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Cadmium, Nickel and Zinc Concentration in Some Common Fruits Samples Collected from Different Super Shops Located in Dhaka City and Probable Health Risk Assessment

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Abstract

Heavy metals concentration in fruits samples collected from different super shops were determined by using Atomic Absorption Spectrophotometry and potential health risk from the consumption of these fruits was estimated. Mean concentration of Cd, Ni and Zn in the studied fruits samples (Fuji Apple, Green Apple, Red Grape, Green Grape, Pear, Malta and Pomegranate) were within the range of 0.00 to 0.15, 0.17 to 10.78, 3.44 to 19.88 mg/kg for Agora; 0.00 to 0.20, 0.00 to 42.75, 3.20 to 13.40 mg/kg for Meena Bazaar and 0.00 to 0.15, 0.60 to 18.65, 4.31 to 17.68 mg/kg of dry weight, for Swapno, respectively. Cadmium concentration was the highest in Fuji Apple and Red Grape (0.15 mg/kg) samples, which was higher than MAC value by FAO/WHO, collected from Swapno. The highest Nickel concentration (42.75 mg/kg) was found in Green Grape, collected from Meena Bazaar, which was 53.44 times higher than MAC value according to FAO/WHO. Mean concentration of metals were found above the maximum allowable limit in most of the fruits though mean Average Daily Intake (ADI) values were below the PMTDI value for all fruits. The Hazard Quotient (HQ) and Hazard Index (HI) values for all metals were below 1.00 which signifies that these fruits were not carcenogenic but continuous consumption of some of high metals containing fruits sold in the market is imposing threat to food security.

Keywords: Fruits; Super Shop; Metals Concentration; Average Daily Intake (ADI); Health Hazard

Abbreviations: ADI: Average Daily Intake; HQ: Hazard Quotient; HI: Hazard Index; AAS: Atomic Absorption Spectrophotometer; MAC: Maximum Allowable Concentration; PMTDI: Permitted Maximum Tolerable Daily Intake.

Introduction

As fresh fruits contain vitamins and mineral salts, water, calcium, iron, sulphur and potassium, they are very useful for the maintenance of our health. Sufficient amount of fruits and vegetables is needed to fight against various diseases and age related pathologies. But when they are contaminated with high amount of heavy metals, they become a threat to our health and may be responsible for diseases. Consuming high metal containing food for long time may cause health hazard [1]. A super shop is a kind of larger store than a traditional store, also known as grocery shops, where a customer is offered various kinds of foodstuff and household products arranged together according to customer's choice with self-picking service [2]. Super shops are getting popular day by day and we are getting dependent on these super shops for our daily grocery materials. Since the standard of life is upgrading day by day with the increase in vast population, business of super shops is also getting popular. All these products are displayed with the alternate choices. So people can choose their products according to their needs. There is no option for bargaining with the sales man, all the products are fixed price with minimum profits. These self-service store facilities are responsible for increasing dependence and create a place of trust to people.

The present study was carried out to evaluate data on heavy metals i.e. Cadmium (Cd), Nickel (Ni) and Zinc (Zn) concentration in some commonly sold fruits in some super shops i.e. Agora, Meena Bazaar and Swapno, located in Dhaka city, Bangladesh. The probable health risk associated with the consumption of these fruits is also assessed, based on the Average Daily Intake (ADI) of fruits, Hazard Quotient (HQ) and Hazard Index (HI).In this study, Fuji apple, Green Apple, Green grape, Malta, Pear, Pomegranate, Red grape were collected from these super shops and analyzed. Therefore, this study gives a representative result of analyses about the food quality and health risk of some common fruits that are sold in these super shops.

Materials and Methods

Study Area

The fruit samples were collected from 3 branches of Agora, Meena Bazar and Swapno, respectively. These shops are located in Mogbazar, Malibagh and Dhanmondi area in Dhaka city.

Samples Collection

Seven fresh fruit samples, i.e. Green Apple, Fuji Apple, Green Grape, Red Grape, Pear, Pomegranate and Malta were purchased from 3 outlets of Agora, Meena Bazar, Swapno, respectively on February, 2019, which are located at the center point of Dhaka city. Scientific and local names of the studies fruits samples are represented in Table 1.

