human health risks.

2. Materials and Methods

2.1. Site Description and Sampling

Konabari in Gazipur District is adjacent to Dhaka megacity in Bangladesh and was selected as the study site, which is located at 90°17'00"N-90°21'00"N and 23°59'05"E-24°30'15"E (Figure 1). Gazipur District is a densely

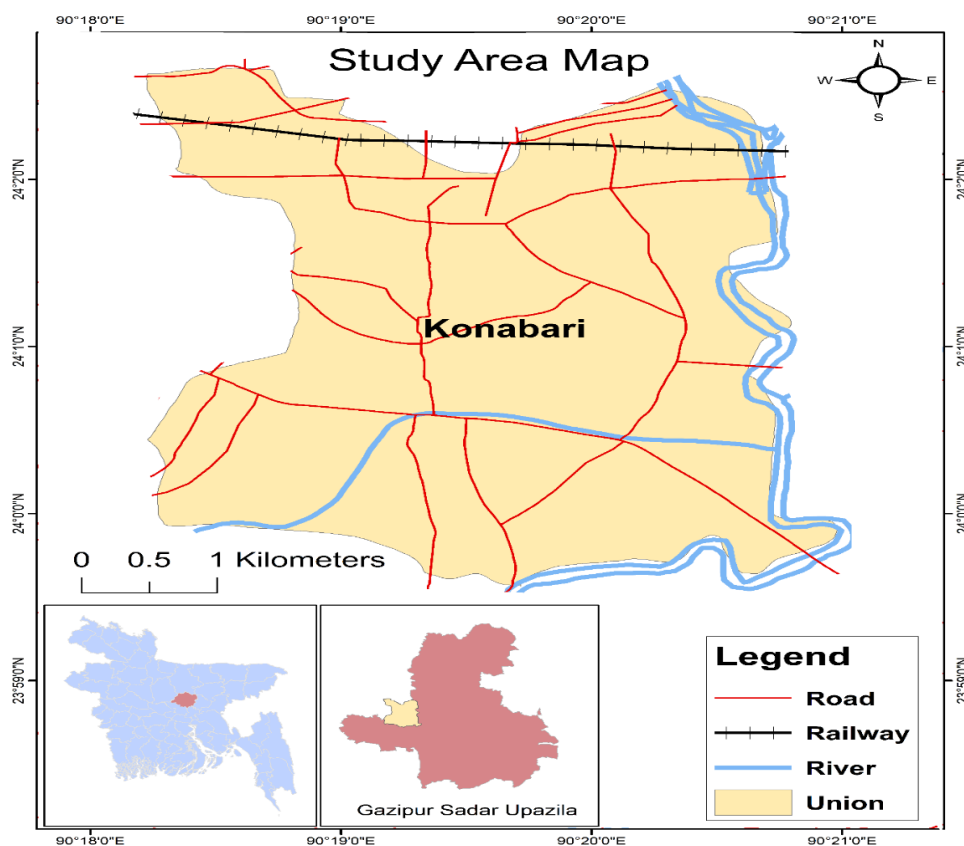


Figure 1: Map of study area (Kkonabari, Ggazipur)

populated industrial area, with the approximate population of 203,378 [19]. The entire area is covered by Konabari (22.10 km²) and is part of Madhupur Tract, lying within the Dhaka-Gazipur terrace, which is located in the middle part of the country. As the soil of Konabari industrial area is highly supplemented with various chemicals and metals, the nutritional levels of the fruits and vegetables growing in this area had to be measured to perceive the possible human health risks of their consumption [20]. The present study was also focused on the evolution of the environmental deterioration of the study area by analyzing the elemental levels in fruits and vegetables.

