Contamination Level of Heavy Metals in Vegetables and Soils of Lalmonirhat in Bangladesh

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Authors’ contributions

This work was carried out in collaboration between both authors. Author MMR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MMR and SR managed the analyses of the study. Author MMR managed the literature searches. Both authors read and approved the final manuscript.

ABSTRACT

Vegetables are an important source of nutrients and play a vital role in maintaining good health. Nowadays, vegetables are destroyed by a variety of unwanted contaminants which have become a serious problem. Eating contaminated vegetables can lead to many ailments and disrupt normal body functions. Therefore, the key objective of this study is to determine the contamination level of heavy metals in known vegetables and their growing soils in Lalmonirhat, Bangladesh; Consumers’ health risks are assessed by targeted health factor (THQ) and target cancer risk (TCR) analysis. Average concentrations of Mn, Fe, Cu, Zn, Cd and Pb in vegetables were 30.83, 429.27, 9.91, 32.19, 0.58, 8.88 mg/kg, as well as 240.83, 3690.45, 22.88, 65.87, 0.69 and 11.58 mg/kg in growing soils. Concentrations of heavy metals were compared with the recommended value of the World Health Organization and the average Fe, Pb, and Cd concentrations in leaf, fruit and root vegetables exceeded the allowable limit. In addition, the value of TSQ and carcinogenic parameters in leaf, fruit, and root vegetables was higher than 1.0 for Fe and Pb. Therefore, the THQ of Fe and Pb is harmful to humans. Also, the risk of cancer exceeds the USEPA risk threshold (>10−6) and the TCR of Pb shows a higher cancer risk, whereas Cd risk is higher. Therefore, the use of this vegetable is of concern and it is strongly recommended to monitor it regularly.

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1. INTRODUCTION

Currently, significant metal pollution may be a terribly dangerous environmental drawback not solely inside the developing country like the People's Republic of Bangladesh however additionally it's a heavy problem globally [1]. The rise of industrial enterprise, varied chemical fertilizers, pesticides and herbicides grime the soil, water and air in agriculture with significant metals. In addition, the capricious disposal of house wastage, animal manure and unused metal elements are very important causes of soil and water contamination [2,3]. The exterior door of significant metal into the food cycle is also a significant manner for humans to express to significant metal [1,4]. The vegetable is an important part of the human diet and a very important supply of minerals and vitamins. Plants similarly as foliose vegetables absorb some significant metals from metal mixed soil. Most of the significant metals are usually placed inside the air in many elements of the vegetable [5]. Significant metals are the main pollutants inside the food chain, which can have an effect on the common biological process worth of vegetables and ultimately these become harmful to human health [6]. Consumption of the significant metal-contaminated vegetables causes significant metals inside the anatomy, damages the polymer inside the body, alters the genetic writing and lowers the energy of the anatomy [7]. Exposure to sure metals, like mercury and lead, can also cause response disorders like inflammatory disease and nephropathy. Also, they inhibit the standard functions of the liver, kidneys and heart [8-9]. Generally, significant metals form a metal advanced complex with the thiol, amino and imino parts of proteins. As a result, proteins lose their biological operate and cause cell breakdown [10]. Similarly, significant metals have an effect on the vegetative functions of plants and slow biological process, chlorosis, metabolism and plant growth [10].

Recently, many countries have begun to watch and evaluate heavy metals in foods and vegetables. However, there is insufficient information on the extent of heavy metal contamination in Bangladesh. Plants within the study area are polluted due to industrialization, geographical location, household activities and excessive use of fertilizers. Therefore, this study aims to work out the amount of heavy metals in most edible vegetables and to assess the danger of cancer and non-cancer in consumers' health through TSQ and TCR analysis.

1.1 Geographical Location of the Study Area

Lalmonirhat district which is located on the northern a part of the People’s Republic of Bangladesh. It’s a neighbourhood of the Rangpur Division. It’s encircled by Kochbehar, Jalpaiguri in northwest Bengal, Rangpur within the south, Kurigram within the east and Nilfamari within the west. Lalmonirhat District International border is 281.6 Km. It lies between 26°00 North latitude and 89°25 East longitudes.

2. MATERIAL AND METHODS

2.1 Sample Collection and Preparation

The leaves, fruits and root vegetables of various species as well as the growing soil of those places were randomly collected from nine related sites in Lalmonirhat, Bangladesh. An outline of vegetables grown during this area is presented in Table 1.