Fruits	Scientific names	Local names
Fuji apple	*Malus domestica*	Apple
Green apple	*Malus domestica*	Apple
Green grape	*Vitis vinifera*	Sobuj Angur
Malta	*Citrus* sinensis	Malta
Pear	*Pyrus communis*	Nashpati
Pomegranate	*Punica granatum*	Dalim
Red Grape	*Vitis vinifera*	Lal Angur

Table 1: Scientific and local names of the analyzed fruits.

Preparation and Preservation of Samples

The clean fruits samples were washed and chopped into small pieces. Composite samples were made for each super shop and then dried on a sheet of paper to eliminate excess moisture. The samples were placed in an electric oven at 60-70°C for 72-96 hours depending on the sample size. The dried fruit samples were ground by means of a clean pestle and mortar to obtain homogenized samples and stored in plastic bottles.

Digestion of Samples

Half gram (0.5g) of the oven dried sample was weighed into 100 ml beaker, followed by the addition of 15 ml conc. HNO_3 and 5 ml conc. $HClO_4$. The digestion was performed at a temperature of about 190°C for 3 hours. After cooling, the solution was made up to a final volume of 25 ml with distilled water in a volumetric flask [3]. The final samples were kept in labeled plastic bottles at ambient temperature before analyses.

Analyses of the Samples

The concentrations of heavy metals (Cd, Ni and Zn) were determined by using Atomic Absorption Spectrophotometer (AAS) (Varian AA 240).

Average Daily Intake (ADI)

The ADI of a heavy metal is a product of average daily fruits consumption per person, percentage of dry weight of fruits, and average heavy metal concentration per dry weight fruit as shown in the following equation [4].

$$ADI = Av_{consumption} \times \%\, DW_{fruits} \times C_{heavy\ metal}$$

ADI is Average Daily Intake of heavy metal per person per day (mg/person/day), $AV_{consumption}$ is average daily consumption of fruits per person per day (g/day), $\%DW_{fruits}$ is the percentage of dry weight of fruit (%DW = [(100 - %moisture)/100)], and $C_{heavy\ metal}$ is the average heavy metal concentration of fruits on dry weight basis (mg/g).

Hazard Quotient (HQ)

Hazard quotient is a proportion of the probable exposure to an element/chemical and level at which no negative impacts are expected. When the quotient is <1, this means no potential health effects are expected from exposure, but when it is >1, it signifies that there are potential health risks due to exposure [5]. The HQ is calculated as a fraction of determined dose to the reference dose as shown in the following equation:

$$HQ = ADI/ R_fD$$

Where ADI is the Average Daily Intake per day (mg/kg/day) and R_fD is the oral reference dose of the metal (mg/kg/day). R_fD is an approximation of daily tolerable exposure to which a person is expected to have without any significant risk of harmful effects during a lifespan [4]. Oral reference dose of some heavy metals are given in the following Table 2.

Name of Heavy Metals	R_fD (mg/kg/day)
Cd	0.0005
Ni	0.02
Zn	0.3

Table 2: Oral reference dose (R_fD) of heavy metals [6].

Hazard Index (HI)

Hazard index is the cumulative effects due to the exposure of more than one pollutant substances. So, Hazard Index (HI) is a powerful tool to estimate the overall effects caused by more than one pollutant. The Hazard Index (HI) is calculated as an arithmetic sum of the Hazard Quotients (HQ) for each pollutant as shown in the following equation [4].

$$HI = \sum_{i=1}^{n} HQ$$

When the HI is >1, this suggests that there are significant health effects from consuming pollutants contained in a food stuff [4].

Statistical Analyses

The results of the studied samples were statistically evaluated by using ANOVA (Analysis of Variance) and Duncan's Multiple Range Test in IBM SPSS statistics version 20 [7]. The letter was used for testing the significance of differences between mean values. The 0.05 level of probability was chosen for the statistical judgment.

Results and Discussion

Metal Concentration in Fruits Samples

This study illustrated that the mean concentration of cadmium in the fruits samples, collected from Agora increased in the order of Green Grape<Fuji Apple<Red Grape<Green Apple<Malta (edible portion)<Pomegranate (edible portion)<Malta (non-edible portion), Pomegranate (non-edible portion)<Pear. Cadmium concentrations ranged from 0 to 0.15 mg/kg. Cadmium concentration was not significantly different in Fuji Apple, Green Apple, and Red Grape.