Samples were collected from different points of Konabari area, and the location was tracked by a GPS receiver (GPSMAP® 64st, Garmin, Lenexa, Kansas, USA). The target sample selection and periodization were performed based on the dietary habits of the inhabitants of the area. In total, 28 samples were collected randomly of three types of fruits, including papaya (*Carica papaya*), guava (*Psidium guajava*), and banana (*Musa acuminata*), and seven types of vegetables, including Malabar spinach (*Basella alba*), eggplant (*Solanum melongena*), jute tender leaves (*Corchorus capsularis*), watercress (*Nasturtium officinale*), water spinach (*Ipomoea aquatica*), gourd leaves (*Lagenaria siceraria*), and cauliflower (*Brassica oleracea*). Minimum duplicate samples were collected for each of the items, some of which were triplicated or more. The samples were directly collected from the plants and carried with leveled zipper poly bags with the inscribed data of the species (common name, date, and GPS location). Afterwards, the poly bags were carried with plastic containers filled with

refrigerants to cool the sample units and transferred promptly to the laboratory.

2.2. Experimental Analysis

In the laboratory, the samples were prepared for elemental analysis by wet acid digestion in a microwave oven. The fruits and vegetables were washed with high-purity distilled water to remove the external particles, chopped with a sharp knife separately, and placed inside the microwave oven for drying at the temperature of 60°C for 48 hours. The dried samples were ground by a mortar and packaged in clean, leveled zipper bags for the further procedures. Following that, 0.5 gram of the dried samples (or equivalent) and five milliliters of concentrated suprapur grade nitric acid (HNO₃; Merck, Darmstadt, Germany) were added to a 50-milliliter Folin digestion tube. The mixture was heated to the temperature of 120-130°C for 16 hours and treated with hydrogen peroxide (H₂O₂).

After digestion, the samples were diluted to 50 milliliters by high-purity water (18 MΩ cm) in a MILLI-Q water purification system (Merck Millipore, Darmstadt, Germany). Each sample was analyzed in triplicate to obtain the mean values of the major and minor components using the ICP-OES. Notably, the samples were analyzed by the ICP-OES in Japan (Varian Vista-PRO CCD Simultaneous ICP-OES, Hitachi, Tokyo, Japan) in optimum conditions. ICP-OES is currently one of the most multipurpose methods of inorganic analysis and is a rapid, multi-element technique used to measure major essential elements, such as calcium (Ca), magnesium (Mg), sodium (Na), potassium (K), iron (Fe), and manganese (Mn), as well as trace metals such as lead (Pb), copper (Cu), nickel (Ni), and zinc (Zn).

The emitted wavelength that was employed in this study was within the range of 213.857-766.490 nanometers, where the detection limit (LoD) could be verified within the range of 0.045-0.405 µg/l, and the limit of quantification (LoQ) was within the range of 0.15-1.35 µg/l (Table 1). For the validation of the internal standard and internal quality controls, each sample was separately prepared and examined in the form of blank, GBW07603 (bush branches and leaves), and GBW07604 (poplar leaves) as the certified reference materials (CRM) (Table 1) with the recovery of > 90%. Each sample was analyzed in triplicate in order to avoid batch-specific errors.

To prepare the calibration curve, multi-element standard XSTC-13 solutions were used (Spex CertiPrep® New Jersey, USA), and 10 mg/l of each element (Al, Ca, Fe, K, Mg, Mn, Na, and Zn) was used for the standard stock solutions. The internal standard calibration solutions contained 1.0 mg/l of indium (In), yttrium (Y), beryllium (Be), tellurium (Te), cobalt (Co), and thallium (Tl). The multi-element standard solution was used to establish the standard curve. In addition, a tuning solution with relative standard deviation (RSD) was assessed, and the values were less than five percent (RSD < 5%).

2.3. Health Risk Assessment

Data analysis was performed in SPSS and Microsoft Excel sheet to calculate the mean values, maximum, minimum, recommended, and estimated daily intake, hazard index, and percentages. The estimated daily intake (EDI) of the target metals in the fruits and vegetables depended on the metal concentrations in the samples based on fresh weight. The daily intake of vegetables and body weight were calculated using the following equation:

$$EDI = \frac{DIM}{BW}$$

Daily intake of metals (DIM) was also calculated by multiplying the daily consumption of fruits and vegetables by the mean concentration of the metals in the fruits and vegetables.

