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EXPLORING HEAVY METAL PRESENCE IN *LYCOPERSICUM ESCULENTUM L.* AND ITS SOIL SAMPLES : PROXIMITY TO RIVER HASDEO AND AHIRAN IN KORBA DISTRICT, CHHATTISGARH

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Abstract - This study investigates the presence of heavy metals in *Lycopersicum esculentum L*. (tomato) and its associated soil samples in the vicinity of River Hasdeo and Ahiran in Korba District, Chhattisgarh. Heavy metal contamination in agricultural products and soil poses significant environmental and health risks. In this research, samples were collected and analyzed for the concentrations of various heavy metals. The analysis was performed using triplicate measurements, and the results were expressed as mean values with standard deviations. The mean concentrations of metals in both tomato and soil samples were calculated. The reported mean concentration of heavy metals are (0.216-1.057) , (0.125- 0.530) (0.444 -0.823) (0.104-1.247) (0.012-0.053) in mg/kg for Zn, Cu, Mn, Fe & Pb respectively for tomato plant. And mean conc. of heavy metals in soil reported as (0.012-0.167) (0.124- 0.044) (0.067- 0.067) (0.098-0.461) (0.012-0.074) in mg\kg for Zn, Cu, Mn, Fe & Pb respectively. The Pearson coefficient correlation between heavy metals also discussed in this research paper. The findings of this study provide valuable comprehensions of heavy metal impurity in agricultural produce and soil in the studied region, aiding in the development of appropriate mitigation strategies to safeguard environmental and human health.

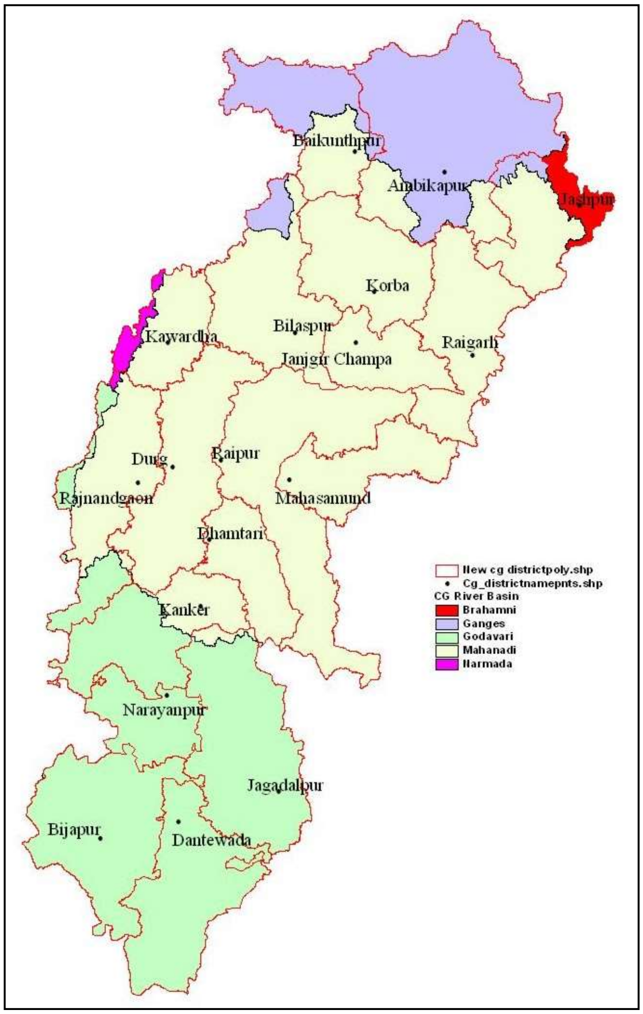
Keywords - Standard deviations, Heavy metals, Vicinity