In case of Meena Bazaar, it was observed that Cd concentration exceeded Maximum Allowable Concentration (MAC) (0.05 mg/kg) in all fruits except Green Grape and edible part of Malta. Cadmium concentration was found the highest in Green Apple (0.20 mg/kg) followed by Pear (0.18 mg/kg), Pomegranate (edible portion) (0.13 mg/kg), Fuji Apple (0.1 mg/kg), Pomegranate (non-edible portion) and Red Grape (0.08 mg/kg), Malta (non-edible portion) (0.06 mg/kg), Malta (edible portion) (0.03 mg/kg). Cadmium concentration in Green Apple was significantly different from other fruits except Pear.

In the fruits samples collected from Swapno, cadmium concentration was the highest in Fuji Apple and Red Grape (0.15mg/kg) which was 200% higher than MAC [8] value and not significantly different from Green Apple, Green Grape and Pear. The highest concentration (0.15 mg/kg) was found in Red Grape and Fuji Apple (0.15 mg/kg) followed by Green Grape and Pear (0.13 mg/kg), Green Apple (0.1 mg/kg). Cadmium concentration was not significantly different in the edible portion of Malta and non edible portion of Pomegranate Table 3.

Name of fruits	Agora	Meena Bazaar	Swapno	MAC [8]
Fuji Apple	0.02 ab	**0.10** c	**0.15** c	0.05
Green Apple	0.05 abc	**0.20** e	**0.10** bc	
Red Grape	0.03 ab	**0.08** bc	**0.15** c	
Green Grape	*Tr	*Tr	**0.13** bc	
Pear	**0.15** e	**0.18** de	**0.13** bc	
Malta (edible portion)	**0.08** bcd	0.03 ab	0.05 ab	
Malta (non-edible portion)	**0.13** de	**0.06** abc	*Tr	
Pomegranate(edible portion)	**0.10** cde	**0.13** cd	*Tr	
Pomegranate(non-edible portion)	**0.13** de	**0.08** bc	0.02 a	

Table 3: Mean Cadmium concentration (mg/kg) in different fruits samples collected from different super shops.
Mean values with same letter(s) in a column do not differ significantly from each other at 5% level by DMRT.
*Tr-Trace.

Various values have been previously reported for fruits which include 0.05, 0.14 and 0.0003 mg/kg for Apple samples which were collected from Alexandria city, Egypt by Radwan and Salama [9], from Pakistan by Parveen, et al. [10] and from Greek market by Karavoltsos, et al. [11], respectively. Radwan and Salama collected Watermelon, Orange and Banana samples from Alexandria city, Egypt [9] and reported Cd values of 0.02 mg/kg for Watermelon, 0.04 mg/kg for Orange, 0.02 mg/kg for Banana. Karavoltsos, et al. [11] collected these fruits samples from Greek market and reported Cd values of 0.0004 mg/kg for Watermelon 0.0009 mg/kg for Orange as well as 0.001 mg/kg for Banana. They all reported lower Cadmium concentration in fruits samples than the present study.

Similar study was carried out in Lagos, Nigeriaby Sobukola, et al. [12] and it was found that Cd concentration were 0.004 and 0.005 mg/kg in Apple and Grape, respectively, which were far lower than that of Agora, Meena Baazar and Swapno. Cadmium concentration was found lower than the maximum permissible limit in Jackfruit, Mango and Banana samples collected from 30 agro ecological zones across all seven divisions of Bangladesh, reported by Shaheen, et al. [13]. Cadmium concentration may be present due to the pesticide residue or it may be present in the preservative or color, used by seller. Cadmium is used in Ni/Cd batteries and in vessels and vehicles as corrosion resistance coating. Phosphate fertilizers, detergents and refined petroleum products may contain Cd as impurity. The geochemical mobility of Cd increases as a result of acid rain which increases its surface water concentration as lake water pH decreases [14].

Table 4 shows that mean concentrations of nickel varied from 0.69 to 10.78 mg/kg among different fruits samples collected from Agora. Nickel concentrations increased in the order of Pear<Red Grape<Green Grape, Malta (edible portion)<Fuji Apple<Green Apple<Pomegranate (edible portion)<Malta (non-edible portion)<Pomegranate (non-edible portion). Nickel concentration was not significantly different in all fruits except in the non-edible part of Pomegranate. Nickel concentration in fruits samples collected from Meena Bazaar varied from 0 to 42.45 mg/kg (Table 4). Nickel concentration was in the increasing orderof Green Apple<Malta (non-edible portion)<Fuji Apple<Pear<Pomegranate (non-edible portion)<Red Grape<Pomegranate (edible portion)<Green Grape. The highest nickel concentration (42.75 mg/kg) was found in Green Grape which was 53.44 times higher than the Maximum Allowable Concentration (MAC)[8] and significantly different from all other fruits samples (Table 4). The second highest of Ni concentration was observed in the edible part of Pomegranate (14.58 mg/kg) which was 18.22 times higher than the permissible limit but not significantly different from other fruits samples.