Table 1. Description of studied vegetables cultivated in Lalmonirhat locality

| Sl. no | Local identity | Common name | Vegetable type | Scientific name | Sample ID |
|-------|----------------|-------------|----------------|-----------------|-----------|
| 01    | Laal Shak      | Red Spinach | Leafy Vegetable| Amaranthus gangeticus | LS        |
| 02    | Palang Shak    | Spinach     | Leafy Vegetable| Spinacia oleracea | PS        |
| 03    | Kalme shak     | Water spinach| Leafy Vegetable| Ipomoea aquatic | KS        |
| 04    | Fulcopi        | Cauliflower | Fruit Vegetable| Brassica oleracea botrytis | FK        |
| 05    | Tomato         | Tomato      | Fruit Vegetable| Solarum lycopersicum | TO        |
| 06    | Papa           | Papaya      | Fruit Vegetable| Carica papaya | PP        |
| 07    | Begoon         | Egg Plant   | Fruit Vegetable| Solarum melongena | BG        |
| 08    | Olcopi         | Kholrabi    | Root Vegetable| Brassica oleracea | OK        |
| 09    | Moola          | Radish      | Root Vegetable| Raphanus raphanistrum | MU        |

Vegetable samples were washed with water and thus edible parts of the vegetables were cut into small pieces. To get a stable weight, the samples...
were air-dried and 100°C. The soil samples were dried in air at atmospheric temperature and placed in fine powder. Vegetable and soil samples (Mn, Fe, Cu, Zn, Pb, Cd) were absorbed to detect heavy metal concentrations [11]. The concentration of heavy metals in the digestible solution decided employing a nuclear adsorption spectrophotometer (Shimatsu AA-AT1000). The analysis was performed by a general practice described by Era et al., Naja et al [12,13]. All data were calculated using the Statistical Package (SPSS) version 16.0 for Microsoft Excel 2010 and Social Sciences.

3. RESULTS AND DISCUSSION

Vegetables are an indispensable part of the human diet and play a vital role in preventing life-threatening diseases. Unfortunately, the largest part of the essential foods is contaminated with heavy metals, which turn into a problem nationally and internationally. Heavy metals give the idea within the crust and are let off the hook decay within the atmosphere. Some heavy metals like Mn, Fe, Cu and Zn are nutrients that are obligatory for the biological functions of the physical body. On the opposite hand, an organism doesn’t need Cd and Pb, in order that they are considered toxic elements in nature. To assess the health risks of the Lalmonirhat population in Bangladesh, the contamination level of heavy metals in commonly used vegetables and harvested soil are measured and displayed in Table 2. The mean concentration of Mn, Fe, Cu, Zn, Cd and Pb is 33.91, 356.71, 10.27, 33.59, 0.57 and 9.76 mg/kg in vegetables respectively. During present study, the decomposition of heavy metals in leaf, fruit and root vegetables was determined as Fe> Mn> Zn> Cu> Pb> Cd, Fe> Zn> Mn> Cu> Pb> Cd, Fe> Mn - Zn> Pb> Cu> Cd respectively. Mn, Fe and Cu (excluding Zn, Cd and Pb) concentrations are greater in leafy vegetables than in fruit and root vegetables. Iron is a crucial a part of the human body for physical activity, like the formation of hemoglobin. The tolerance limit is useful to humans, but large doses (450 mg/kg) can cause harmful side effects of the alimentary canal. Additionally, the very best Fe is found altogether vegetables starting from 99.25 to 1661.30 mg/kg counting on the species of the tree. Generally, Fe is involved in photosynthesis and chlorophyll synthesis. As a result, leafy vegetables have higher Fe than fruit and root vegetables [14-17].

Because of the low solubility, Pb and Cd are easily concentrated within the soil and most of the time in the atmosphere. Occasional exposure can cause autoimmune disorders like arthritis and renal disorder in the body [8,18-21]. To estimate the pollution rate, heavy metal concentrations were compared with the previously referred value [22–24] identified by FAO / WHO and other similar studies (Table 3) consistent with Figs. 1 and 2, it is often seen that the concentration of Fe, Cd and Pb in vegetables exceeds the allowable limit. The typical density of the Cd is above the other studied result except Varanasi, India and Rajshahi, Bangladesh. Furthermore, the mean concentration of Pb was found to be above all other studies. This will be explained by various sources, including automobile smoke, Leclanche cell batteries, sewage, waste and therefore the advent of heavy vehicles moving faraway from atmospheric deposits. Likewise, the utilization of organic and volatile fertilizers, fungicides, pesticides, fertilizers and biomaterials in their respective areas contributes to the quantity of those heavy metals [25-27].