Introduction -

The problem of heavy metals in soil is a significant environmental concern due to their toxicity and persistence in the environment (Hu W et al., 2014). Heavy metals, such as lead, cadmium, mercury, arsenic, and chromium, can enter soil through various sources, including industrial activities, mining, agriculture, and urban runoff. Addressing the problem of heavy metals in soil requires interdisciplinary approaches involving soil science, environmental chemistry, toxicology, and public health (Sultana MS et al., 2017 & Ahmad e.al., 2010). Strategies for prevention, monitoring, remediation, and sustainable land management are essential to mitigate the impacts of heavy metal contamination on ecosystems and human health (Zoran SI et al., 2014). Overall, the detection of heavy metals in soil and vegetables is essential for protecting human health, ensuring food safety, safeguarding the environment, and promoting sustainable land use practices. Regular monitoring and effective management of heavy metal contamination are critical components of environmental stewardship and public health protection efforts (Buteh DS et al., 2013). The scientific name of tomato is *Solanum lycopersicum* belongs to the family Solanaceae family. Tomato plants are herbaceous perennials grown as annuals in temperate climates (Eences Abbasnia et al., 2018). They have branching stems with hairy leaves that are typically pinnate or compound. The flowers are yellow and star-shaped, and they develop into fruits known as tomatoes. Tomatoes are rich in essential nutrients, including vitamins (such as vitamin C, vitamin A, and vitamin K), minerals (such as potassium and manganese), and antioxidants (such as lycopene, beta-carotene, and flavonoids) (Kachenko et al., 2006 & Harmanescu et al., 2011). They are low in calories and fat, making them a healthy addition to various diets. Tomato consumption has been linked to a number of health advantages, including a lower risk of chronic conditions like cardiovascular disease, several types of cancer, and age-related macular degeneration., attributed to their antioxidant content, particularly lycopene (Sharma R J et al., 2009). Tomatoes also contain dietary fiber, which promotes digestive health, and vitamins and minerals essential for overall well-being. Tomatoes are not only a popular culinary ingredient but also a valuable source of nutrition and health-promoting compounds, making them a staple in diets worldwide (Suruchi S & Khanna P 2011) .The present study conducted in the Hasdeo River, also known as the Hasdeo Bango, is a significant river in the central Indian state of Chhattisgarh. It originates in the northern part of Chhattisgarh, near Surguja district, and flows through the Korba and Bilaspur districts before eventually joining the Mahanadi River. The river serves as a lifeline for the local communities, supporting agricultural activities and providing water for irrigation, domestic use, and industrial purposes (Zhuang P et al., 2009). the detrimental impact of industrial pollution on the Hasdeo River in Korba District. This pollution not only contaminates the water but also extends to the soil, adversely affecting plant life and posing health risks to humans. The Hasdeo River, once a vital water source and ecosystem, is now under significant threat due to industrial activities along its banks. The discharge of pollutants into the river has led to widespread water pollution. This polluted water, in turn, harms the surrounding soil when used for irrigation, affecting the growth of plants and crops. the contamination cycle completes itself when these polluted plants bear fruits that are consumed by local residents. This poses serious health risks as the fruits and crops absorb the pollutants from the soil and water, leading to potential health issues for those who consume them. The consequences of this pollution are dire and require urgent attention. Not only is the natural environment suffering, but the health and well-being of the communities relying on the river and its resources are also at stake.. Efforts are being made to address these challenges through environmental conservation initiatives and regulatory measures to mitigate pollution and ensure sustainable management of the river's resources (Agca et al., 2014 & Alghobar et al., 2017).

Location

The Present study site covers area around korba district. City is located at 22.35°N 82.68E in the vicinity of river Hasdeo and Ahiran. Five sampling sites (SS) are SSI- Belakacchar, Balco, SSII-Godhi, SSIII- Surakachhar, Kusmunda, SSIV- Kharmora, Dader, SSV- Gervaghat .