Nickel concentration in Green grape samples, collected from Swapno was found the highest (18.65 mg/kg) followed by non-edible part of Malta (11.075 mg/kg) and the lowest concentration (0.6 mg/kg) were found in Red Grape (0.60 mg/kg). The concentration decreased in the order of Green Grape>Malta (non-edible portion)>Pomegranate (edible portion)>Pomegranate (non-edible portion)>Green Apple>Pear>Fuji Apple>Malta (edible portion)>Red Grape. Nickel concentration was 23.31 times higher in Green Grape than the Maximum Allowable Concentration (MAC) recommended by FAO/WHO [8] and was not significantly different from Malta (non-edible portion), Pomegranate (edible portion) (Table 4).

Name of fruits	Agora	Meena Bazaar	Swapno	MAC [8]
Fuji Apple	**1.28 a**	**1.98 a**	**1.07 a**	
Green Apple	**1.59 a**	0.12 a	**4.35 a**	
Red Grape	0.73 a	**6.45 a**	0.60 a	
Green Grape	**0.83 a**	**42.75 b**	**18.65 b**	
Pear	0.69 a	**5.38 a**	3.03 a	0.8
Malta (edible portion)	**0.83 a**	*Tr	0.80 a	
Malta (non-edible portion)	**8.20 ab**	**0.84 a**	**11.08 ab**	
Pomegranate (edible portion)	0.17 a	**14.58 a**	**10.05 ab**	
Pomegranate(non-edible portion)	**10.78 b**	**5.70 a**	4.48 a	

Table 4: Mean Nickel concentration (mg/kg) in different fruits samples collected from different super shops.
Mean values with same letter(s) in a column do not differ significantly from each other at 5% level by DMRT.
*Tr-Trace.

The concentrations of nickel in all fruits in this study was higher than Apple and Sweet Orrange samples, collected from Lagos, Nigeria, reported by Omoyajowo, et al. [15]. However, the concentration of Ni in Apple, Grape was many-fold higher than what was reported by Sabukola, et al. [12] in the fruits samples collected from Lagos, Nigeria. Nickel concentration was found higher than maximum allowabe limit in Jackfruit samples collected from 30 agro ecological zones across all seven divisions of Bangladesh, reported by Shaheen, et al. [13]. The major sources of nickel contamination in the soil are metal plating industries, combustion of fossil fuels, and nickel mining and electroplating [16].

The concentration of zinc decreased in the order of Pomegranate (edible portion)> Malta (edible portion)>Fuji Apple>Green Apple>Pomegranate (non-edible portion)> Pear>Malta (non-edible portion)>Red Grape>Green Grape, collected from Agora. It was found highest in the edible part of Pomegranate which was significantly different from others which is shown in Table 5. The concentrations were increasing in the order of Green Apple<Red Grape<Green Grape<Fuji Apple<Pomegranate (non-edible portion)<Pear<Malta (edible portion)<Malta (non-edible portion)<Pomegranate (edible portion), collected from Meena Bazaar. Significantly different zinc concentrations were found in the edible part of Pomegranate, Fuji Apple and Green Apple. In the fruits samples, collected from Swapno, zinc concentrations increased in the order of Red Grape<Pear<Green Apple<Malta (edible portion)<Pomegranate (non-edible portion)< Fuji Apple<Green Grape<Malta (non-edible portion)<Pomegranate (edible portion) (Table 5).