$DIM = \text{Daily Vegetable Intake} \times \text{Mean Metal Concentration in Vegetables}$

Body weight (BW) of an adult resident was considered to be 60 kilograms in the present study. According to the FAO, the daily fruits and vegetables consumption of an adult are 44.7 and 130 grams on average, respectively [3,4]. In the current research, the human health risks associated with the consumption of fruits and vegetables by local residents

were evaluated based on the target hazard quotients (THQs). The THQ estimation method has been provided in the U.S. EPA Region III report and was calculated using the following formula [21]:

$$THQ = \frac{EF \times ED \times FI \times MC}{RfD \times BW \times AT} \times 10^{-3}$$

where EF shows the exposure frequency (365 days/year), ED is the exposure duration (70 years), FI represents food ingestion (g/day/person), MC is the metal concentration in vegetables (mg/kg based on raw weight), RfD shows the oral reference dose (mg/kg/day), BW is the body weight of an adult (60 kg), and AT represents the averaging time of non-carcinogens (365 days/year × number of exposure years assuming 70 years in our study). Notably, the RfD values were based on 0.3, 0.14, and 0.3 mg/kg/day of iron, manganese, and zinc, respectively [22, 23].

$$HI = \sum TTHQ = TTHQ \text{ food 1} + TTHQ \text{ food 2} \dots + TTHQ \text{ food n}$$

Potential health risk depends on the calculated value of THQ. When the THQ value is less than one, the exposed population is safe from adverse effects, while the exposurer has the potential health risk when the THQ value is equal to or higher than one. Under such circumstances, the affected individuals should take protective measures and use the related interventions.

3. Results and Discussion

In the present study, the concentrations (mg/kg) of essential elements of aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc were determined in Konabari composite, located in Gazipur area in highly consumed samples of three fruits (papaya, guava, and banana) and seven vegetables (Malabar spinach, eggplant, jute leaves, watercress, water spinach, gourd leaves, and cauliflower). Table 2 and Figure 2 show the levels of the essential elements in the analyzed fruits and vegetable samples.

Accordingly, the maximum concentration of aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc was detected in Malabar spinach (2,296 mg/kg), watercress (16,582 mg/kg), Malabar spinach (1,242 mg/kg), Malabar spinach (5,579.2 mg/kg), Malabar spinach (12,874 mg/kg), watercress (2,512 mg/kg), watercress (2,500 mg/kg), and watercress (202 mg/kg), respectively.

The findings indicated that Malabar spinach and watercress were the predominated samples to separately contain the maximum concentration of four elements.

Table 1: Emitted wavelength, LOD, LOQ, and CRM values detected by ICP-OES

Elements	Wavelength (nm)	LOD (µg/L)	LOQ (µg/L)	GBW07603 (mg/kg)	GBW07604 (mg/kg)
Al	396.152	0.05	0.17	1879.5	656
Ca	315.887	0.40	1.35	17841.0	19067
Fe	238.207	0.02	0.07	971.5	232
K	766.490	0.12	0.42	9601.5	14175
Mg	285.213	0.04	0.15	4778.0	6758
Mn	257.610	0.30	1.0	<LOD	<LOD
Na	588.995	0.18	0.60	19301.5	204
Zn	213.857	0.16	0.53	134.5	90

Table 2: Mean concentrations (mg/kg) of essential elements in samples (*BDL: below detection limit)

Samples	Essential elements (mg/kg)							
	Al	Ca	Fe	K	Mg	Mn	Na	Zn
Papaya	638 ± 10	8352 ± 13	378 ± 0	5727.8 ± 370	5350 ± 70	570 ± 10	1098 ± 20	134 ± 0
Banana	72 ± 0	962 ± 10	58 ± 0	380 ± 160	1760 ± 20	BDL	220 ± 10	102 ± 0
Guava	274 ± 10	1670 ± 10	400 ± 0	1993.2 ± 180	1236 ± 10	BDL	464 ± 10	116 ± 0
Malabar spinach	2296 ± 10	8634 ± 50	1242 ± 20	5579.2 ± 890	12874 ± 13	BDL	1776 ± 30	170 ± 0
Eggplant	120 ± 0	2244 ± 26	148 ± 0	3064 ± 230	2468 ± 16	BDL	308 ± 20	170 ± 0
Jute leaves	1528 ± 0	12952 ± 11	814 ± 6	4391.6 ± 300	8340 ± 80	BDL	1150 ± 30	166 ± 0
Watercress	1526 ± 10	16582 ± 17	762 ± 0	3997.4 ± 296	6136 ± 44	2512 ± 16	3200 ± 36	202 ± 0
Water spinach	384 ± 10	8858 ± 11	1204 ± 0	4062 ± 160	2022 ± 0	20 ± 20	2756 ± 40	134 ± 0
Gourd leaves	312 ± 0	2306 ± 30	224 ± 0	3360 ± 296	2238 ± 16	BDL	1556 ± 20	80 ± 0
Cauliflower	492 ± 10	4086 ± 40	332 ± 0	2956.2 ± 80	2370 ± 24	BDL	3070 ± 40	82 ± 0
Average	764.2	6664.6	556.2	3551.14	4479.4	1034	1559.8	128.6
Maximum	2296	16582	1242	5727.8	12874	2512	3200	202
Minimum	72	962	58	380	1236	20	220	80

