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Heavy Metal Concentration of Vegetables and Respective Soil in Korba Region, India.

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Abstract

Growing vegetables has a significant impact on the biological, chemical and physical characteristics of the soil around. Heavy metal contamination of soil is now a global issue that reduces agricultural productivity, degrades the nutritional value of vegetables, and poses a risk to human health once they enter the food chain. In present study, analyses the concentration of heavy metals (Fe, As, Cr, Cu, Cd, Pb, Hg, and Zn.) of common vegetables i.e., *Solanum lycopersicum* (Tomato), *Solanum melongena* (Brinjal) and respective soil samples obtain from the Korba Region, India are described. The concentration of Fe, As, Cr, Cu, Cd, Pb, Hg and Zn in the soil was ranged from 880-1540, 109-184, 75-82, 79.20-172, 0.62-1.52, 92-204, 0.28-0.42 and 172-222 mg/kg respectively. Results indicate the heavy metals concentration were generally higher Fe>Zn>Pb>As>Cu>Cr>Cd>Hg, indicating the need for immediate action to reduce contamination rates and identify the serious problem of heavy metal pollution in this area.

Keywords: Heavy Metals, Soil Contamination, Health Effect

1. Introduction

Worldwide environmental pollution is continuously increasing. The soil contaminated with heavy metals like lead (Pb), cadmium (Cd), boron (B), nickel (Ni) chromium (Cr), arsenic (As), molybdenum (Mo)…etc., has serious environmental problems since these metals are non-essential and toxic to plants and animals and have significant implications for human being health [1]. Vegetables take up heavy metals by absorbing them from contaminated soils, as

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well as from deposits on parts of the vegetables exposed to the air from polluted environments [2]. However, both essential and toxic elements were absorbed by vegetables from the soil [3]. Vegetables (eggplant, tomato, cucumber and pepper…etc.) constitute an important part of the human's diet. In addition, they are considered as a potential source of important nutrients, carbohydrates, proteins, and vitamins [4]. The Solanaceae family includes some of the world's most economically important berry-producing vegetables such as pepper (*Capsicum annuum L.*), tomato (*Solanum lycopersicum L.*) and eggplant (*Solanum melongena L.*) [5]. In 2019, they ranked seventh (38·106 t), first (181·106 t) and fifth (55·106 t), respectively, among vegetables for world total production [6]. This study was carried out to analyse the concentration of heavy metals in selected vegetables (i.e. *Solanum lycopersicum* and *Solanum melongena*) grown in Korba Region, India, and is presented.

2. Materials and Methods

2.1 Study Area

Korba is the power capital of the Chhattisgarh State. The district comes under Bilaspur division and is inhabited mainly by tribal including the protected tribe Korwas (Pahadi Korwa).

Korba is blessed with lush green forect cover, where a sizable number of tribal populations are found.. Korba is blessed with lush green forect cover. The district within itself is enriched with all the essential raw materials needed for power generation namely coal and water. The four Thermal Power Plants (NTPC, KTPS, BALCO, & BCPP, DSPM, CSEB East, CSEB West) together generates 3650 MW of electricity. The SECL, a profit-making Coal Company under the Coal India Limited has many of its important mines in Korba district. BALCO (Bharat Aluminium Company) an aluminium major being the single largest aluminium producer at one location is also based in the Korba.

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2.2**. Vegetables plant sample collection and preparation**

The vegetables plants were collected from four sampling areas of Korba region in September to December, 2021. Two commonly edible vegetables i.e. Tomato (*Solanum lycopersicum*) and Brinjal *(Solanum melongena*) were selected for analysis of the heavy metal concentration. To remove adsorbed dust and foliar contaminants, the vegetable plant samples were washed in the lab using tap water and deionized water. After cleaning, the samples were cut into small pieces using a stainless-steel knife to facilitate drying. The samples were then further dried in a hot air oven at 60 °C to remove moisture and maintain constant mass. The dried samples were ground into a powder using a lab mortar and pestle and then sieved using a sieve with a mesh size of 2 mm. Finally, the sieved samples were placed in polyethylene bags and preserved in desiccators until digestion and analysis [7].

2.3. **Soil samples collection and preparation**

Soil samples (about 100 g) were collected into a clean polyethylene bag from the same sites where the vegetable samples were collected carefully (for selected vegetable separately) at 0–20 cm depth using a stainless -ssteel hand-trowel. The soil samples were air dried in lab at room temperature and then dried in an oven at 60-70˚C for 12 hr. Then dried, sieved (2mm) and homogenized soil samples were kept in clean plastic bags and stored in desiccators until digestion and analysis [8].