Name of fruits	Agora	Meena Bazaar	Swapno	MAC [17]
Fuji Apple	14.32 abc	8.83 b	8.36 ab	
Green Apple	11.10 abc	3.20 a	4.84 a	
Red Grape	5.15 ab	6.13 ab	4.31 a	
Green Grape	3.44 a	6.57 ab	9.56 b	
Pear	7.12 ab	9.13 b	4.41 a	50
Malta (edible portion)	15.60 bc	9.25 b	7.70 ab	
Malta (non-edible portion)	7.04 ab	9.30 b	11.34 b	
Pomegranate (edible portion)	19.88 c	13.40 c	17.68 c	
Pomegranate(non-edible portion)	7.62 ab	9.12 b	7.94 ab	

Table 5: Mean Zinc concentration (mg/kg) in different fruits samples collected from different super shops.
Mean values with same letter(s) in a column do not differ significantly from each other at 5% level by DMRT.

Zinc concentrations were observed very low in Banana, Jackfruit and Mango samples, collected from 30 agro ecological zones across all seven divisions of Bangladesh, reported by Shaheen, et al. [13]. The concentration was also found in very low amount in Orange (0.039-0.043 mg/kg), Grape (0.035-0.046 mg/kg), Apple (0.045-0.551 mg/kg) in Lagos, Nigeria which was reported by Sabukola, et al. [12]. Available literature have shown that the concentration of Zn in Apple samples were 1.36 mg/kg, 5.35 mg/kg in Watermelon, 2.38 mg/kg in orange, 5.59 mg/kg in banana, collected from Alexandria city, Egypt, reported by Radwan and Salama [9]. The concentration of Zn in Apple samples were 0.16 mg/kg, 7.40 mg/kg in Watermelon, 2.20 mg/kg in orange, 1.50 mg/kg in banana, collected from Ibadan city, Nigeria, reported by Onianwa, et al. and Parveen, et al. [18] have reported that Zn concentration in apple was 2.05 mg/kg, collected from Pakistan [10]. Most Zn is added during industrial activities, such as mining, coal, and waste combustion and steel processing. Water is polluted with Zn when untreated industrial effluens are deposited into river and its bank. Irrigation with this water may increase Zn level in agricultural soil and plants [19]. Though, in this study, zinc concentrations were found below the MAC value endorsed by WHO [17], but they were higher than the findings of previous study regarding this topic.

Average Daily Intake

We consume fruits on daily basis for its nutritional value and health benefits. But consuming high metals containing fruits for a long time may cause health hazard [20]. In the present study, the Average Daily Intake (ADI) of three metals were calculated on the basis of 44.7g edible fruits part in a person's daily diet according to Household Income and Expenditure Survey in Bangladesh [21] by considering the mean concentration of each metal in fruits, corresponding to dry weight of fruits and average body weight of 60 kg of a person [22]. Permitted Maximum Tolerable Daily Intake (PMTDI) of Cd, Ni, Zn is 0.046 [23], 0.30 [24], 20.00 [25] mg/person/day, respectively. Average daily intake value of Cd were 0.0004, 0.0007, 0.0007 mg/person/day, respectively, for all fruit samples collected from Agora, Meena Bazaar and Swapno. Daily intake value of Ni were 0.0065, 0.089, 0.042 mg/person/day mg/person/day, respectively, for all fruit samples collected from Agora, Meena Bazaar and Swapno. Daily intake value of Zn were 0.08, 0.06, 0.061 mg/person/day, respectively, for all fruit samples collected from Agora, Meena Bazaar and Swapno. They were found below the Permitted Maximum Tolerable Daily Intake (PMTDI) value (Table 6). As Cadmium can retain in the body for many years, people may face chronic toxicity after consuming high Cd containing food [26]. Now-a-days, with rapid urbanization and industrialization of Bangladesh, industries emit large amount of metal containing fumes which contaminate agricultural soils and food chain by depositing heavy metals on the fruit and vegetable surfaces during their production, transportation, and retailing.

The order of contribution for metals intake via dietary consumption of studied fruits, collected from Agora, was:
Cd: Pear>Pomegranate (edible portion)>Malta (edible portion)>Green Apple>Red Grape>Fuji Apple>Green Grape.
Zn: Pomegranate (edible portion)>Malta (edible portion)>Green Apple, Fuji Apple>Red Grape> Pear>Green Grape.
Ni: Green Apple>Fuji Apple>Green Grape>Red Grape>Malta (edible portion)>Pear> Pomegranate (edible portion).
The order of contribution for Cd, Zn, Ni intake via dietary consumption of studied fruits, collected from Meena Bazaar, are given below:
Cd: Green Apple>Pomegranate (Edible portion)>Pear>Fuji Apple>Red Grape>Malta (edible portion)>Green Grape.
Zn: Pomegranate (edible portion)>Fuji Apple>Green Grape>Pear >Malta (edible portion)>Red Grape>Green Apple.
Ni: Green Grape>Pomegranate (edible portion)>Red Grape>Pear>Fuji Apple>Green Apple> Malta (edible portion).

