Assessment of Heavy Metal (Pb, Hg, Cd & As) in Leafy Vegetable (Red Amaranth) Grown in Different Contaminated Area.

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ABSTRACT

This study aimed to determine the concentration of lead (Pb), arsenic (As) cadmium (Cd) and mercury (Hg) in popular leafy vegetable red amaranth (*Amaranthus oleraseus*) and that in the respective soils, irrigation water were assessed. These leafy vegetable, irrigation water and soils were collected from one industrial area (Rupgonj, Naraongonj), two rivers bank area (Shitolakha, Naraongonj ; Torag, Gazipur), one garbage area (Norsindi Sadar), road side area (Rupgonj, Naraongonj), One Lake area (hatirjil, Dhaka) and one area Bangladesh Institute Research and Training on Applied Nutrition -BIRTAN under Naraongonj district. Present study revealed that all the heavy metal contain was found greater in industrial area in polluted areas, only Hg was found trace amount in plant of amaranth in the different location. With few exceptions, the magnitude of heavy metals detected in various components particularly in plant, soil and irrigation water was found as irrigation water> plant> soil. Contain of heavy metal in different area of red ammaranth followed the trend as BIRTAN HQ> garbage> road side> Hatirjil lake> River Turag> river Shitalakha> industrial area. It was observed that heavy metal contains trend of Hg>Cd>As> Pb were accumulated in red amaranth. Red amaranth produced in industrial areas and riverine areas (Shitalakha, Turag) has been found to contain excessive amounts of lead and cadmium, which are hazardous to human health. Although the presence of arsenic is at tolerable levels, it may pose a risk to human health in the near future. This study found high levels of lead and other heavy metals in the soil of the industrial area. Health-risk individuals, including children aged 6 months to 5 years, are advised not to consume red amaranth produced in the mentioned regions.

Keywords: Contamination, Leafy vegetables, heavy metal, industrial areas, Plant.

INTRODUCTION

Excess amounts of such trace metals in irrigated soil cause metal uptake by cultivating crops, affecting food quality (Nemati *et al*., 2023; Ullah *et al*., 2023). Trace element (TE) accumulation is higher in edible parts of leafy vegetables than in grain or fruit crops (Arora etal.,2008). Different orders of TEs concentration and accumulation patterns also may vary from vegetable to vegetable and even among different edible parts (root, stem, leaf) of vegetables (Teo *et al*., 2022). Consequently, toxic metal-polluted vegetables pose a danger to human health and inhibit countries from meeting the United Nations Sustainable Development Goals 2 (Zero Hunger), Goal 3 (Good health and well-being), and Goal 12 (Responsible Consumption and Production) (Resolution A/RES/70/1,2015). Previous studies found that excessive consumption of heavy metal-contaminated vegetables may cause carcinogenic, mutagenic, neurotoxic, and teratogenic effects on human health, leading to serious health risks like Alzheimer's in adults, intellectual disability in children, DNS (deviated nasal septum), insomnia, kidney, and liver diseases, and more (Altunay *et al*., 2022; Salman *et al*., 2021, 2021a, 2023,2023a). In this case, it is necessary to investigate the amount of heavy metals added to leafy vegetables from the soil of different regions of Bangladesh, which will be known in this study. One industrial

area (Rupgonj, Naraongonj), two rivers bank area (Shitolakha, Naraongonj ; Torag, Gazipur), one garbage area (Norsindi Sadar), road side area (Rupgonj, Naraongonj), One Lake area (hatirjil, Dhaka) and one area Bangladesh Institute Research and Training on Applied Nutrition -BIRTAN under Naraongonj district. In this context, the present study was undertaken to investigate the concentration of heavy metals (As, Pb, Cd and Hg) in red ammaranth and their level in respective plant, soils and irrigation water.

MATERIALS AND METHODS

The research was used of leafy vegetables as test crops: red amaranth at the BIRTAN HQ Research Farm and farmer's field in different location (Dhaka, Gazipur, Norshindi & Naraongonj) of Bangladesh during July 2024- June 2025. The selected leafy vegetables have specific growing duration of about one month for red amaranth (BARI, 2020). Physiochemical parameters of vegetable, growing soil and irrigation water were examined during study period. No pesticides were used on the crops so that there wouldn't be any other different nutrients interaction in the present investigation. Soil area: BIRTAN (HQ); Garbage soil; Road side soil; Industrial area soil; Lake area soil; River Shitalokha and. River Turag soil.

Sample collection location: Dhaka; Naraongonj; Gazipur; Norshindi

Analysis component: Plant (red amaranth), Soil and irrigation water was (Pb, Hg, Cd and As) analyzed by AAS. This experiment was RCBD with three replications. Total Sample Size: 7x3x4x3=252. Lab: BIRTAN HQ & Waffen Lab, Dhaka, Bangladesh.

Statistical Analysis

Collected data was subjected to statistical analysis through computer based statistical model (MSTAT-C, SPSS programme) following the basic procedure outlined by Gomez and Gomez (1984). Significant effects of treatments were determined by analysis of variance (ANOVA) and treatment means were compared by Duncun's Multiple Range Test (DMRT).