Cancer and non-cancer health risks were calculated and therefore the results of EDI, HI, THQ and TCR are presented in Table 4 [22]. When comparing the EDI values of heavy metals with relative reference levels (DF), we found that the EDI values of Pb and Cd were above DF for all vegetables, whereas the EDI values of Fe were above that of leaf and DF fruits and vegetables. During this regard, the NY State Department of Health (NYSDO) suggests that if the EDI / DF ratio is a smaller amount than or adequate to DF, the danger is lower. But if this ratio is 1 to five times above DF, the danger is lower. If it’s 5 to 10 times above TF, the danger is moderate and if the TF is 10 folds greater, the danger is higher [34]. During this study, the ratio of PT (ETI/TF) to all or any sorts of vegetables was many times above the corresponding TF, indicating its potential for health. The comparison of contamination Level of Heavy Metals in Vegetables with the standard value is shown in the Figs. 1 and 2.

It is a possible risk factor for cancer-free health risks and a suitable guideline value for THQ is ≤ 1.0 [19]. Consistent with Ambedkar and Manian, if an individual’s THQ value for heavy metal exceeds its tolerance limit, this will cause unhealthy health consequences for humans [35]. During this study, the TSH values of most heavy metals are below the allowable range of Fe (2.5788) and Pb (8.0196); Fe (1.7596) and Pb (5.0581) for fruit vegetables; Fe (1.0074) and Pb (8.2116) for root vegetables. Therefore, TSQ
analysis indicates that Fe and Pb are harmful to those living during this cancer-free region. Furthermore, the combined effect of all metals (HI) is above the allowable range (1.0) for all kinds of vegetables. Therefore, regular consumption of leafy vegetables and root vegetables may be a concern for the health risks of non-cancer patients. The value of TCR isn’t only cancer that causes cancer but also the danger of cancer in humans [34]. During this study, the danger of cancer depends on the USEPA decision-making process. Long exposure to a specific cancer increases contact and get in touch with time. TCR sections are described to a specific cancer increases contact and get in touch with time. TCR sections are described consistent with NYSDOH; If the TCR value is a small amount than 10^2, the danger of cancer is low; When the worth is 10^3 to 10^2, the danger is moderate; However, the danger is higher and better, starting from 10^3 to 10^-1 and greater than or equal to 10^-1.

In the present study, the TCR of Cd (5.2×10^-2, 3.8×10^-2, 5.9×10^-2 for leafy, fruity and root vegetables respectively) is higher than that of Pb (3.1×10^-1, 2.3×10^-1, 3.4×10^-1 for leafy, fruity and root vegetables respectively). So Cd is more in danger for cancer within the population. Therefore, the TCR of Pb and Cd may affect those within the study area.

Contamination level of Heavy metal was investigated, and Fe (3690.45), Mn (240.83), Cu (22.88), Zn (65.87), Cd (0.69) and Pb (11.58) mg were wont to identify potential sources of contamination. Calculating per kg, respectively (Table 5) the slope order of the heavy metal content is Fe> Mn> Zn> Cu> Pb> Cd. Furthermore, the quantity of individual heavy metals within the soil samples was compared with the quality value provided by Mahabusa et al. [17] (Table 5). Regarding pollution rates, concentrations of Fe-Cu, Zn, Cd and Pb were found to be within the allowable range, apart from Mn in L-04 and L-05. Additionally, the concentrations of heavy metals within the studied soils are often compared with those in other countries (Table 6). This study shows that the concentration of Fe, Cu and Zn in soil samples is less than in Bangladesh and other countries, while Mn, Cd and Pb show some exceptions.