Cadmium (mg/person/day)			
Name of fruits	**Agora**	**Meena Bazaar**	**Swapno**
Fuji Apple	0.0001	0.0008	0.001
Green Apple	0.0004	0.0016	0.0008
Red Grape	0.0002	0.0006	0.0014
Green Grape	0	0	0.0009
Pear	0.0009	0.001	0.0007
Malta (edible portion)	0.0006	0.0001	0.0003
Pomegranate (edible portion)	0.0008	0.0011	0
Average	0.0004	0.0007	0.0007
PMTDI	0.046 [23]		
Nickel (mg/person/day)			
Name of fruits	**Agora**	**Meena Bazaar**	**Swapno**
Fuji Apple	0.0078	0.015	0.007
Green Apple	0.0128	0.001	0.034
Red Grape	0.0066	0.049	0.006
Green Grape	0.0069	0.401	0.139
Pear	0.0039	0.031	0.017
Malta (edible portion)	0.0063	0	0.005
Pomegranate (edible portion)	0.0014	0.127	0.088
Average	0.0065	0.089	0.042
PMTDI	0.30 [24]		
Zinc (mg/person/day)			
Name of fruits	**Agora**	**Meena Bazaar**	**Swapno**
Fuji Apple	0.09	0.067	0.055
Green Apple	0.09	0.026	0.037
Red Grape	0.05	0.046	0.041
Green Grape	0.03	0.062	0.071
Pear	0.04	0.052	0.024
Malta (edible portion)	0.12	0.047	0.045
Pomegranate (edible portion)	0.16	0.117	0.154
Average	0.08	0.06	0.061
PMTDI	20.00 [25]		

Table 6: Average Daily Intake (ADI) of Cadmium, Nickel, Zinc (mg/person/day) in fruits samples collected from Agora, Meena Bazaar and Swapno.

The order of contribution for Cd, Zn, Ni intake via dietary consumption of studied fruits, collected from Swapno, are given below:
Cd: Red Grape>Fuji Apple>Green Grape>Green Apple>Pear>Malta (edible portion)> Pomegranate (edible portion).
Zn: Pomegranate (edible portion)>Green Grape>Fuji Apple>Malta (edible portion)>Red Grape >Green Apple>Pear.
Ni: Green Grape>Pomegranate (edible portion)>Green Apple>Pear>Fuji Apple>Red Grape> Malta (edible portion).
Average Daily Intake (ADI) of Cadmium, Nickel and Zinc (mg/person/day) in fruits samples collected from Agora, Meena Bazaar and Swapno is shown in Table 6, all the values were found below Permitted Maximum Tolerable Daily Intake (PMTDI) values.

Hazard Quotient (HQ) and Hazard Index (HI)

Hazaer Quotient (HQ) and Hazard Index (HI) were calculated to determine the health risk associated with the consumption of different fruits collected from Agora, Meena Bazaar, Swapno in Dhaka city. When Hazard Quotient exceeds 1, it means there are potential health effects from exposure [5]. The findings showed that Hazard Quotient values of all heavy metals were less than 1 in all fruits, so consumers are said to be free of risks for the consumption of the studied fruits. The results of the HQs for individual heavy metals for each fruit are shown in Table 7.

The comparison among fruits, collected from Agora, revealed that Hazard Quotient (HQ) values for the metals decreased in the following order:
Cd: Pear>Pomegranate (edible portion)>Malta (edible portion)>Green Apple>Red Grape>Fuji Apple>Green Grape.
Zn: Pomegranate (edible portion)>Malta (edible portion)>Green Apple>Fuji Apple>Red Grape>Pear>Green Grape.
Ni: Green Apple>Fuji Apple>Green Grape>Red Grape>Malta (edible portion)>Pear> Pomegranate (edible portion).