2.4 **Digestion of soil and vegetable samples**

The samples were first air dried, then placed in electric oven at a temp. of 40 °C for 30 minutes. Homogenized 0.1g sample is weighed out and transferred to reaction vessel. 2.0 ml of concentrated nitric acid and 5.0 ml of conc. HCI acid were then added to each vessel. Vessels then placed in the rotor and the rotor is microwave at the given instrument condition. At the end of the microwave program, the vessels were allowed to cool for a minimum of 25 minutes before removing them from the microwave system. The vessels were carefully uncapped & the digests were filtered through Whatman No.41 filter paper and the filtrate was collected in a 100-ml volumetric flask, the volume was adjusted to 100 ml with 0.5% HNO_3 [9].

2.5 **Heavy metal analysis**

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Heavy metals ie. Fe, As, Cr, Cu, Cd, Pb, Hg, and Zn were analysed using Atomic Absorption Spectrophotometer (VARIAN GTA-120, AA240). Prior to analysis, the samples were diluted with 2% 1N nitric acid solution [9].

3 Results and Discussion

Heavy metal concentration range in table 1 and mean concentration in Table 2 of Soil Samples and Selected Vegetables (VS-I & VS-II) during 2021 are summarised.

Table – 1: Concentration of Heavy Metals (HMs) in Vegetables and Respective Soil Samples

Sl. No.	Heavy Metals	Concentration range in Soil (mg/kg)	Concentration range in VS-I (mg/kg)	Concentration range in VS-II (mg/kg)
1	Fe	880-1540	24-502	32-412
2	As	109-184	0.08-0.82	0.08-0.92
3	Cr	75-82	1.5-3.2	0.5-1.2
4	Cu	79.20-172	9-32	12-28
5	Cd	0.62-1.52	0.15-0.62	0.09-0.32
6	Pb	92-204	0.8-2.3	0.04-0.9
7	Hg	0.28-0.42	0.06-0.09	0.04-0.09
8	Zn	172-222	12-34	9-34

VS-I (*Solanum lycopersicum)*, VS-II (*Solanum Melongena*)

Table - 2: Mean Concentration (mg/kg) of Heavy Metals in Soil and Vegetables

		Soil				**VS-I**				**VS-II**			
SL. No.	HMs	SS-I	SS-II	SS-III	SS-IV	SS-I	SS-II	SS-III	SS-IV	SS-I	SS-II	SS-III	SS-IV
1	Fe	1047	1074	1156	1322	66	276	42	494	138	91	299	375
2	As	145	146	144	174	0.20	0.15	0.42	0.63	0.14	0.28	0.49	0.7

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3	Cr	79	77	77	79	2.7	2.1	2.9	2.4	1.05	0.92	0.65	1.1
4	Cu	91	89	147	108	14	24	29	20	22	15	25	19
5	Cd	0.68	1.08	1.43	1.29	0.26	0.27	0.49	0.58	0.19	0.20	0.27	0.27
6	Pb	110	124	111	190	1.5	1.3	2.02	2.07	0.08	0.1	0.31	0.5
7	Hg	0.30	0.38	0.32	0.41	0.30	0.38	0.31	0.40	0.06	0.06	0.23	0.06
8	Zn	186	198	189	208	21	27	30	30	16	14	20	25

SS (Sampling Site), VS-I (*Solanum lycopersicum*), VS-II (*Solanum Melongena*)

3.1. Heavy Metal Concentration in Soils

All soil sample was analyzed and heavy metals concentration of Fe, As, Cr, Cu, Cd, Pb, Hg and Zn was ranged from 880- 1540, 109 - 184, 75 - 82, 79.20 - 172, 0.62 – 1.52, 92 - 204, 0.28-0.42, 172 - 222 mg/kg, respectively. HMs i.e. Al, Fe,Mn, Cr, Cu, Zn, Cd, Pb, As and Hg in the earth crust reported was 81,530, 39,200, 775, 92, 28, 67, 0.09, 17, 4.8and 0.05 mg/kg [10]. In the soil of the study area As, Cu, Cd, Pb, Hg, and Zn concentrations were significantly higher.