*BDL: Below detection limit

On the other hand, the minimum concentration of aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc was detected in banana (72 mg/kg), banana (962 mg/kg), banana (58 mg/kg), banana (380 mg/kg), banana (1,236 mg/kg), papaya (20 mg/kg), banana (220 mg/kg), and gourd leaves (80 mg/kg). In addition, most of the elements were detected at the minimum concentration in banana.

Among the studied elements, manganese was only detected in three samples, while the level of this element was below the detection level in the other samples. The concentration of essential elements or nutrients (mg/kg) in these fruits and vegetables was determined using the ICP-OES technique (Table 2). According to the obtained results, the maximum concentration was estimated at 16,582 mg/kg of calcium, while the minimum concentration was calculated to be 58 (Table 2) of iron. The mean concentration of the elements was estimated at 764.2, 6,664.6, 556.2, 3,551.14, 4,479.4, 1,034, 1,559.8, and 128.6 mg/kg for aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc, respectively in the fruits and vegetables samples. Furthermore, the findings of the current research demonstrated that the mean concentration of the elements in the samples was higher than the average nutritional levels, which are 1,499.69, 32.91, 3,550.48, 434.49, 4.095, 398.82, and 6.96 mg/kg for calcium, iron, potassium, magnesium, manganese, sodium, and zinc, respectively in fruits and vegetables [24].

In the fruits and vegetable samples, the maximum and minimum mean concentrations were determined to be 6,664.6 and 128.6 mg/kg for calcium and zinc, respectively. The mean concentration values decreased in the following order (Figure 3): Ca>Mg>K>Na>Mn>Al>Fe>Zn.

Overall, the results of the present study indicated that the total nutrient concentration of the fruits and vegetables was 32,418.2, 29,191.6, 22,247.8, 19,319, 13,388.2, 10,076, 8,362, 6,153.2, 3,554 mg/kg, respectively in watercress, Malabar spinach, jute leaves, papaya, water spinach, cauliflower, gourd leaves, eggplant, guava, and banana, respectively shown in Figure 4.

The maximum concentration (34,917.4 mg/kg) was also detected in watercress, and the minimum concentration (3,380 mg/kg) was observed in banana. However, the total nutrient values in all the fruits and vegetable samples decreased in the following order: watercress > Malabar spinach > jute leaves > papaya > water spinach > cauliflower > gourd leaves > eggplant > guava > banana.

In the current research, The EDI of eight elements (Al, Ca, Fe, K, Mg, Mn, Na, and Zn) was calculated based on the mean concentration of each element in each sample and the individual consumption rates divided by the body weight (60 kg for an adult). Table 3 shows the calculated EDI, reference daily intake (RDI), and inoffensive upper level of intake (UL) of the studied elements in the consumption of fruits and vegetables per kilogram of body weight. According to the obtained results, the mean EDI was 1.516, 12.878, 1.086, 6.542, 8.519, 1.970, 3.126, and 0.229 mg/day/kg body weight for aluminum, calcium, iron, potassium, magnesium, manganese, sodium, and zinc, respectively. The mean EDI of all the metals was less than the UL, with the exception of iron (1.086) and manganese (1.970) (Figure 5). In the fruits and vegetable samples, the mean values of EDI increased in the following order: Zn < Fe < Al < Mn < Na < K < Mg < Ca.