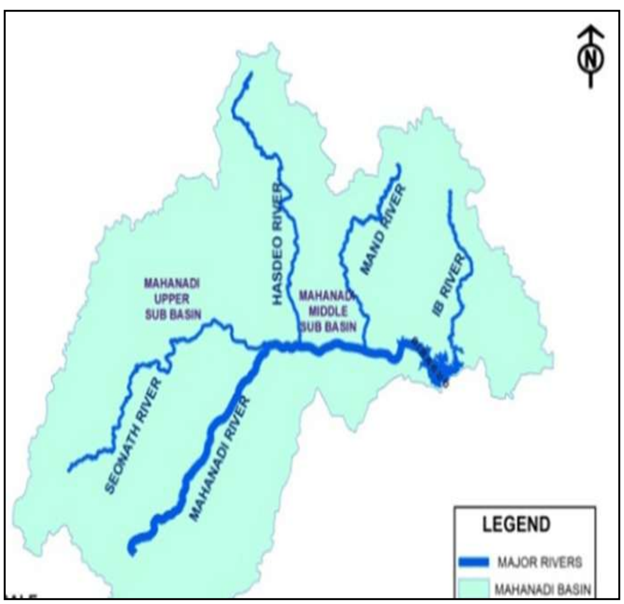


Figure no . 01 Map of study area Chhattisgarh and Hasdeo river

Materials & experimental work

Collection & Pretreatment of Soil Samples

Soil samples were collected from 5 sampling sites of baby plant stages of selected plants species (vegetables) Tomato (Nov 2019 to Jan 2020).The soil samples collected from the top 10cm-15cm layer of the soil utilising a stainless steel trowel to sample the plants in the area. Each soil sample will air dried and oven dried at 70°c for 72hrs and ground using agate mortar and pestle. The samples then filtered through a 2 mm screen and kept in plastic bags with a closure at room temperature for further analysis. (Duressa et al., 2015).

Collection and Pretreatment of plant sample

Selected plant species samples were collected from 5 sampling sites of baby plant stage of the sampled plants. Samples of plants were first shade-dried, then they were dried for 48 hours at 65° to 70°C. Each plant samples grounded separately by homogenizer . After homogenizing, plant samples mixed carefully and dried out again in oven at 70°C & separated through 1.5mm sieve. Plant samples kept in plastic bottles with screws at room temp. for further analysis.(Adimalla et al., 2015 & Addis 2017).

Detection method of Heavy metals

After pretreatment of soil sample and plant sample, they were sent for detection of heavy metals via Atomic Absorption Spectrophotometric method to Indira Gandhi Agricultural University in Jora Raipur Chhattisgarh. Heavy metals in soil sample was detected by DTPA(diethylenetriaminepentaacetic acid) method and plant sample was detection by digestion method. Atomic absorption spectrophotometer of electronics corporation of india limited brand was used for analysis. The detected heavy metals are reported in result and discussion section(Abreu et al.,2022).

Target hazard quotient (THQ)

Target Hazard Quotient (THQ) is a risk assessment tool used in environmental health and toxicology to guesstimate probable healthiness hazards associated with exposure to a particular chemical through a specific route, typically ingestion, inhalation, or dermal contact. THQ is often employed in the context of human health risk assessment for environmental contaminants such as heavy metals, pesticides, and other toxic substances. The THQ is calculated by dividing the estimated exposure dose of a chemical by a reference dose (also known as a safe dose or acceptable daily intake) established for that chemical by regulatory agencies such as the Environmental Protection Agency (EPA) or the World Health Organization (WHO).

$$THQ = \frac{DIVxCm}{RfDxB}$$

Here

DIV = Daily intake of vegetable in kg per day

Cm = concentration of heavy metal in the vegetable in mgkg-1

B = Average body weight of humans(kg)

RfD = Oral reference dose of the heavy metal

It is essential to note that THQ values are used as screening tools and do not provide a definitive assessment of actual health risks. They are part of a broader risk assessment process that considers various factors such as exposure pathways, toxicity data, and sensitive populations to better understand and manage potential health risks associated with chemical exposures in the environment (Ali et al., 2013).

Table no. 01 Reported Mean value Heavy metal in soil of *Lycopersicum esculentum L*

HM	SSI	SSII	SSIII	SSIV	SSV
Zn	1.633 ± 0.0984	1.766 ± 0.061	1.803 ± 0.0122	54.466 ± 0.047	2.123± 0.167
Cu	0.853±0.0449	0.906±0.0124	0.936±0.030	0.923±0.012	0.71±0.008
Mn	21.02±0.1023	21.75±0.477	25.08±0.117	26.093±0.067	21.706±0.436
Fe	33.74±0.461	35.09±0.132	36.12±0.169	36.68±0.417	11.126±0.098
Pb	1.773±0.012	0.74±0.035	2.11±0.074	1.753±0.044	0.466±0.0124