The red amaranth samples, irrigation water and soils were collected from BIRTAN (Bangladesh Institute of Research and Training on Applied Nutrition 23°46′2.93″N, 90°43′24.63″E), experimental field, regarded as low-level pollution area. The collected plant samples of red amaranth (*Amaranthus tricolor*).

Plant samples were collected from 6 week olds plants. Soil, irrigation water and vegetable samples were collected from different sites of each location. The plant samples represented different parts of plant roots, stem and leaves. Irrigation water, Soil samples of 0–15 cm depth were collected by a stainless-steel auger at the same time when vegetable samples were collected, and samples were taken to the laboratory.

Preparation and preservation: In the laboratory, all vegetables were washed with fresh running water to remove dust, dirty materials, possible parasites or their eggs and then were again washed with deionized water. The clean vegetable samples were air-dried and placed in an electric oven at 65 °C for 72–96 h depending on the sample size. The samples were homogenized by grinding using a ceramic coated grinder. All soil samples were spread on plastic trays and allowed to dry at ambient temperature for one week. Soil pH was determined by glass electrode pH meter and electricity conductivity (EC) was measured by conductivity meter in 1:5 ratio of soilwater suspension (Yong *et al*., 2011). The dry samples of soils were ground with a ceramic coated grinder and sieved through a nylon sieve. The final samples were kept in labeled polypropylene containers at ambient temperature before analysis.

Digestion and determination: The samples were digested with HNO3 and HClO4 (5:1 volume) for total metal estimation, as described by Misra and Chaturvedi (2007). One gram of each sample was weighed into 50-ml beaker, followed by the addition of 10 ml mixture of analytical grade acids HNO3: HCIO4 in the ratio 5:1, and left overnight for complete contact of material. Next day, the digestion was performed at a temperature of about 190 ºC for 1.5 h. After cooling, the samples were transferred into 50 ml volumetric flask

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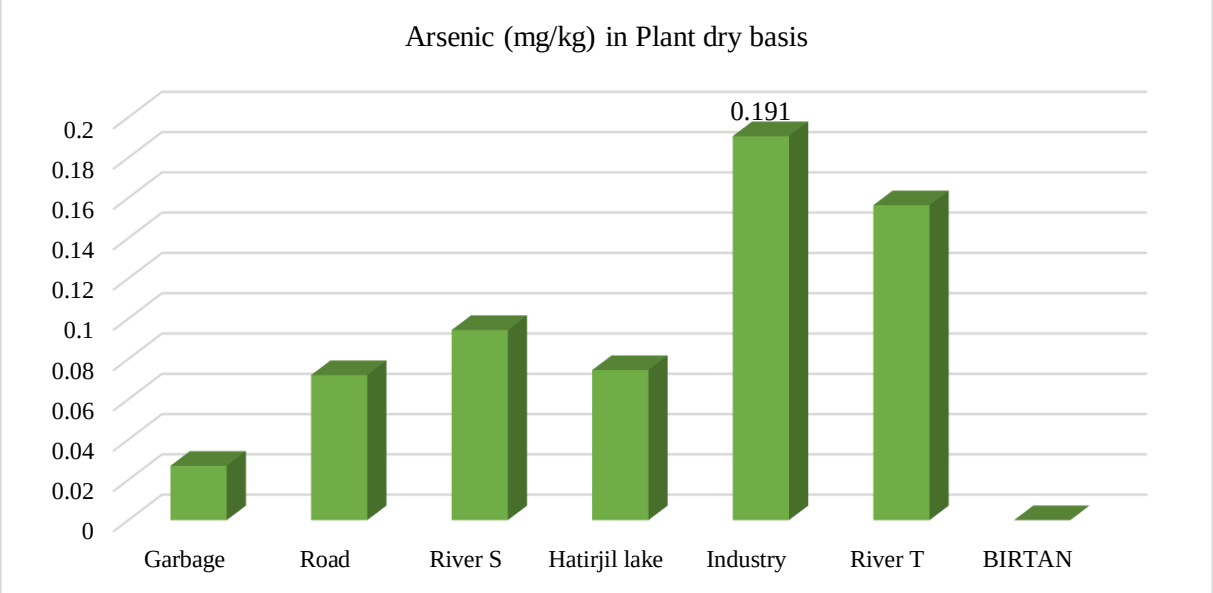
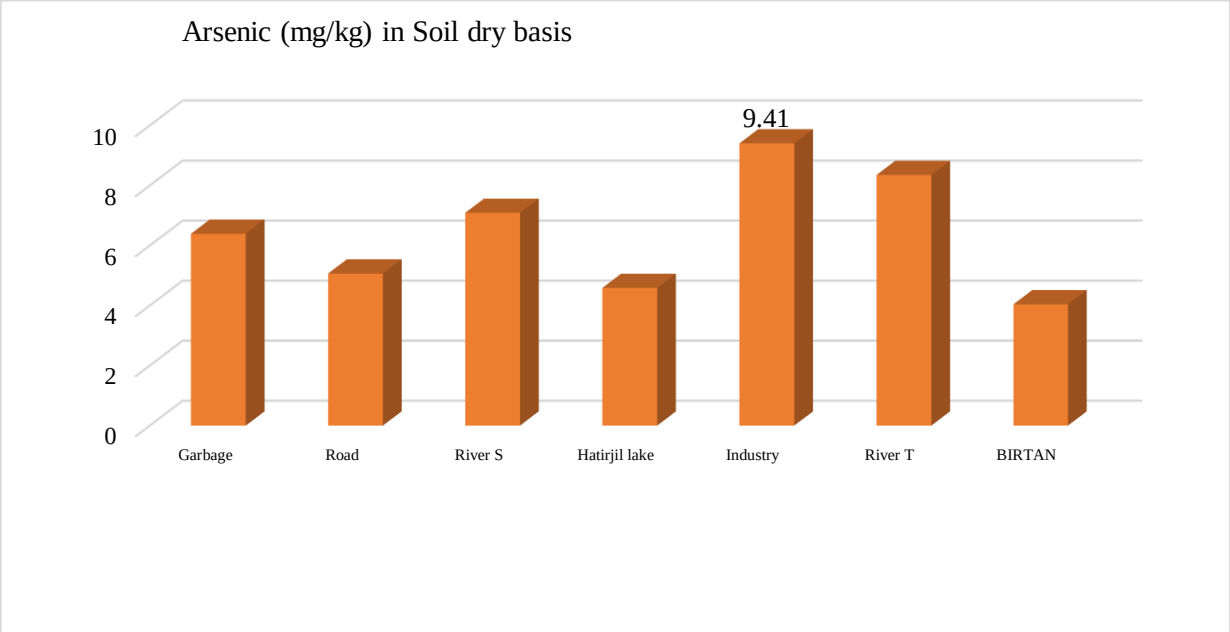
and solution was made up to a final volume raised up to the mark with distilled water. The metal concentrations were determined by atomic absorption spectrometry using a VARIAN model AA2407.