The calculated THQs indicated the potential health risks associated with the consumption of contaminated fruits and vegetables by adult populations, which is the ratio of the determined dose of a pollutant to the reference dose level. The consumption of fruits and vegetables is considered safe with THQ<1, while it is considered unsafe with THQ>1. In the present study, the THQ was only calculated for iron, manganese, and zinc since the RfD was not established for the other metals (Table 4). On the other hand, the TTHQ was not >1, and it was concluded that all the studied fruits and vegetable were safe to consume. However, a previous study reported the heavy metal status and presence of arsenic in a rural area in Bangladesh [25], and the levels of trace metals have also been mentioned in the vegetables growing near a mining area in Andhra Pradesh (India, southeast Nigeria) [26-28].

Figure 6 depicts the health risk index of iron, manganese, and zinc with HI < 1.

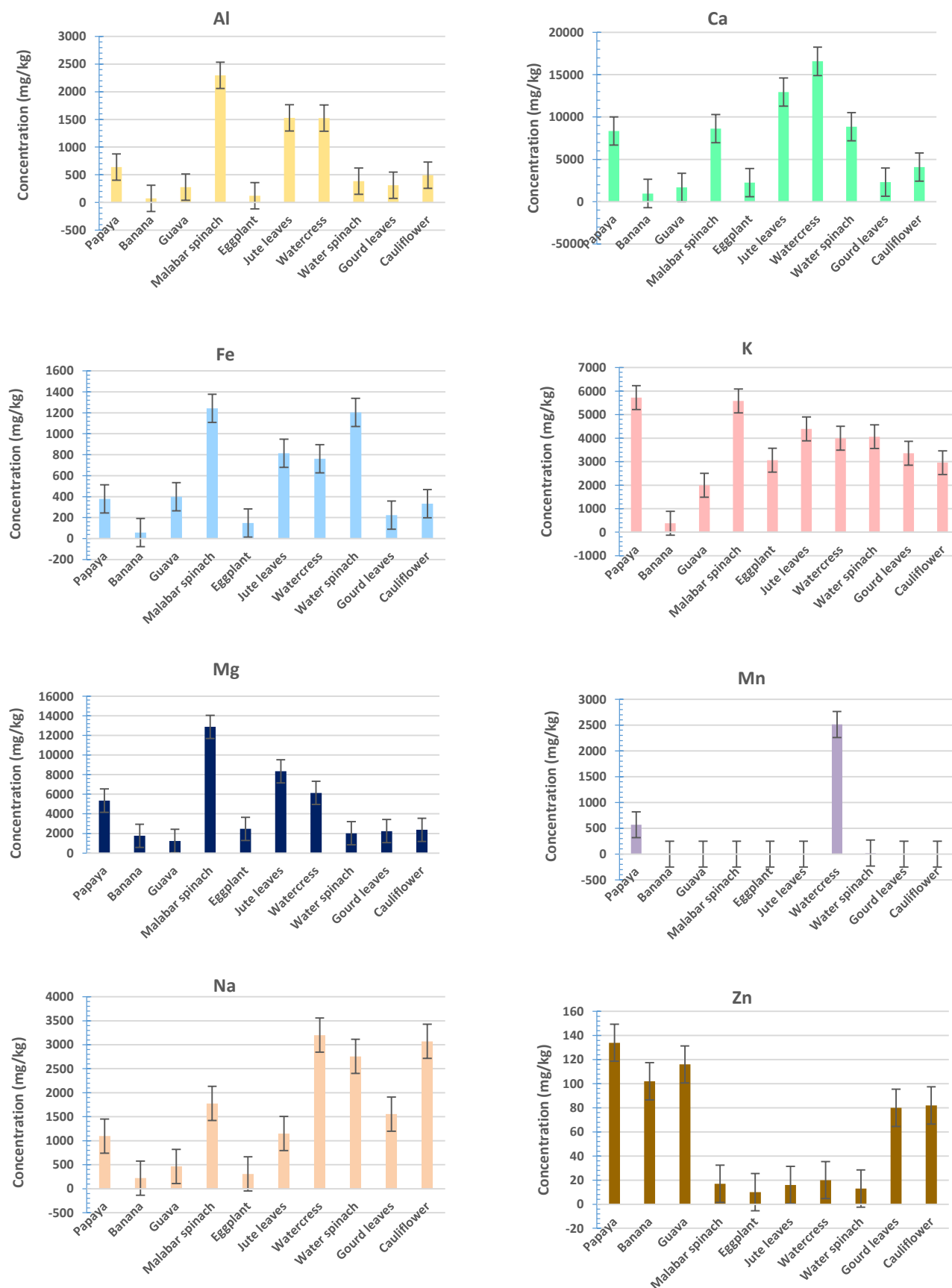


Figure 2: Concentration level as fresh weight of trace elements in studied samples

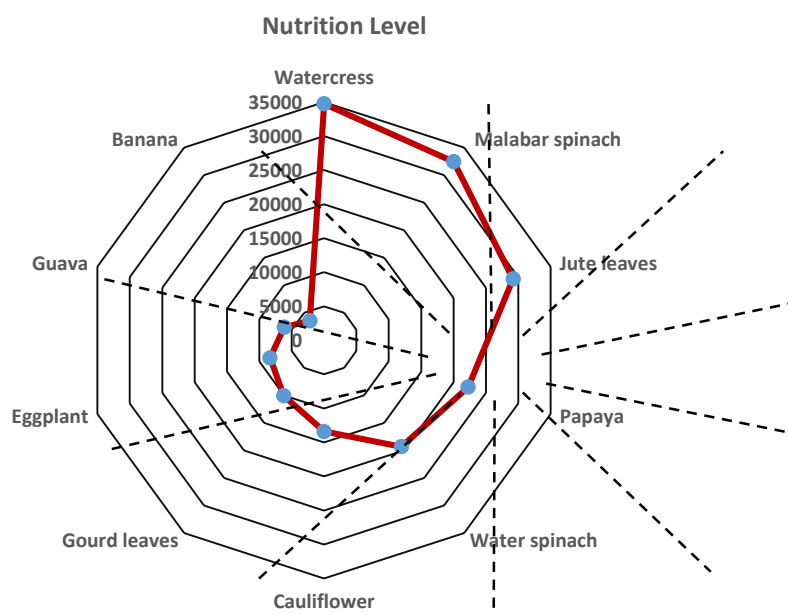


Figure 3: Descending order of trace metals in fruits and vegetables in industrial area near Dhaka city

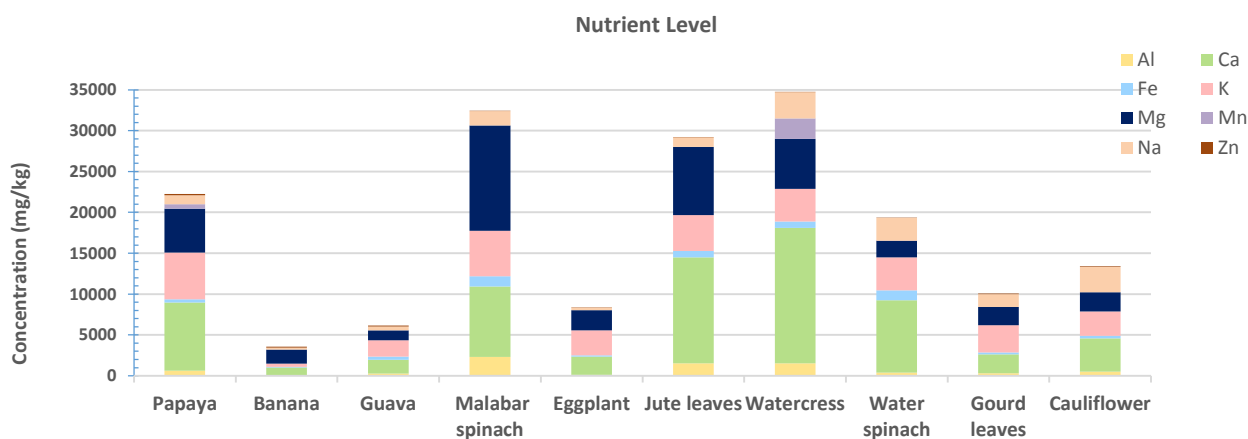


Figure 4: Comparative presence of essential elements in fruits and vegetable samples