Table no.02 Reported Pearson Coefficient Correlation of Heavy metal in soil of *Lycopersicum esculentum L*

HM	Zn	Cu	Mn	Fe	Pb
Zn	1				
Cu	0.399	1			
Mn	0.724	0.589	1		
Fe	0.306	0.967	0.437	1	
Pb	0.295	0.691	0.589	0.295	1

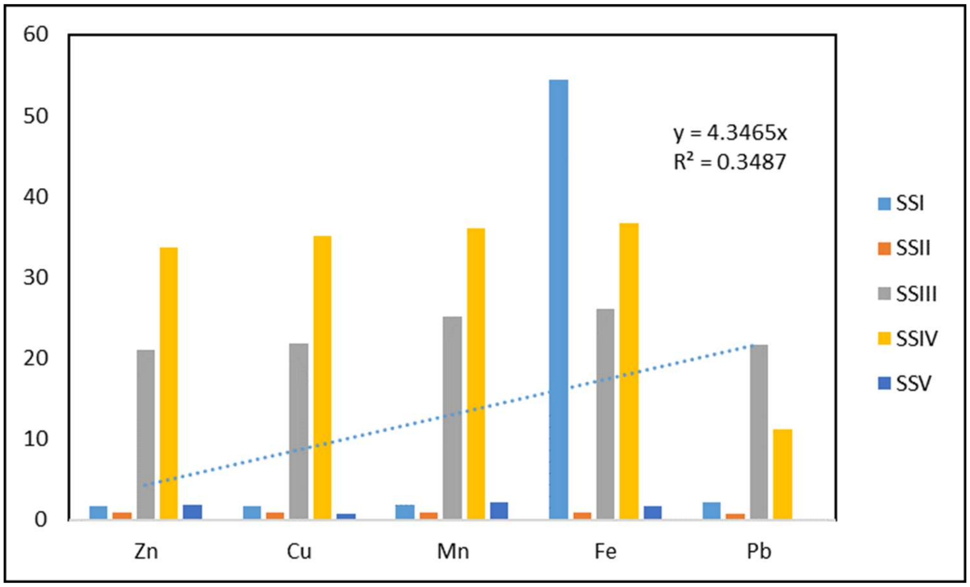


Figure no. 02 Graph of reported heavy metals in Soil of *Lycopersicum esculentum L*

Table no. 03 Reported Mean value of Heavy metals in *Lycopersicum esculentum L* plant

HM	SSI	SSII	SSIII	SSIV	SSV
Zn	54.3 ±0.637	54.74±0.521	61.28 ±1.057	54.2±0.216	60.98±0.543
Cu	14.41±0.276	14.84±0.530	17.27±0.244	14.176±0.228	16.13±0.125
Mn	137.67±0.473	41.75±0.516	38.82±0.444	35.73±0.454	145.83±0.823
Fe	251±0.8164	236.66±1.247	249.036±0.129	254.14±0.104	230.55±0.494
Pb	0.613±0.012	0.54±0.032	0.776±0.053	0.643±0.026	0.49±0.016

Table no. 04 Reported Peasrson Coeffiient Correlation of heavy metals in *Lycopersicum esculentum L* plant

HM	**Zn**	**Cu**	**Mn**	**Fe**	**Pb**
Zn	1				
Cu	0.11	1			
Mn	0.166	0.129	1		
Fe	0.649	0.294	0.543	1	
Pb	0.786	0.368	0.537	0.667	1