| Sample ID | Mn   | Fe    | Cu    | Zn    | Cd   | Pb   |
|-----------|------|-------|-------|-------|------|------|
| LS        | 20.18| 807.12| 11.45 | 21.41 | 0.74 | 11.11|
| PS        | 23.18| 665.12| 12.43 | 48.13 | 0.78 | 12.02|
| KS        | 82.51| 505.19| 11.24 | 12.11 | 0.48 | 7.91 |
| FK        | 8.21 | 322.41| 3.89  | 35.11 | 0.39 | 4.42 |
| TO        | 20.11| 415.15| 9.58  | 33.21 | 0.65 | 12.33|
| PP        | 10.03| 237.12| 8.12  | 45.36 | 0.52 | 6.24 |
| BG        | 17.57| 459.73| 12.78 | 32.31 | 0.21 | 2.62 |
| OK        | 36.33| 300.01| 8.75  | 30.18 | 0.59 | 11.50|
| MU        | 36.44| 240.13| 10.05 | 35.59 | 0.73 | 8.31 |
| Av. conc. in LV | 41.96| 659.14| 11.71 | 27.21 | 0.66 | 10.34|
| Av. conc. in FV | 13.98| 358.60| 8.61  | 36.49 | 0.44 | 6.40 |
| Av. conc. in RV | 36.55| 270.07| 9.40  | 32.88 | 0.66 | 9.90 |
| Average   | 30.83| 429.27| 9.91  | 32.19 | 0.58 | 8.88 |

Where, Av. conc = Average concentration, LV = Leafy vegetables, FV = Fruit vegetables, RV = Root vegetables

| Location    | Fe    | Mn   | Cu    | Zn    | Cd   | Pb   |
|-------------|-------|------|-------|-------|------|------|
| Jashore     | 190.3 | 33.30| 9.32  | 28.23 | 0.52 | 5.44 |
| Dhaka       | 1160.0| ---  | 17.63 | ---   | 0.33 | 11.50|
| Rajshahi    | ---   | 4.55 | ---   | 1.05  | 5.10 | [16] |
| Patuakhali  | ---   | 42.35| ---   | 2.1   | 8.36 | [29] |
| Narayanganj | ---   | 9.36 | 19.75 | 0.167 | 3.70 | [30] |
| Misurata    | ---   | 3.36 | 8.15  | 0.14  | 0.25 | [31] |
| Changxing   | ---   | ---  | 0.035 | 0.039 |      | [32] |
| Varanasi    | ---   | 22.40| 48.63 | 1.52  | 1.16 | [33] |
| Lalmonirhat | 429.27| 30.83| 9.91  | 32.19 | 0.58 | 8.88 |

Table 3. Comparison of heavy metals (mg/kg dry weight) in vegetables with similar extracts

References
Fig. 1. Comparison of contamination level of heavy metals in vegetables with the standard value
Fig. 2. Comparison of contamination level of heavy metals in vegetables with the standard value.
Table 4. Leafy, fruit and root vegetable’s EDI, THQ, HI and TCR

| Parameters | Sample types         | Fe    | Mn    | Cu    | Zn    | Cd    | Pb    |
|------------|----------------------|-------|-------|-------|-------|-------|-------|
| EDI        | Leafy Vegetable      | 1.6052| 0.1402| 0.0468| 0.0821| 0.0381| 0.0116|
|            | Fruit Vegetable      | 1.3417| 0.0451| 0.0214| 0.0944| 0.0011| 0.0127|
|            | Root Vegetable       | 0.8352| 0.0936| 0.0201| 0.0899| 0.0016| 0.0227|
| THQ        | Leafy Vegetable      | 2.5288| 0.8587| 0.9199| 0.2402| 0.5413| 8.0136|
|            | Fruit Vegetable      | 1.7196| 0.3223| 0.5369| 0.3148| 0.3597| 5.0541|
|            | Root Vegetable       | 1.0174| 0.6688| 0.5029| 0.2999| 0.5481| 8.2136|
| HI         | Leafy Vegetable      |       |       |       |       |       | 132.15|
|            | Fruit Vegetable      |       |       |       |       |       | 8.45  |
|            | Root Vegetable       |       |       |       |       |       | 10.73 |
| TCR        | Leafy Vegetable      |       |       |       |       |       | 3.1x10^-1| 5.2x10^-2|
|            | Fruity Vegetable     |       |       |       |       |       | 2.3x10^-1| 3.8x10^-2|
|            | Root Vegetable       |       |       |       |       |       | 3.4x10^-1| 5.9x10^-2|