3.2. Heavy Metal Concentration in Vegetables

Solanum lycopersicum (Tomato) is a staple common vegetable consumed by all classes of Indian citizens. Tomatoes are often a significant part of the human diet and are also abundant sources of antioxidants. The safe limits reported for As, Fe, Cr, Mn, Cu, Zn, Cd, Pb and Hg in the vegetables were 0.1, 425, 2.3, 500, 40, 100, 0.1, 0.2 and 0.03 mg/kg, respectively [11] The heavy metal concentration range of Fe, As, Cr, Cu, Cd, Pb, Hg and Zn was found to be 24 - 502, 0.08 – 0.82, 9-32, 0.15- 0.62, 0.8- 2.3, 0.06- 0.09, 12- 34 mg/kg, respectively. It was observed that the concentrations of As, Cd, Pb, and Hg exceeded the safe limits.

Solanum melongena (Brinjal), a member of the Solanaceae family, is a widespread vegetable crop growing in the subtropics and tropics, even on pollutant-contaminated soil. The concentration range of Fe, As, Cr, Cu, Cd, Pb, Hg and Zn was 32 - 412, 0.08 - 0.92, 0.5 - 1.2, 12 – 28, 0.09 - 0.32, 0.04 – 0.9, 0.04 – 0.09, 9 - 34 mg/kg, respectively. Four metal concentrations -As, Cd, Pb, and Hg were found to be higher than acceptable limit in brinjal.

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4. Conclusion

Heavy metal concentrations of As, Cu, Cd, Pb, Hg, and Zn in soil and As, Cd, Pb, and Hg in both selected vegetables are higher than acceptable levels. This can be explained by anthropogenic activities including the excessive use of manures, industrial waste, fertilisers, and pesticides in agricultural fields. Furthermore, the content of heavy metals in soil and vegetables may be influenced by atmospheric depositions from vehicle emissions and different particulate matter created by industries. The details available here demonstrates the urgent need for heavy metal pollution control and remediation solutions in the Korba region Chhattisgarh, India.

5. References

1. Kanwar, J. S. and Sandha, M. S. 2000. Waste water pollution injury to vegetable crops, a review. Agric. Review., 21(2): 133-136.

2. Wang XL, Sato T, Xing BS, Tao S. Health risks of heavy metals to the general public in Tianjin, China via consumption of vegetables and fish. Sci Total Environ 2005;350:28–37.

3. Hajeb, P., Sloth, J.J., Shakibazadeh, S., Mahyudin, N.A. and Afsah-Hejri, L. (2014) Toxic Elements in Food: Occur rence, Binding and Reduction Approaches. Comprehensive Reviews in Food Science and Food Safety, 13, 457-472. http://dx.doi.org/10.1111/1541-4337.12068

4. Arai, S. 2002. Global view on functional foods: Asian perspectives. Brit. J. Nutr., 88:139-143.

5. Olmstead, R. G., Bohs, L., Migid, H. A., Santiago-Valentin, E., Garcia, V. F., & Collier, S. M. (2008). A molecular phylogeny of the Solanaceae. Taxon, 57(4), 1159–1181. https://doi.org/10.1002/tax.574010.

6. FAOSTAT. (2019). FAOSTAT. http://www.fao.org/faostat/en/.

ISSN PRINT 2319 1775 Online 2320 7876

Research paper UGC CARE Listed (Group -I) Journal Volume 11, Iss 12, Dec 2022

7. Kalra, Y.P. (1998) Handbook of Reference Methods for Plant Analysis. CRC Press, Boca Raton.

8. Tan, K.H. (2005) Soil, Sampling, Preparation and Analysis. 2nd Edition, CRC Press, Boca Raton.

9. Tiwari, M. K., Bajpai, D. S., & Dewangan, D. U. (2015). An Analytical Study of Heavy Metal Concentration in Soil of an Industrial Region of Chhattisgarh, central India. International journal of Scientific and Research Publication, 5(7).

10. Rudnick, R.L. and Gao, S. (2003) Composition of the Continental Crust. In: Rudnick, R.L., Holland, H.D. and Turekian, K.K., Eds., The Crust: Treatise on Geochemistry, Vol. 3, Elsevier-Pergamum, Oxford, 1-64.http://dx.doi.org/10.1016/b0-08-043751-6/03016-4.

11. Ramteke, S., B. L. Sahu, N. S. Dahariya, K. S. Patel, B. Blazhev, and L. Matini. 2016. Heavy metal contamination of vegetables. Journal of Environmental Protection 7:996–1004. doi:10.4236/jep.2016.77088.