Atomic Absorption Spectrophotometer (AAS). Analysis of each sample was carried out three times to obtain representative results and the data reported in µg g -1 (on a dry matter basis). Statistical differences were judged by Tukey's multiple comparisons test by using Excel Statistics version 4.0 (Esumi Co. Ltd., Tokyo, Japan).

RESULTS AND DISCURSION

The results of the current study demonstrated that the heavy metal content of red amaranth collected from farmers field locations Dhaka; Naraongonj; Gazipur; Norshindi in the Bangladesh. To determine the level of plant, soils and irrigation water contamination, the detected quantities of As, Pb,Cd, and Hg in leafy vegetables were compared to the safety limit established by the FAO/WHO and other reference standards. The concentration of Arsenic (As) in different areas of red amaranth plant followed the BIRTAN HQ> garbage > road side > Hatirjil lake > river Shitalakha> River Turag > industrial area; in soils the order was BIRTAN HQ > Hatirjil lake > road side> garbage> river Shitalakha> River Turag> industrial area and in irrigation water the trend was BIRTAN HQ> road side> garbage River Turag> river Shitalakha> Hatirjil lake> industrial area.





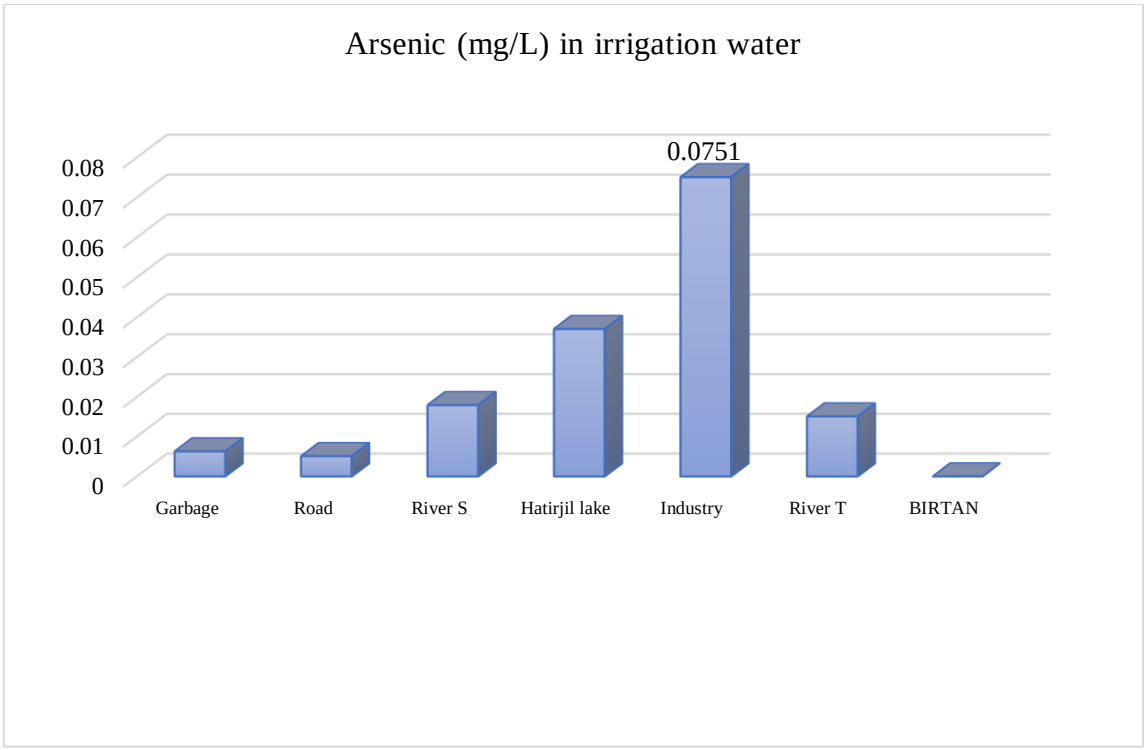
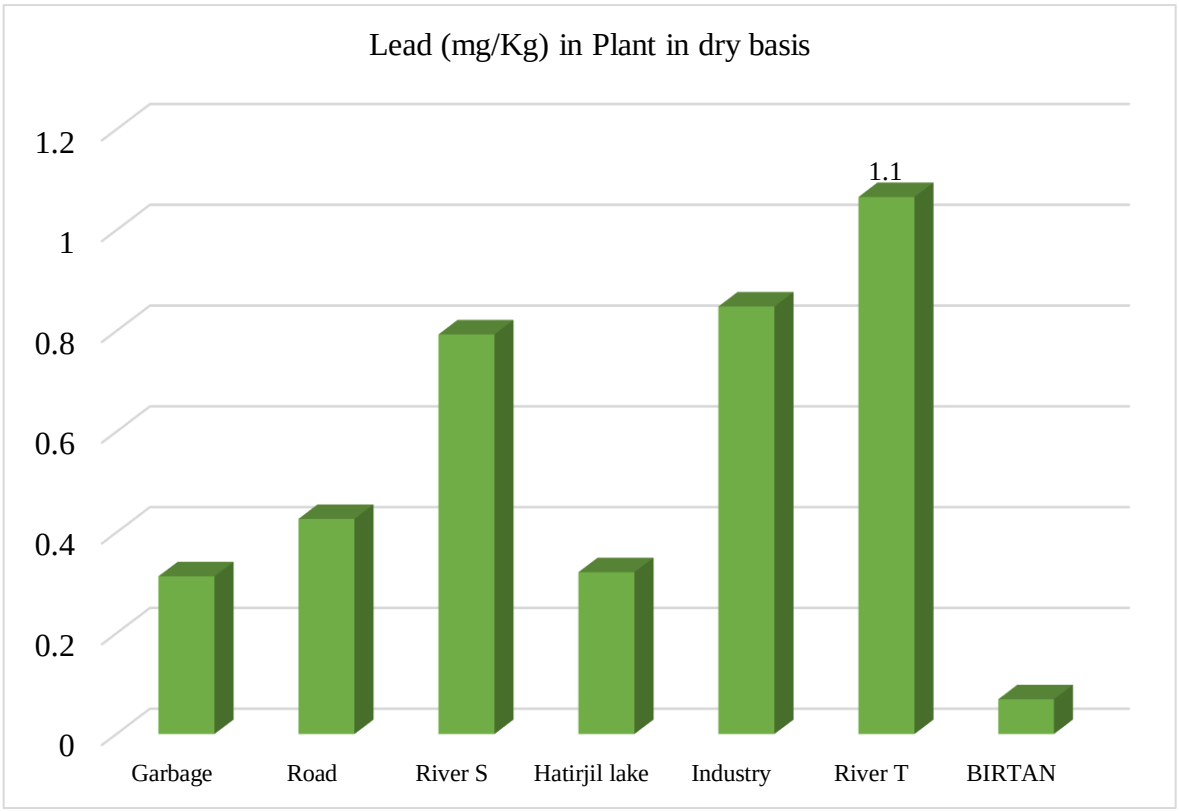
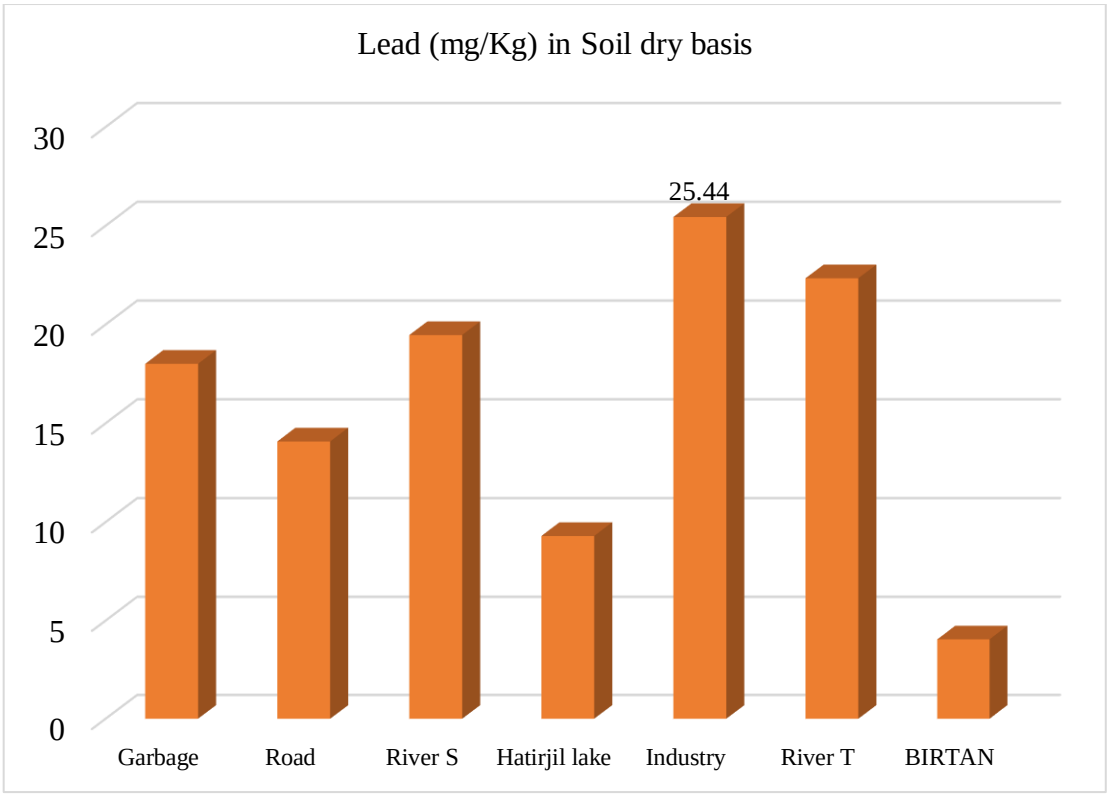