Table 3: Comparison of estimated daily intake (EDI) of essential elements in samples, reference daily intake (RDI), and inoffensive upper level of intake

Samples	Elements (mg/day/kg body weight)							
	Al	Ca	Fe	K	Mg	Mn	Na	Zn
Papaya	0.475	6.222	0.282	4.267	3.986	0.425	0.818	0.100
Banana	0.054	0.717	0.043	0.283	1.311	BDL	0.164	0.076
Guava	0.204	1.244	0.298	1.485	0.921	BDL	0.346	0.086
Malabar spinach	4.975	18.707	2.691	12.088	27.894	BDL	3.848	0.368
Eggplant	0.260	4.862	0.321	6.639	5.347	BDL	0.667	0.217
Jute spinach	3.311	28.063	1.764	9.515	18.070	BDL	2.492	0.360
Watercress	3.306	35.928	1.651	8.661	13.295	5.443	6.933	0.438
Water spinach	0.832	19.192	2.609	8.801	4.381	0.043	5.971	0.290
Gourd Spinach	0.676	4.996	0.485	7.280	4.849	BDL	3.371	0.173
Cauliflower	1.066	8.853	0.719	6.405	5.135	BDL	6.652	0.178
Average EDI	1.516	12.878	1.086	6.542	8.519	1.970	3.126	0.229
RDI	*	16.667	0.300	58.500	7.000	0.038	33.333	0.183
UL	*	41.667	0.750	*	12.500	0.183	38.333	0.667

