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Evaluation of Heavy Metal Contamination in Green Leafy Vegetables Grown in Allahabad

Swati Singh Chandel[1,*], Dr. Ram Bharose[2]

[1]Research Scholar (PhD), Department of Environmental Sciences and NRM, SHUATS, Allahabad, India
[2]Assistant Professor Department of Environmental Sciences and NRM, SHUATS, Allahabad, India
*Corresponding Author: swati.singh197@gmail.com

Abstract*— *In the following study, we have collected municipal wastewater and have studied heavy metal accumulation and health risk factors in two leafy vegetables i.e in Spinach (Spinacia oleracea) and coriander (Coriandrum sativum). The following heavy metals were analyzed i.e. Cu, Zn and, Cr using Atomic absorption spectrophotometer. Present study explains about the amount of heavy metal contamination that is found in green leafy vegetables. Results showed that spinach plant contain Cu, Zn and Cr at all the study area. Cr was under the secure value limit recommended by FAO/WHO at S1, S2, S5. Cr was detected at S1,S2and S3 areas, but at experimental area S2 Cr in spinach (70.79ppm) and coriander(127.27ppm) was higher than the allowable limit. Soil analysis has not revealed any measurable increase in the concentration of heavy metal according to the fixed standards but the values were higher than control which shows that the abomination was due to pesticides and industrial waste.

***Keywords*— Heavy metals, green leafy vegetables, spinach, coriander, wastewater, soil.**

I. INTRODUCTION

In present times, we can observe that larger part of population have noticeable nutrient deficient syndrome. In day-to-day routine we use variety of leafy vegetables to maintain a balanced diet (116/mg) as they are rich in minerals and vitamins. Heavy metals has caused significant risk to human life and that too in upraised concentration(Gupta& Gupta, 1998).

Vegetable consumption has been identified with heavy metals like cadmium, zinc and copper posing health issues in human being (kachenko& Singh, 2006).Many authorities are advising people to utilize the sewage water but this deserves special attention as it is making our environment unsuitable for human health, animals and plants. Untreated water when used for irrigation increases heavy metals in soil and crops. Roots or foliage are the main source of heavy metals in the plant body. Wastewater irrigation not only pollutes the soil but also results in mineral absorption in edible tissue of the leafy vegetables. Metals play a very vital role in our body for the regular growth and development. Chromium works closely with insulin and regulates blood sugar. . Sewage water is the metro cities are the primary cause of pollution as this is drained into rivers without threshold treatment. Biological Demand of oxygen (BOD), eutrophication and several diseases are the mainly outcome of untreated disposal of sewage water. The source of polluted water is highly because of Domestic households, industrial and agricultural uses. The waste pollutants water from household, industries are treated in water treatment plant. The waste after water treatment system disposed in sea, which affect the surroundings. Mud applications are the main cause to increase the concentration of metals in the soil. The Edible part of crops now contains high value of Cd, Cu, Zn and Ni. These heavy metals are affecting major crop and vegetable production such as wheat, potato, spinach, red beet, cabbage and spinach.