Table 5. Size of heavy metals (mg/kg) within the soil sample of Lalmonirhat, Bangladesh

| Sampling sites | Mn   | Fe   | Cu   | Zn   | Cd   | Pb   |
|----------------|------|------|------|------|------|------|
| L-01           | 182.67 | 3760.77 | 35.14 | 49.5  | 0.71 | 11.97 |
| L-02           | 168.22 | 3865.64 | 34.62 | 63.78 | 0.86 | 10.78 |
| L-03           | 204.11 | 3768.39 | 17.81 | 72.76 | 0.71 | 12.49 |
| L-04           | 262.46 | 3748.97 | 15.56 | 64.84 | 0.85 | 11.17 |
| L-05           | 272.81 | 3843.24 | 24.2  | 71.75 | 0.73 | 11.47 |
| L-06           | 276.97 | 3742.68 | 18.72 | 61.74 | 0.62 | 11.38 |
| L-07           | 261.77 | 3856.95 | 23.53 | 66.85 | 0.59 | 9.08  |
| L-08           | 274.55 | 3739.19 | 23.65 | 74.86 | 0.64 | 12.78 |
| L-09           | 227.25 | 3838.84 | 17.43 | 84.75 | 0.6  | 12.48 |
| L-10           | 277.56 | 2739.87 | 18.19 | 47.86 | 0.66 | 12.17 |
| Mean           | 240.83 | 3690.45 | 22.88 | 65.87 | 0.69 | 11.58 |
| Ref. value [17]| 270  | 40000 | 30   | 100  | 1   | 50   |

Table 6. Average concentrations of heavy metals (mg/kg) in growing soil are compared with similar studies [12]

| Study area               | Mn     | Fe     | Cu     | Zn     | Cd     | Pb     | Ref. |
|--------------------------|--------|--------|--------|--------|--------|--------|------|
| Entire Bangladesh        | 669.56 | 37247.15 | 54.29 | 202.81 | 1.26 | 9.4  | [17] |
| Jashore, Bangladesh      | 199.38 | 3773.29 | 11.85 | 49.56  | 0.68 | 12.61 | [12] |
| Iswardi, Bangladesh      | 283.50 | 15684.70 | 21.43 | 123.283 | 0.538 | 68.84 | [28] |
| Chittagong, Bangladesh   | 160.79 | --     | 32.63  | 139.30 | 2.43 | 7.33  | [36] |
| Mymensingh, Bangladesh   | 182.33 | 24683.33 | 49.10 | 123.19 | --   | 59.39 | [37] |
| Bogra, Bangladesh        | --     | --     | 131.87 | 28.46 | 6.95 | 9.6   | [38] |
| Gazipur, Bangladesh      | --     | --     | 36.18  | 176.66| 0.2  | 75.71 | [39] |
| Dhaka, Bangladesh        | --     | --     | 75.04  | 103.34| 0.52 | 3.84  | [40] |
| Dhaka, Bangladesh        | --     | --     | 1715.80 | 39.14 | 115.43 | 11.42 | 49.71 | [1] |
| Rosetta, Egypt           | --     | 65387.8 | 92.8  | 156.3 | 13.5 | 45.7  | [41] |
| West Africa              | --     | 6224.92 | --    | 275.57 | 1.42 | 28.76 | [42] |
| Nador, Morocco           | 263.00 | 76429.00 | 37.50 | 73.00 | --   | --   | [43] |
| Palermo, Italy           | 519.00 | --     | 63.00  | 138.00 | 0.68 | 202   | [44] |
| Sialkot, Pakistan        | --     | 17991.62 | 26.85 | 94.2  | 36.8 | 121.4 | [45] |
| Fuyang, China            | --     | --     | 40.77  | 159.85| 0.37 | 40.59 | [46] |
| Lalmonirhat, Bangladesh  | 240.83 | 3690.45 | 22.88 | 65.87 | 0.69 | 11.58 | Present study |

4. CONCLUSION

From this study, we were able to set up a database on the contamination of well-known vegetables and heavy metals in the growing soil of Lalmonirhat in Bangladesh. Although concentrations of heavy metals in the soil are within the permitted limits, the concentrations of Fe, Cd, and Pb in vegetables exceed the safe limits recognized by the US FAO/WHO. Avoiding vehicle emissions, excessive use of wastewater in agricultural areas, pesticides and pesticides Human activities Heavy metals in vegetables, To assess consumers’ health risks, various health
risk indicators (EDI, THQ, HI and TCR) were calculated to control people's high health risks. Consuming contaminated vegetables is a major concern for cancer and cancer-free health activities. Therefore, stringent monitoring and effective measures should be taken to prevent heavy metals from entering the food chain.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