The Hazard Quotient (HQ) values for the metals in fruits samples, collected from Meena Bazaar, are shown in Table 7 and they decreased in the following order:
Cd: Green Apple>Pomegranate (edible portion)>Pear>Fuji Apple>Red Grape> Malta (edible portion)>Green Grape.
Zn: Fuji Apple>Green Grape.
Ni: Pomegranate (edible portion)>Fuji Apple>Green Grape>Pear>Red Grape, Malta (edible portion)>Green Apple.
The Hazard Quotient (HQ) values for the metals in fruits samples, collected from Swapno, are shown in Table 7 and they decreased in the following order:
Cd: Red Grape>Fuji Apple>Green Grape>Green Apple>Pear>Malta (edible portion)> Pomegranate (edible portion).
Zn: Green Apple>Fuji Apple>Pomegranate (edible portion)>Malta (edible portion)>Pear>Red Grape, Green Grape.
Ni: Pomegranate (edible portion)>Green Grape>Fuji Apple>Malta (edible portion)>Red Grape> Green Apple>Pear.

Agora				
Name of fruits	Hazard quotient(HQ)			HI
	Cd	Zn	Ni	
Fuji Apple	0.003	0.0048	0.0065	0.0143
Green Apple	0.013	0.005	0.0107	0.0287
Red Grape	0.008	0.0026	0.0055	0.0161
Green Grape	0	0.0016	0.0058	0.0074
Pear	0.029	0.0023	0.0033	0.0346
Malta (edible portion)	0.019	0.0065	0.0052	0.0307
Pomegranate (edible portion)	0.027	0.009	0.0011	0.0371
Meena Bazaar				
Name of fruits	Hazard quotient(HQ)			HI
	Cd	Zn	Ni	
Fuji Apple	0.025	0.021	0.0037	0.0497
Green Apple	0.054	0	0.0014	0.0554
Red Grape	0.019	0	0.0026	0.0216
Green Grape	0	0.007	0.0034	0.0104
Pear	0.033	0	0.0029	0.0359
Malta (edible portion)	0.004	0	0.0026	0.0066
Pomegranate (edible portion)	0.036	0	0.0065	0.0425
Swapno				
Name of fruits	Hazard quotient(HQ)			HI
	Cd	Zn	Ni	
Fuji Apple	0.033	0.0755	0.0031	0.1116
Green Apple	0.026	0.2274	0.0021	0.2555
Red Grape	0.048	0	0.0023	0.0503
Green Grape	0.031	0	0.0039	0.0349
Pear	0.023	0.0038	0.0013	0.0281
Malta (edible portion)	0.01	0.0041	0.0025	0.0166
Pomegranate (edible portion)	0	0.0272	0.0085	0.0357

Table 7: Hazard Quotient (HQ) and Hazard Index (HI) for each studied fruits samples collected from Agora, Meena Bazzar and Swapno.

Conclusion

Mean concentrations were found above the maximum allowable limit in most of the fruits though mean ADI values were below the PMTDI value for all fruits. The Hazard Quotient (HQ) and Hazard Index (HI) values for all metals were below 1 which signify that these fruits were not carcenogenic (Table 7). The reason may be the low fruit consumption rate (44.7 g/person) in daily diet in Bangladesh [21]. But continuous consumption of higher metal containing fruits may be responsible for health hazards. Limited published data are available on heavy metal concentrations in the fruits from the market sites in Bangladesh. Therefore, this study suggests that, fruits should be washed properly before consumption to remove atmospheric deposition carrying heavy metals, use of preservative materials, growth hormones should be monitored, heavy metal contaminated water should not be used in irrigation and finally, extensive research on heavy metals presence in foodstuff is required to avoid extreme accrual (rate of increase) in the food chain and thus elude human health risk.