Fig: The concentration of Arsenic (As) in different areas of red amaranth plant, soil and irrigation water.

The concentration of Lead (Pb) in different areas of red amaranth plant followed the BIRTAN HQ > garbage> road side > Hatirjil lake> river Shitalakha> industrial area >River Turag ; in soils the order was BIRTAN HQ >Hatirjil lake > road side> garbage> river Shitalakha> River Turag> industrial area and in irrigation water the trend was BIRTAN HQ> road side> garbage> River Turag> Hatirjil lake> industrial area > river Shitalakha. Under this investigation pollution of lead (Pb) followed the irrigation water > plant >soil.





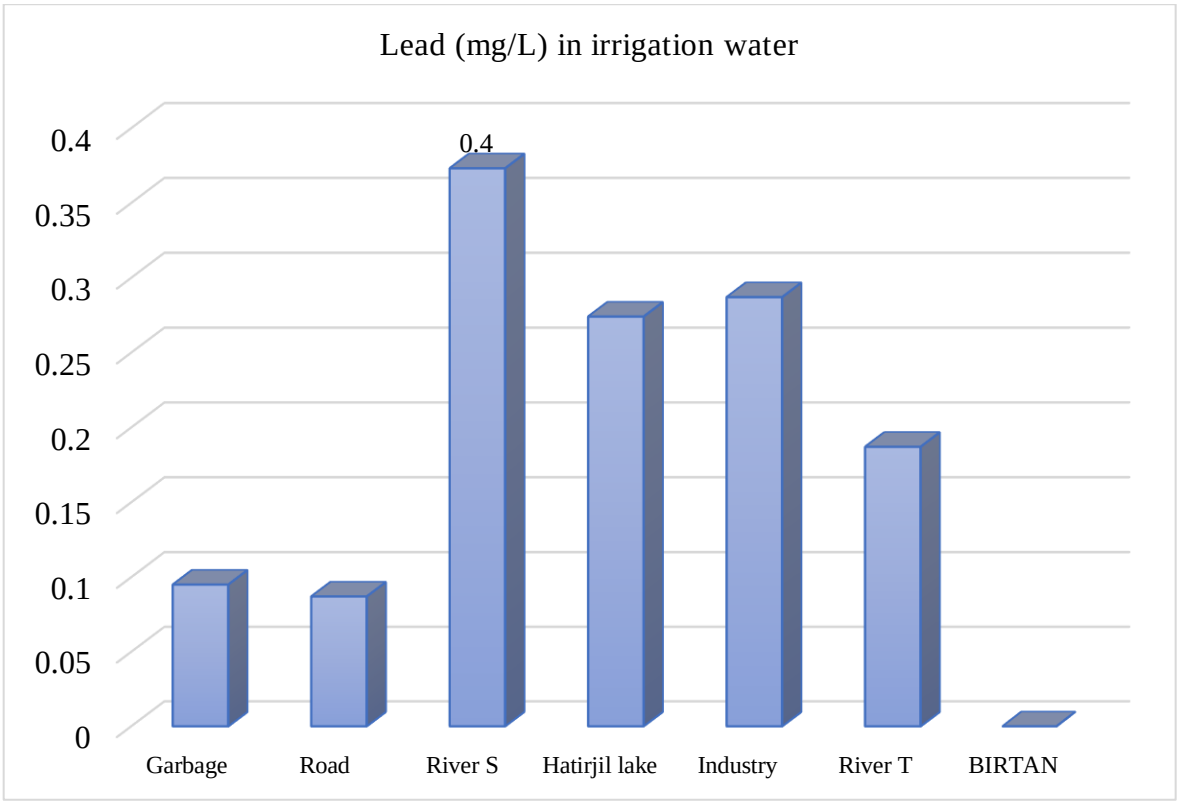
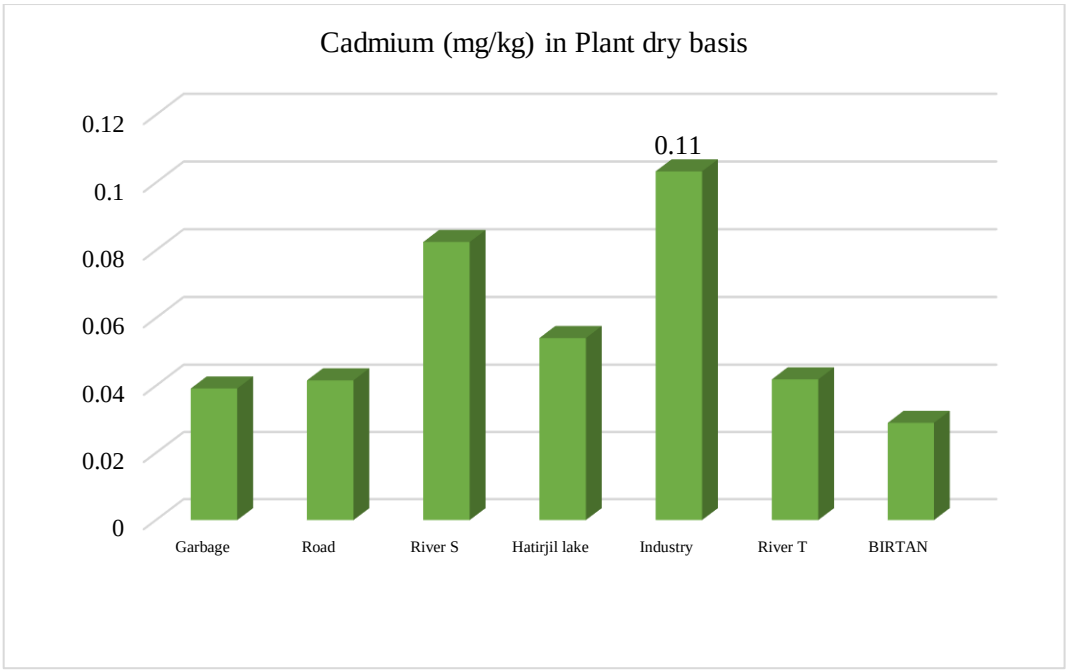
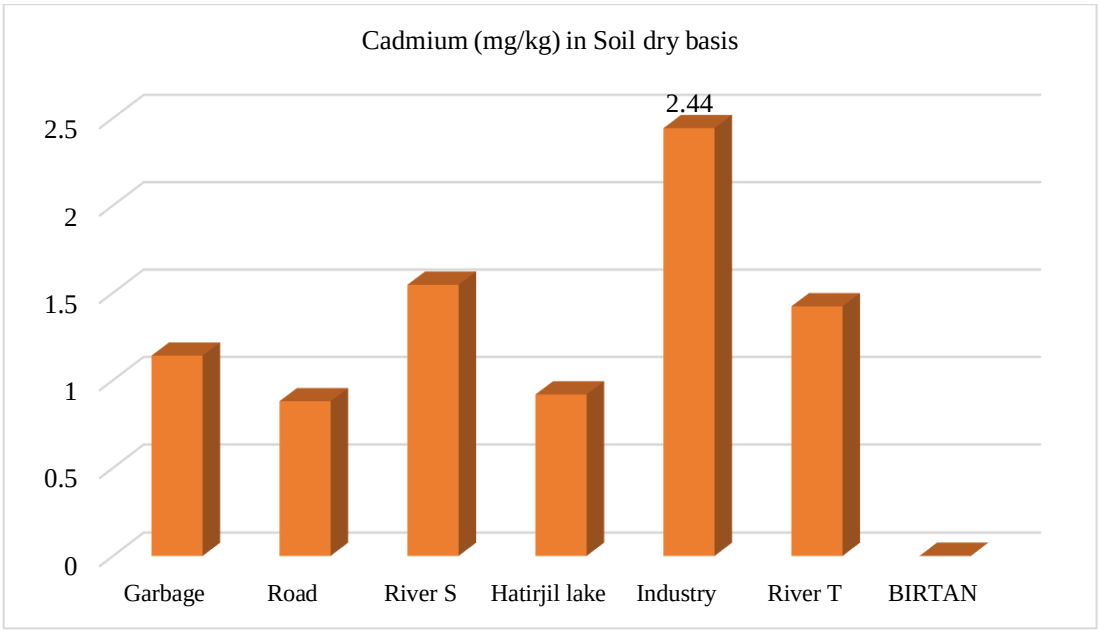


Fig 2: The concentration of lead (Pb) in different areas of red amaranth plant, soil and irrigation water.