II. MATERIALS AND METHODS

2.1 Details of the research area

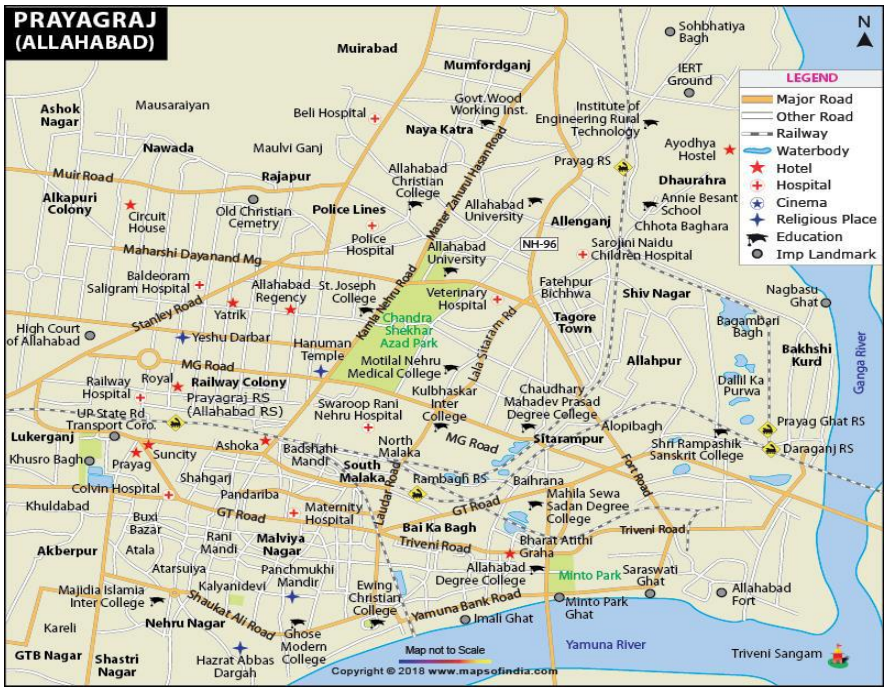

Fig.1: Research areas in Allahabad

Five experimental sites selected for sewage water contamination were Sarasvati ghat (S1),Bai kabagh (S2), Civil lines (S3), Allahapur(S4), Jhalwa(S5)

2.2 Collection AndPreparation Of Water Samples

We have collected the samples from five different areas of Allahabad in precleared 100ml polythene bottles and 2ml of HNO_3 was adjoin as preservative. Water samples that we have collected was kept in insulated field kit containing ice and was brought to laboratory. Further 10ml of water sample was taken in Teflon tubes and 1 ml conc.HNO_3 was added to it. .We have closed the vessel and checked the valve of the tubes. System was pre-programmed using Ethos D control terminal for 5 min of digestion..For control samples were collected from the research areas where normal water is used for agricultural purposes.

2.3 Collection and Preparation of Soil Samples

The soil sample that we have collected from the research area was dried at40°Cfor 48hrs in the hot air oven and was crushed into pieces to pass through 2mm sieve. Extraction of soil with D- acid digestion was done to determine the availability of heavy metals in the soil.The digestion mixture used was a Di- acid mixture. Mixture was made up of conc.HNO3 and HCLO4.5ml of conc. HNO3 was added to 1gm of soil. 12 ml of Di- acid mixture was added and digested in hot water plate in the ratio 3:1 until reddish brown fumes of perchloric acid starts coming out.. Completely dissolved soil samples in the digestion mixture was then evaporated until 2ml was left over in the flask. The digested sample obtained was then transferred and filtered into tubes and were sent for analysis in the Soil Science Lab at Allahabad for Atomic Absorption.

Daily intake of metals.

Average consumption of vegetables and fruits per person per day is 98 and 78 gm respectively. The limit set by FAO/WHO for heavy metal intake for an average adult is 0.01% of 70 kg body weight. Manganese damages the central nervous system. Cobalt and Nickel are carcinogens in nature. More than 5mg of Selenium can be highly toxic to human body. The recommended intake is 0.45 mg which is ten times higher than the daily intake limit. Entry of these metals in our body is due to contamination in water soil and air which becomes concentrated as a result of industrial and human activities.

III. EXPERIMENTAL METHODOLOGY

To analyze heavy metals water samples that were collected from five different research areas i.e (S1-S5) and were sent

to the Soil Science Department for atomic absorption spectrophotometer.

IV. RESULTS AND DISCUSSION

4.1 Copper

From the result obtained we can summaries that copper concentration showed diversion between 7.29ppm(S1) to 34.70ppm(S2). S2(34.70ppm),S4(34.66ppm) and ,S5(34.56)ppm study areas have crossed the acceptable limits i.e 30ppm. In S1,S3 and control study areas Cu concentrations were far below the allowable Indian Standard.

In coriander Cu was at its highest concentration at the study area S2 (60.77ppm). In other areas Cu concentration was far below the crucial level i.e from S5(3.58ppm) to S1(19.29ppm). Result from the control showed 2.19ppm. S2 study area showed binary increase in the copper concentration. (Table 1 and 2). Similar finding was reported by Demirezen and Ahmet (2006) that copper concentration ranged from 22.19 to 76.50 mg/kg in leafy vegetables as compared to non leafy vegetables and the reason was due to the richness of chlorophyll. Further Fytianos *et al.*,(2001) reported that no significant difference in metal engagement in leafy vegetables i.e spinach and coriander from industrial areas were recorded. Present research showed that spinach showed highest Cu concentration as compared to coriander. Control values showed lesser value with soil irrigated with waste water . Results obtained are accordance with the study conducted by Debopam Banerjee *et al.,(*2010).