*BDL: below detection level; *not established

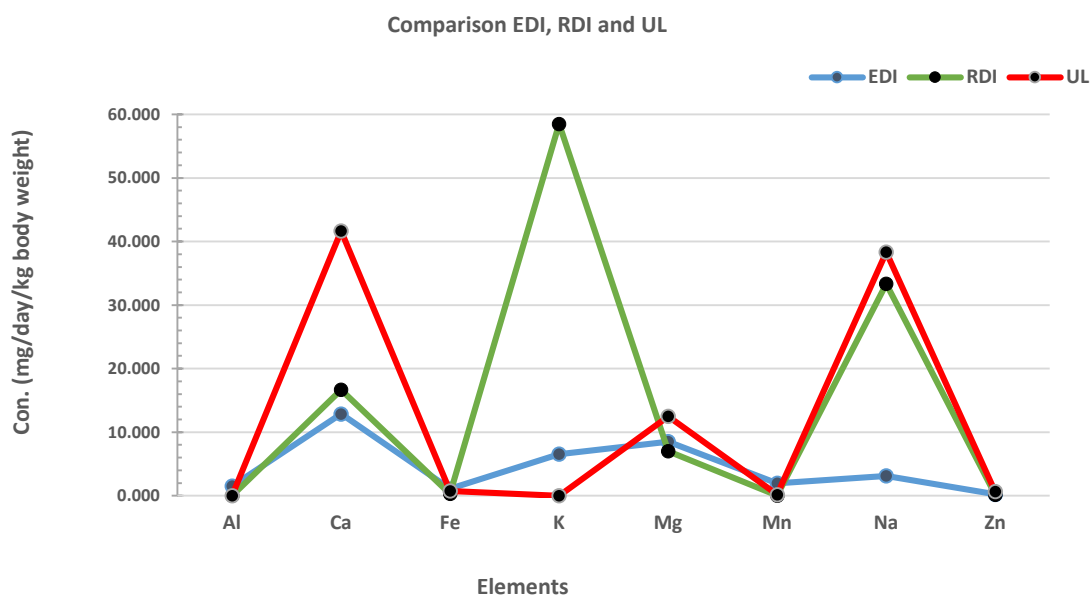


Figure 5: Comparison of EDI, RDI, AND UL of targeted elements in samples

Table 4: Target hazard quotient (THQ) of iron, manganese, and zinc

Sample	Fe	Mn	Zn	TTHQ
Papaya	0.009387	0.030332	0.003328	0.043047
Banana	0.009933	BDL	0.002881	0.012814
Guava	0.030843	BDL	0.004222	0.035065
THQ	0.050163	0.030332	0.01043	0.090925
Malabar spinach	0.010689	BDL	0.007222	0.017911
Eggplant	0.058789	BDL	0.011989	0.070778
Jute leaves	0.055033	0.388762	0.014589	0.458384
Watercress	0.086956	0.003095	0.009678	0.099729
Water spinach a	0.016178	BDL	0.005778	0.021956
Gourd leaves	0.004189	BDL	0.007367	0.011556
Cauliflower	0.023978	BDL	0.005922	0.0299
THQ	0.25581	0.39186	0.06255	0.71021
Total	0.305974	0.422189	0.072974	0.801138

*BDL: Below detection limit

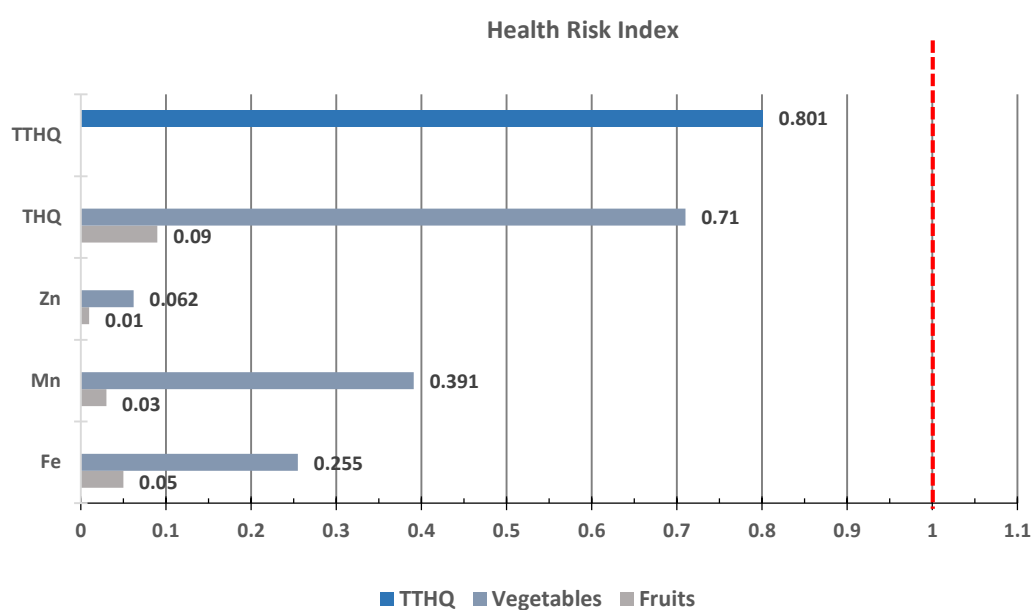


Figure 6: Health risk index of iron, manganese, and zinc in fruits and vegetables (red dash shows threshold value of thq for health impacts)

4. Conclusion

The measurement of essential elements or minerals concentration in fruits and vegetables is important for human health benefits and health risk assessment during food consumption. In this study, we evaluated the concentrations of essential metals or minerals in 10 types of fruits and vegetables and compared the data with the nutritional values of the fruits and vegetables. According to the results, all the values were acceptable, and the consumption of the samples had no major health risks. However, some data were lacking since the literature in this regard was mainly focused on heavy metals. The Environmental Protection Agency (EPA) has not yet established the RfD for some elements. Therefore, the outcomes of similar investigations could be used as a tool for farmers and decision-makers to adopt and implement action-oriented, sustainable strategies to save the population by minimizing the issues associated with nutritional deficiency.

Authors' Contributions

M.J.M., and M.Sh.S., conceived the idea and execute it through laboratory experiments. M.J.M., and M.M.R., S.H., and S.S., conducted field work and sample collections. M.J.M., and M.M.R., analyzed the data and interpreted the data and wrote the manuscript. All the authors read and revised the final manuscript, and agreed for publication in journal.

Conflict of Interest

The Authors declare that there is no conflict of interest.

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