REFERENCES
1. Ahmed JU, Crow MC. Heavy Metal Pollution in Water, Soil and Vegetable Products in Koni, Bangladesh and the Environment. Manit. Evaluation. 2010;166: 347–357.
2. Zheng N, Chem J. Liu and Professor Wang and Jet. Liang, Health Risk Assessment and Heavy Metal Exposure Sciences for Road Dust in China's Northeast Zinc Grinding District, Total Gifts 40. 2010;726-733.
3. Zhuang P, Macbridge PP, Zia HP, NYL, IZA. Eating food crops near South China, Li, Dobson Khan and Science is losing health to heavy metals. Perfection Ecology. 2009;40:1551-1561.
4. J Calderon, T Artemis-Perez, L Yance, FA Diaz-Bariga. Human exposure to metals, exposure pathway, biomarkers of impact and host factors, ecotoxicol. Ecology, Sci. 2003;56:93-103.
5. Wang XL, Sato D, Jing BS, The S. By using science, vegetables and fish, the heavy metals in Tianjin, China, endanger people's health. Total Prizes. 2005;350: 28–37.
6. Bouchard MF, Saw S, Barbo B, Legrand M, Brodier M, D The. Buford E. Limoges, TC Bellinger, T Merckler. Ballet Secondary school drinking water, environment and age exposure in manganese. 2011;119: 138–143.
7. Zamova Jet K, Jenisova, M Festerova, S Brothers, J Liska, M Volko. Arsenic: Toxicity, antioxidant stress and human disease, J. App. If Toxics. 2011;31:95–107.
8. HTN. Heavy metal collection from chisel and wastewater: A review. J. Environment. Science. 2018;9:2345–2355.
9. Thomas S, Glenn F, M. The effects of foam, heavy metals and tobacco smoke increase the levels of toxic glutathione in cultured human lung lung cells. Permit. 2008;189:224-S225.
10. Kumar A. Cheema, Heavy metals accumulation and wastewater irrigation in soils and greens, J. Phys. Chem. Chem. Croatia. Scientific Toxicology and Food Technology. 2016;10:8–19.
11. Ara MSH, Khan A, Nuddin, Dhar PK. Mongla industrial area, Bangladesh. JJ. assessing the health risk of heavy metals in leaves, fruits and vegetables near Human Animals, Health Development. 2018;4:144–152.
12. MSH Era, UK Mantle, PK Dhar, MD. The presence of heavy metals in vegetables is different from Uddin, Jashore, Bangladesh: Human Health Risk Assessment, vol. Chemical. Chemical. Health Risk. 2018;8: 277–287.
13. Jet Naja, Keim. Elgariff, M, Alsthevi H. Applicable Chem. 2015;4:1821–1827.
14. NS Cherry, CD. In food processing and harvesting of waste water purified soils. Kamala and TS Evaluation of Heavy Metals from Raj Ecotoxicology Saif. 2008;69:513–524.
15. MS Ali. VPD how and vegetables in Bangladesh: Economic and nutritional impact of new varieties and technologies, Technol Technology Bulletin No. 2011; 25.
16. Saha A, MR MS. Heavy metals in fish, fruits and vegetables Rangshahi, Bangladesh: A statistical approach, Chemical Country, Sci. 2012;6:237-252.
17. Mahabusa SS, Jolly YN, Yasmin S, Shutter S, Islam A, SM. Transition of heavy metals and radio nuclides from soil to vegetables and plants in Bangladesh. 2014;331–336.
18. USEPA, Risk-Based screening schedule. combined table: Summary Tab 0715; 2015.
19. USEPA and USEPA Regional Screening Status Summary Index; 2011.
20. USEPA and EPA Region III Risk Based Concentration (RPC) List, Region III; 2012.
21. K Kura, J Phys. Kanche KY, Niberem G, Exposure Factors Handbook; 2010.
22. FAO/WHO., National Research Council recommends food allowances; 1989.
23. FAO/WHO., Some Food Additives and Pollution Assessment: 41st Report of the Food Additives of the US FAO/WHO Expert Panel, WHO Technical Report Series No. 837; 1993.