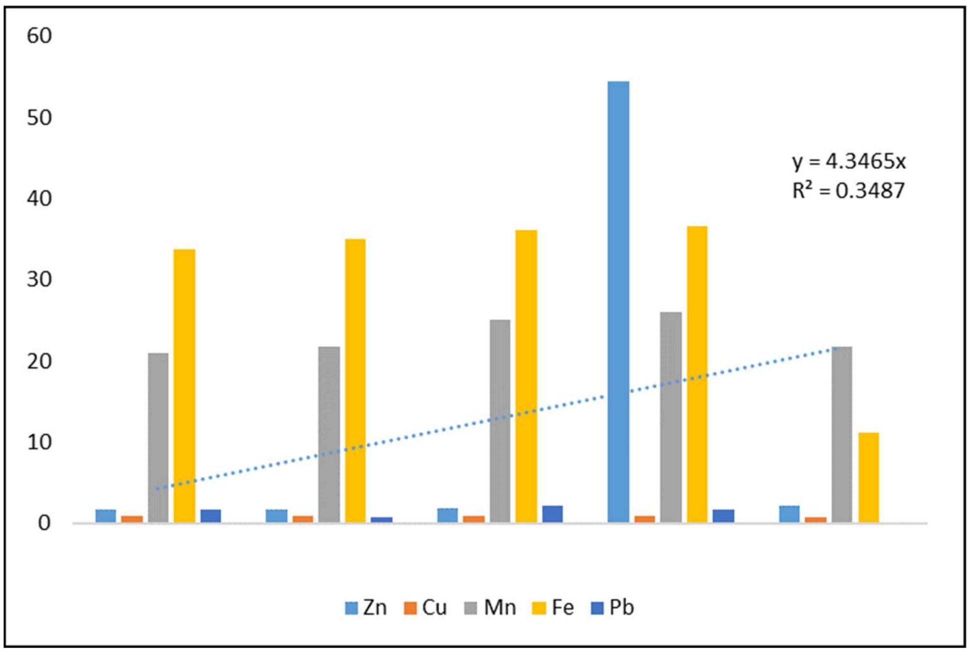


Figure no. 03 Graph of Reported heavy metals in *Lycopersicum esculentum L* plant

Table 05 Target Hazard Quotients (THQ) of heavy metals in *Lycopersicum esculentum L*

HM	**SSI**	**SSII**	**SSIII**	**SSIV**	**SSV**
Zn	0.043	0.03	0.03	0.014	0.031

Cu	0.11	0.22	0.1	0.09	0.05
Mn	0.15	0.17	0.14	0.15	0.27
Fe	0.19	0.29	0.02	0.24	0.11
Pb	0.08	0.21	0.35	0.17	0.1

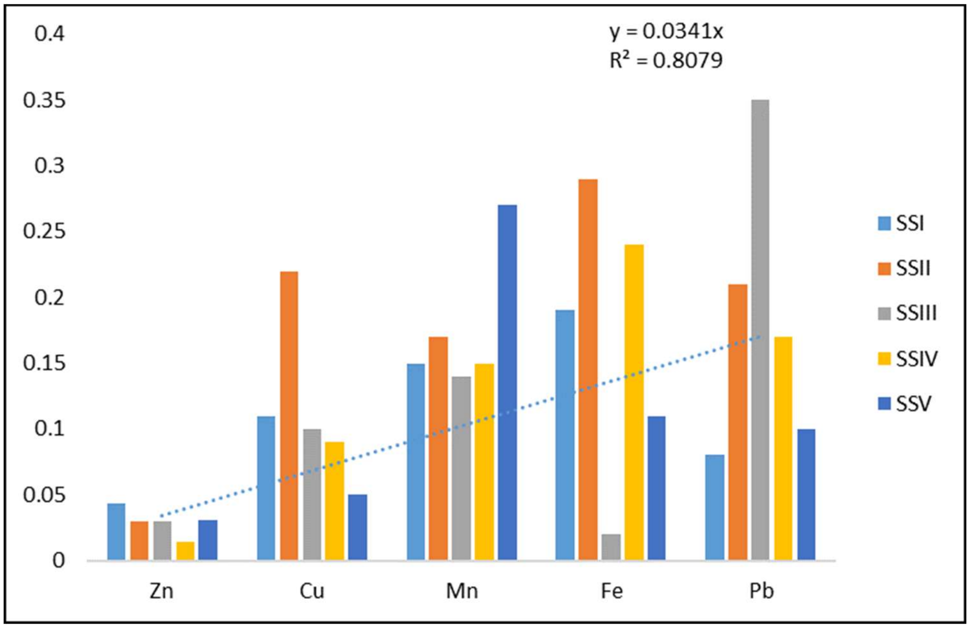


Figure no. 04 Reported Concentration of Heavy metals in Tomato plant at different stations