References

1. Prakash D, Upadhyay G, Gupta C, Pushpangadan P, Singh KK (2012) Antioxidant and free radical scavenging activities of some promising wild edible fruits. International Food Research Journal 19(3): 1109-1116.
2. Blum WE, Spiegel HH, Wenzel WW (1996) Soil condition inventory. Conception, implementation and evaluation, recommendations for standardizing the procedure in Austria. Federal Ministry of Land and Forestry, Vienna, pp: 1-19.
3. Kacholi DS, Sahu M (2018) Levels and health risk assessment of heavy metals in soil, water, and vegetables of Dar es Salam. J Chem 18: 1-9.
4. Bermudez GMA, Jasan R, Pla R, Pignata ML (2011) Heavy metal and trace element concentrations in wheat grains: Assessment of potential noncarcinogenic health hazard through their consumption. J Hazard Mater 193: 264-271.
5. WHO/FAO (2013) Tech. Rep, Guidelines for the safe use of wastewater and food stuff, Report of the joint World Health Organization and Food and Agriculture Organization, Geneva, Switzerland, 2(1).
6. Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research. 2nd(Edn.), International Rice Research Institute Book, John wiley & sons, Inc, NewYork, pp: 1-690.
7. FAO/WHO (2002) Codex Alimentarius: General Standards for Contaminants and Toxins in Food. Schedule 1 Maximum and Guideline Levels for Contaminants and Toxins in Food. Joint FAO/WHO Food Standards Programme, Codex Committee, Rotterdam, The Netherlands, pp: 4-32.
8. Radwan MA, Salama AK (2006) Market basket survey for some heavy metals in Egyptian fruits and vegetables. Food Chem Toxicol 44(8): 1273-1278.
9. Parveen Z, Khuhro MI, Rafiq N (2003) Market basket survey for lead, cadmium, copper, chromium, nickel and zinc in fruits and vegetables. Bull Environ Toxicol 71(6): 1260-1264.
10. Karavoltsos S, Sakellari A, Dimopoulos M, Dssenakis M, Scoullos M (2002) Cadmium content if foodstuffs from Greek market. Food Add Contam 19(10): 954-962.
11. Sobukola OP, Adeniran OM, Odedairo AA, Kajihausa OE (2010) Heavy metal levels of some fruits and vegetables from selected markets in Lagos, Nigeria. Afr J Food Sci 4(2): 389-393.
12. Shaheen N, Irfan NM, Khan IN, Islam S, Islam MS, et al. (2016) Presence of heavy metals in fruits and vegetables: Health risk implications in Bangladesh. Chemosphere 152: 431-438.
13. Campbell PGC (2006) Cadmium-A priority pollutant. Environ Chem 3(6): 387-388.
14. Omoyajowo KO, Njoku K, Babalola OO, Adenekan OA (2017) Nutritional composition and heavy metal content of selected fruits in Nigeria. Journal of Agriculture and Environment for International Development 111(1): 123-139.
15. Khodadoust AP, Reddy KR, Maturi K (2004) Removal of nickel and phenanthrene from kaolin soil using different extractants. Environmental Engineering Science 21(6): 691-704.
16. WHO (1996) Trace Elements in Human Nutrition and Health. World Health Organization, Geneva, Switzerland.
17. Onianwa PC, Adeyemo AO, Idowu OE, Ogabiela EE (2001) Copper and zinc contents of Nigerian foods and estimates of the adult dietary intakes. Food Chem 72(1): 89-95.
18. Greany KM (2005) An assessment of heavy metal contamination in the marine sediments of Las Perlas Archipelago, Gulf of Panama. M.S. thesis. School of Life Sciences Heriot-Watt University, Edinburgh, Scotland, pp: 73-95.

19. Ibrahim D, Froberg B, Wolf A, Rusyniak DE (2006) Heavy metal poisoning: clinical presentations and pathophysiology. Clin Lab Med 26(1): 67-97.

20. IHES (2010) Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Dhaka, Bangladesh. Household Income and Expenditure Survey.

21. JECFA (1993) Evaluation of certain food additives and contaminants: 41st report of FAO/WHO Expert Committee on Food Additives. World Health Organization, Geneva, Switzerland, pp: 1-15.

22. FAO (2003) Food additives and food contaminants. FAO procedural guidelines for the Joint FAO/WHO Expert Committee on Food Additives, Joint FAO/WHO Expert Committee on Food Additives, Rome, Italy, pp: 11.

23. WHO (1996) Guidelines for drinking-water quality. Health criteria and other supporting information. 2nd(Edn.), World Health Organization, Geneva, Switzerland, 2: 34-45.

24. FAO/WHO (2011) Codex Alimentarius Commission. Joint FAO/WHO food standards programme codex committee on contaminants in foods. Fifth Session. The Hague, The Netherlands, pp: 3-38.

25. Jackson AP, Alloway BJ (1992) The transfer of cadmium from agricultural soils to the human food chain. In: Adriano DC (Ed.), Biogeochemistry of trace metals. Lewis Publishers, Boca Raton, Florida, USA, pp: 50.

26. Ikeda MZ, Zhang ZW, Shimbo S, Watanabe T, Nakatsuka H, et al. (2000) Urban population exposure to lead and cadmium in east and south-east Asia. Sci Total Environ 249(1-3): 373-384.