24. FDA, Fish and Fisheries Risk and Control Guidance; 2001.
25. Sultana SM, Rana S, Yamazaki S, Ioanno T, S Science. 2017;3:1–17.
26. Shaheen N, et al. Heavy metals in fruits and vegetables in Bangladesh and the Chemosphere. 2016;152:431–438.
27. Islam R, Kumar S, et al. S, Islam and Islam Aimis. Environment: A sub-urban industrial area of Bangladesh, identifies the concentration of metals in vegetables and assesses health risks. Science. 2014;5:130–162
28. Tasrina A. Roshan, AMR Mustafizur, I Rafiqul, MP Ali. Heavy metal pollution in vegetables and its growing soil, JS Chem. Anids Supplement, Chemicals. 2015;2:142.
29. Islam S, Islam Ahmed, Prasad R, Ahmed MS. Assessment of toxic metals in vegetables with health effects in Bangladesh. Environment Race. 2017;6:241–254.
30. Rathul AK, Hassan M, Uddin MK, Sultana MS, Agobar MC, Ahsan MC. Health risks of heavy metal collection in vegetable vegetables in contaminated River Food Racing. JR. 2001;25:329.
31. Alpacarmi MA, Edwards HGM, Alcatel Al. Libya, int. Scholar. Race Medal 1. 2012;1–5.
32. Chen Y, Phys B, Wu, et al. Zhao Y, et al. Ying, heavy metals health risk assessment in growing vegetables around battery production area, Syria Agricola. 2014;71:126-132.
33. Sharma R, Agarwal M, FM. Chemicals in marshals, heavy metals, vegetables from the manufacturing and marketing areas of tropical urban India. Toxicol. 2009;47:583–591.
34. NYSDOH, index C-NYS DOH, Health Resource Assessment Procedure for Practical Course; 2007.
35. Gu, Ambedkar M. Biochemistry of commercially important freshwater metals, Munian, Velar River, Tamil Nadu, India, Applied Science Race. 2011;2:221-225.
36. MS Alamgir, M Islam, N Hussein, MG Giberia, MM. Assessment of heavy metal contamination in urban soils of Rahman, Chittagong and Bangladesh. JR. Plant Soil Science. 2015;7:362–372.
37. Sabi AC, Wahid M, M My Woodin MS. Expansion of some heavy metals in soil near Islam and Islam Islam, Baluca Industrial Area, Mamsingh, Bangladesh, yes. JR. Science E Race. 2016;2:38–47.
38. Begum K, Mohiuddin Kim, Hessem Zakir, MM. Rahman MN. Assessment of heavy metal pollution and essential nutrients in Pokhara City Soil, Hassan, Bangladesh, Chemicals Transac. 2014;2:316–326.
39. COM. Industrial Waste Water and Toxic Metal Pollution in Selected Areas of Sumi, Gazipur, Bangladesh. MSc thesis, Department of Chemistry Chemistry, Bangladesh Agricultural U
40. Nutrients and heavy metal pollution in some roadside soil and grass in Khaka, Sultana N. Bangladesh. MSc thesis, Department of Chemistry, Bangladesh Agricultural University, Mimsingh; 2010.
41. EAA El-Anwar, YM Sami, SA Salman. The risk of heavy metals in rosetta branch sediments, J. Mater. Environmental Science. 2018;9:2142–2152.
42. Hankup JP, Keloma NC, Echina R, Lavani RN. Benin (West Africa), J. Evaluation of heavy metals pollution sediment in Ahme Lake south of Mather. Environmental Science. 2017;8:4369–4377.
43. L-Madney MS, Nador B, Hatch J. Spatial estimation of some heavy metal ions in the surface sediment of a matter barrier. Environmental Science. 2017;8:1996–2005.
44. Manta TS, Angeloon M, Bellanga A, R Niyari, M. Total Gifts. 2002;300:229-243.
45. RN Malik, WA Jiyokem. Health. 2010;32:179-191.
46. Zhang XY, Lynn FF, China Puang, China, for detecting the sources of heavy metal in Mana from anthropogenic activity and assessing the resulting environmental pollution, Assessment. 2009;154:439-449.

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