Result & Discussion

The mean & standard deviation of heavy metal in soil and Tomato plant has been presented in Table 01 to Table no.04. Heavy metal concentration is reported in mgkg-1. The results in Table 01 & Table 02 presented the concentration of the metals in soil vacillated from (0.216-1.057) and (0.012-0.167) in tomato & soil one-to-one for Zn, & (0.125- 0.530) and (0.124- 0.044) in tomato and soil respectively for Cu. The mean concentration accumulated by the vegetables ranged from (0.444 -0.823) and (0.067- 0.067) in tomato and soil respectively for Mn, and (0.104-1.247) and (0.098-0.461) in tomato and soil respectively for Fe. The mean concentration ranges (0.012-0.053) and (0.012-0.074) in tomato and soil respectively for Pb. Neither the tomato nor the soil had either Hg or Ni. The findings also showed that there is no discernible difference between the metal content in the soil and the concentration that the tomato plant has accumulated. The availability of heavy metals in the soil for plant accumulation is influenced by a number of variables, including the metal's chemical form, pH, and soil texture. Numerous studies have demonstrated that as soil pH drops, the cationic forms of the metals become more soluble in the soil solution and are more accessible for plant accumulation. Therefore, compared to neutral or alkaline soils, acidic soils encourage the accumulation of metals by vegetables.

The analysis was conducted in triplicate, and the findings were presented as mean values with their respective standard deviations (±S). Subsequently, the mean concentrations and standard deviations of metals in both tomato and soil samples were computed. Over all reporting, detection of heavy metals in *Lycopersicum esculentum L* the highest conc. of heavy metal reported in order i.e Zinc(Zn), Iron(Fe) , Manganese(Mn) & Lead(Pb). And in soil high conc. of Iron (Fe) & Manganese(Mn) reported. Data compared between stations for some heavy metal was found that highest conc. of Zinc (zn) reported in SSIII(Surakachhar, Kusmunda), highest conc.of Copper(Cu) reported in SSIII (Surakachhar, Kusmunda), highest conc.of Manganese (Mn) reported in SSV(Gervaghat) , highest conc.of Iron (Fe) reported in SIV (Kharmora, Dader) and highest conc. of Pb reported in SSIII (Surakachhar, Kusmunda). Therefore concluded that due to the presence of heavy metal Fe & Mn in high conc. in soil leads to high conc. of same heavy metal in tomato plant, as plant fulfilled the nutrients level from soil for its growth therefore the contamination of soil leads to contamination of fruits of plant and ultimately results in health hazards. Table 03 indicates the value of target hazards quotients (THQ) of the heavy metals in tomato plant at study site vicinity of Hasdeo river Korba district. The reported data reveals that the value of heavy metals are less than one therefore they belongs to permissible range and further no such health risk is considerable. Additionally, the THQ values corroborate that despite the presence of these metals in vegetables, their mean concentrations remain low and fall within the permissible limits outlined by the World Health Organization (WHO) and the Food and Agriculture Organization (FAO).

Conclusion

The metals such as Zinc, Iron, Manganese , Copper & lead were analyzed by using atomic absorption spectroscopy in the tomato and soil samples. Highest concentration of heavy metals reported in tomato plant in the order Zn, Fe, Mn, Cu & Pb respectively. Highest concentration of heavy metals reported Fe, Mn, Zn, Pb & Cu respectively in soil. As per WHO standard of heavy metals in soil falls under acceptable limits but heavy metals in plants are found to exceed these limits. One of the initial tactics is restricting their assimilation from the ground by combining metals with organic substances generated and released by the roots. Growth circumstances and plant genetic background have a major role in strategy selection. Also this may be due to nearby industrial activities, mining operations, improper waste disposal, improper soil management & improper water management. This can be overcome by Phytoremediation & regular soil testing monitoring . The presence of heavy metals in tomatoes raises concerns about food safety and public health, as these contaminants can accumulate in the food chain and pose risks to human consumers. Additionally, the contamination of soil with heavy metals may have long-term implications for soil fertility and ecosystem health. Overall, this study emphasizes the need for continued efforts to mitigate heavy metal pollution in agricultural areas, particularly in regions like Korba District where industrial and mining activities are prominent. Implementing effective pollution control measures, promoting sustainable agricultural practices, and raising awareness among stakeholders are crucial steps towards safeguarding both environmental quality and human well-being in the studied region. Further research is warranted to comprehensively assess the extent of heavy metal contamination and its potential impacts on food security and ecosystem sustainability in the area.