The concentration of Cadmium (Cd) in different areas of red amaranth plant followed the BIRTAN HQ> garbage> road side> River Turag> Hatirjil lake> river Shitalakha> industrial area; in soils the order was BIRTAN HQ> Hatirjil lake > road side> garbage > River Turag > river Shitalakha > industrial area and in irrigation water the trend was BIRTAN HQ >road side > garbage > River Turag > Hatirjil lake > river Shitalakha> industrial area .





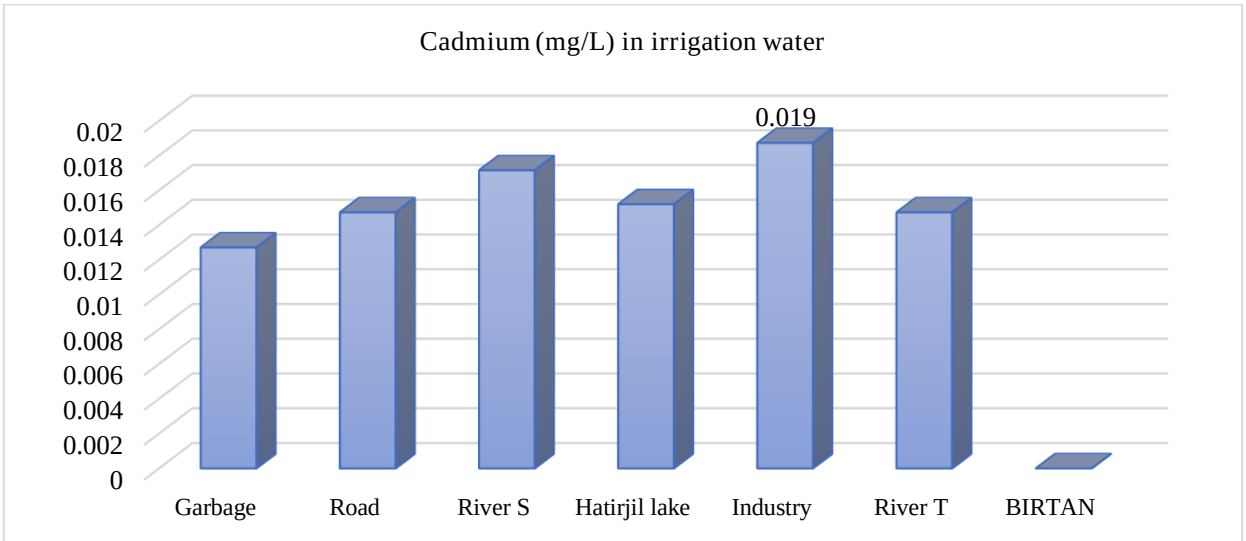


Fig 3: The concentration of cadmium (Cd) in different areas of red amaranth plant, soil and irrigation water.

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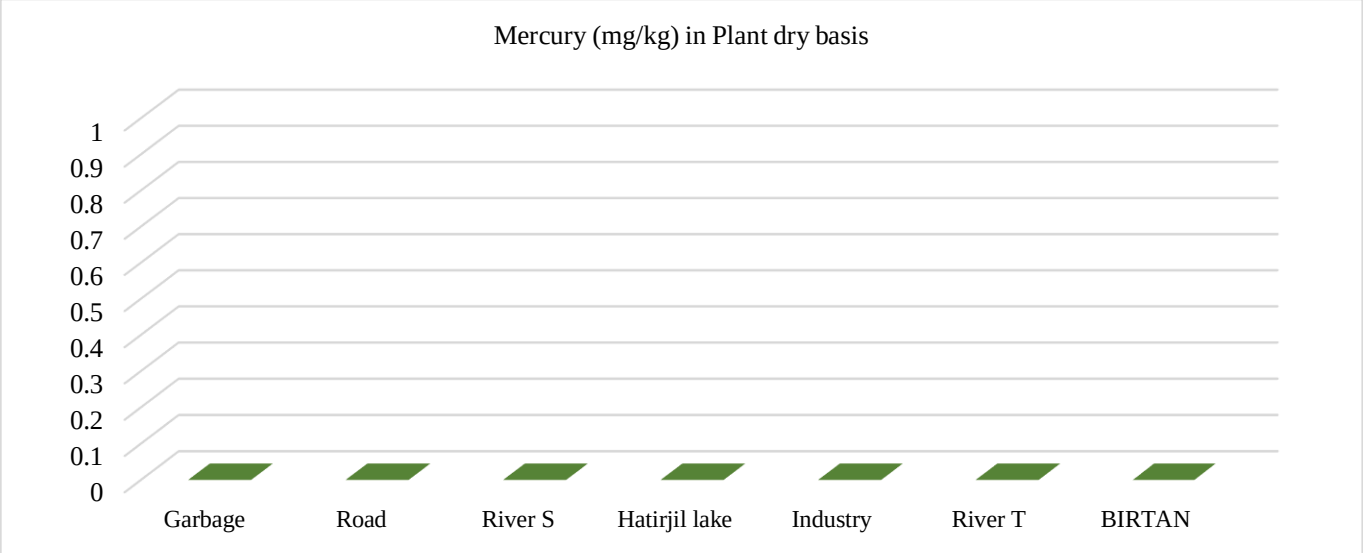
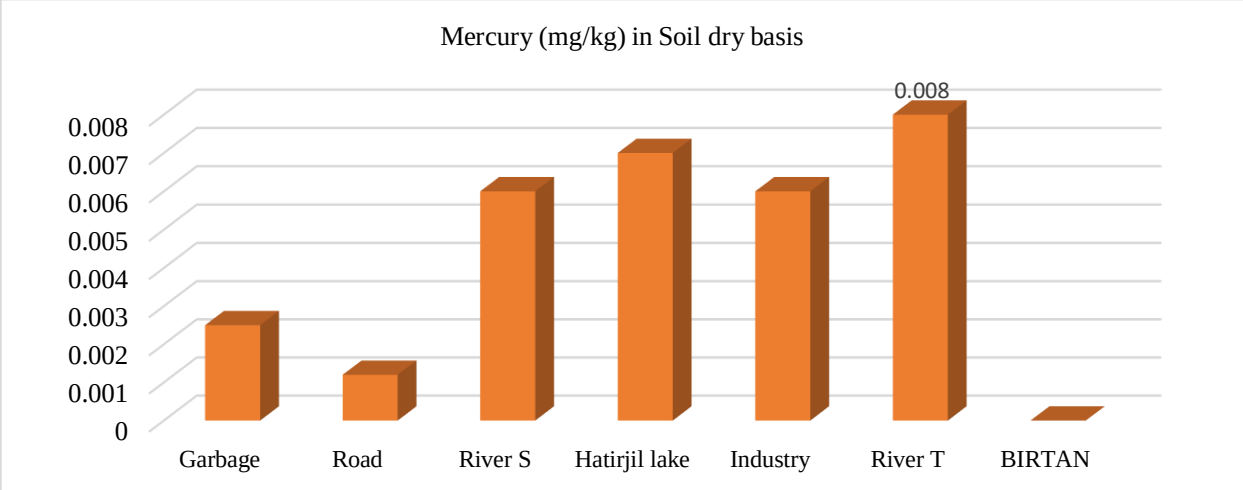
The concentration mercury (Hg) different areas of soil followed the BIRTAN HQ> road side> garbage> river Shitalakha> Hatirjil lake> River Turag >industrial area ; in irrigation water the order was river BIRTAN HQ >road side> Hatirjil lake > industrial area > garbage > River Turag > Shitalakha and in plant part required trace amount.





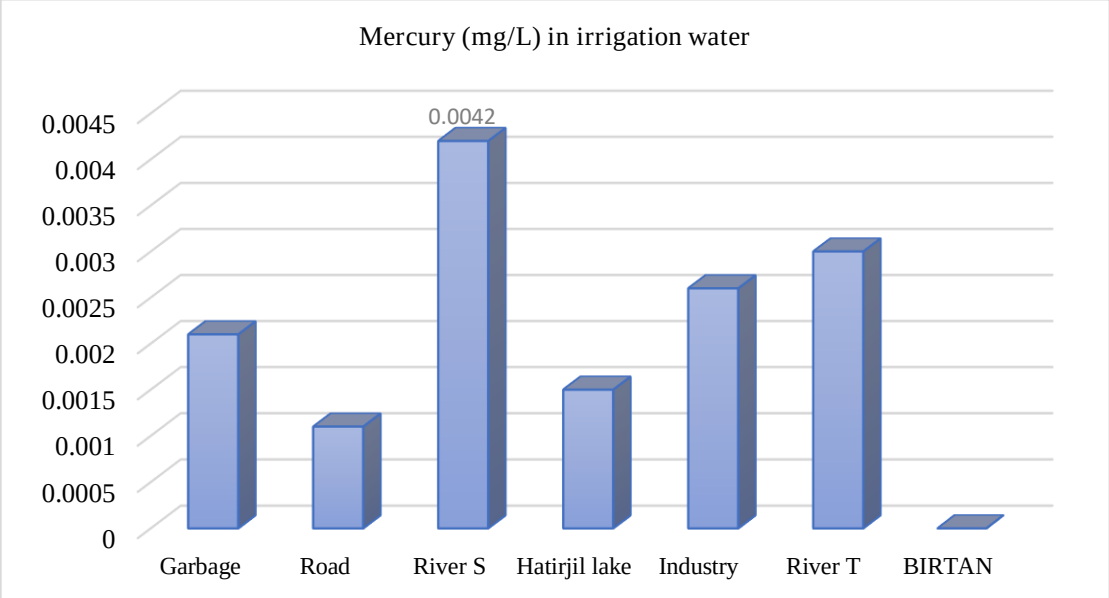


Fig 3: The concentration of cadmium (Cd) in different areas of red amaranth plant, soil and irrigation water.

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CONCLUSION

Red amaranth produced in industrial areas and riverine areas (Shitalakha, Turag) has been found to contain excessive amounts of lead and cadmium, which are hazardous to human health. Although the presence of arsenic is at tolerable levels, it may pose a risk to human health in the near future. This study found high levels of lead and other heavy metals in the soil of the industrial area. Health-risk individuals, including children aged 6 months to 5 years, are advised not to consume red amaranth produced in the mentioned regions.

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