References -

Hu W, Chen Y, Huang B, Niedermann S. Health Risk Assessment of Heavy Metals in Soils and Vegetables from a Typical Greenhouse Vegetable Production System in China. Hum Ecol Risk Assess An Int J. 2014; 20: 1264–1280.

Sultana MS, Rana S, Yamazaki S, Aono T, Yoshida S. Health risk assessment for carcinogenic and non-carcinogenic heavy metal exposures from vegetables and fruits of Bangladesh. Kanan S, editor. Cogent Environ Sci. 2017; 3.

Ahmad, J.U., Goni, M.A., 2010. Heavy metal contamination in water, soil, and vegetables of the industrial areas in Dhaka, Bangladesh. Environ. Monit. Assess. 166, 347–357 pmid: 19521788.

Zoran SI, Nikolas K, Ljubomir S, Dragoljub B, Natasa M (2014) Heavy metals and nitrate contents in tomato fruit grown in organic and conventional production systems. Poland Journal of Environmental Studies 23: 2027-2032.

Buteh DS, Chindo IY, Ekanem EO, Williams EM. Impact assessment of contamination pattern of solid waste dumpsites soil: A comparative study of Bauchi metropolis. World Journal of Analytical Chemistry. 2013;1(4):59-62.

Eences Abbasnia, A., Radfard, M., Mahvi, A.H., Nabizadeh, R., Yousefi, M., Soleimani, H., Alimohammadi, M., 2018. Groundwater quality assessment for irrigation purposes based on irrigation water quality index and its zoning with GIS in the villages of Chabahar, Sistan and Baluchistan, Iran. Data Brief 19, 623–631.

Kachenko A G, Singh B (2006) Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia. Water, Air and Soil Pollution 169(1-4): 101-123.

Harmanescu M, Alda LM, Bordean DM, Gogosa I, Gergen I. Heavy metals health risk assessment for population via consumption of vegetables grown in old mining area: A case study of Banat County, Romania. Chemistry Central Journal. 2011;5:64. DOI: 18:1186/1752-153x-5-64.

Sharma R J, Agrawal M, Marshall F M (2009) Heavy metals in vegetables collected from production and market items of a tropical urban area of Indian. Food Chem Toxicol 47(3): 583-591.

Suruchi S, Khanna P. Assessment of heavy metals contamination in different vegetables grown in and around urban areas. Research Journal of Environment and Toxicology. 2011;5:162-179.

Zhuang P, Mcbride MB, Xia H, Li N, Li Z. Health risk from heavy metals via consumption of food crops in the vicinity of Daboashan mine, South China. Science of the Total Environment. 2009;407(5):1551- 1561.

Agca, N., Ozdel, E., 2014. Assessment of spatial distribution and possible sources of heavy metals in the soils of Sariseki-Dortyol District in Hatay Province (Turkey). Environ. Earth Sci. 71, 1033–1047.

Alghobar, M.A., Suresha, S., 2017. Evaluation of metal accumulation in soil and tomatoes irrigated with sewage water from Mysore city, Karnataka, India. J. Saudi Soc. Agric. Sci. 16, 49–59.

Duressa T F, Seyoum L (2015) Determination of levels of as, cd, cr, hg and pb in soils and some vegetables taken from river mojo water irrigated farmland at koka village, oromia state, east Ethiopia. International Journal of Sciences: Basic and Applied Research (IJSBAR) 21: 352-372.

Adimalla, N., 2020. Heavy metals pollution assessment and its associated human health risk evaluation of urban soils from Indian cities: a review. Environ. Geochem. Health 42, 173–190.

Abreu, C. A., M. F. Abreu, and R. S. Berton. 2002. Análise química de solo para metais pesados. In Topics in Soil Science, ed. V. H. Alvarez, 645–692. Viçosa: Brazilian Society of Soil Science

Addis Ababa City Structure Plan Office: City Structure Plan Preparation Office, 2017.

Ali, H., Khan, E., Sajad, M.A., 2013. Phytoremediation of heavy metals-Concepts and applications. Chemosphere 91 (7), 869–881.