Table 1 Heavy metal accumulation (ppm) in spinach leaves

Study Area	Copper	Zinc	Chromium
S1	7.28	37.71	0.38
S2	33.70	48.30	70.78
S3	9.61	23.32	28.57
S4	34.61	61.41	13.32
S5	34.55	43.59	BDL
Control	16.28	21.11	BDL
Indian Standard	30.0	50.0	20.0
WHO	40.0	60.0	-

Table 2 Heavy metal accumulation (ppm) in coriander leaves

Study Area	Copper	Zinc	Chromium
S1	19.28	30.82	12.12
S2	60.77	73.71	127.26
S3	9.04	35.21	BDL
S4	14.47	9.97	BDL
S5	3.57	99.55	8.46
Control	2.18	10.22	BDL
Indian Standard	30.0	50.0	20.0
WHO	40.0	60.0	-

4.2 Zinc (Zn)

Zn concentration at S4 was 61.42 ppm and in showed noticeably variation in other selected areas . S4 result showed that the concentrations was exceeding permissible limits of Indian Standard i.e 50ppm. Zn ranged from 24.32ppm to 48.31ppm while control showed 21.11 ppm variation. In coriander Zn concentration overrun the permissible limit i.eS2(73.72ppm) and S5(99.56ppm), whereas S1(30.82ppm), S3(35.23ppm), S4(9.98ppm) and control(10.21ppm) showed lesser value than the permissible limit. (Table 1 and 2).Zn is found throughout our system ,it helps in metabolism function. It plays an important role in wound healing, DNA synthesis and protein production.

4.3 Chromium(Cr)

Chromium was found in spinach in following ranges i.e S3(28.59ppm) and S2(70.79ppm). In samples S5 and control chromium was not detectable. In S1(0.39ppm), and S4(13.31ppm) which is far below the permissible limit. Sample from S2 and S3 overpassed the permissible limit i.e (20ppm). In coriander Chromium was higher in concentration at S2(127.27ppm). At S1 and S5 variations were less as compared to other sites, BDL i.e below detection level **(Table 1 and 2**). Present study showed that chromium in spinach and coriander at specific study area needs urgent evaluation. Chromium shows effects such as skin irritation, headache ,impaired thinking ,blood disorder and other serious health issues.

Chromium exposure occurs through presence of Cr in breathing area, drinking water and eatables. Certain range of Chromium is essential for lipid metabolism but within a certain range (200µg/day). Higher variation in values may lead to accumulation and further cause toxicity in the flora and fauna (Garcia *et al*., 2001).

4.4 Soil

Chromium was not discovered in any of the study areas. Copper was found in the soil and the concentration showed ranges from 7.39ppm to 35.32ppm**(Table 4**). Zinc showed maximum value at S3(32.58ppm) to minimum at (10.31ppm) and control showed value (17.79ppm) and all the values obtained were under the permissible limit.

4.5 Water

Zinc was identified at only S1(<0.05) . No traces of Chromium was observed. Copper concentration showed higher values at all the research areas (**Table 3**) i.e. exceeding the WHO standard . Water pH at S2(7.10) was alkaline as compared to others that showed acidic nature S1(5.24ppm) ,S3(5.16ppm),S4(5.70ppm) and S5(5.39ppm).Physicochemical parameters examined were pH, Electrical conductivity, Total hardness, Calcium ,Magnesium , Total dissolved solid and Dissolved oxygen. showed maximum variation at S2(7.11) and minimum at S3(5.16). Electrical conductivity was maximum found at S3 (1690Mv) to minimum at S2(1214Mv). Total hardness ranged from S1(330mg/l) S2(550mg/l) S3340(mg/l) S4(210(mg/l) S5(370 mg/l). Calcium showed variation from 56 mg/l to 144 mg/l in all the selected area. Magnesium was highest at S2(45.6mg/l) followed by S1(43.2mg/l), S3(36mg/l), S5(28.4mg/l) and S4(16.8mg/l) (**Table 5**).Total dissolved solid ranged maximum from S5(616.30mg/l) to minimum at S4513(mg/l). Dissolved oxygen showed maximum variation from S4(6.2ppm)to minimum at S2(5.5ppm).

Table 3 Heavy metal accumulation (ppm) in waste water

Study Area	Copper	Zinc	Chromium
S1	0.035	BDL	BDL
S2	0.170	BDL	BDL
S3	0.025	BDL	BDL
S4	0.012	BDL	BDL
S5	0.036	BDL	BDL
Control	0.016	BDL	BDL
Indian Standard	0.05	5.0	0.05
WHO	0.20	2.0	0.10

Table 4 Heavy metal accumulation (ppm) in soil

Study Area	Copper	Zinc	Chromium
S1	17.05	29.26	76.88
S2	7.39	10.12	BDL
S3	35.32	32.58	116.93
S4	12.67	15.01	53.03
S5	23.70	18.98	86.98
Control	22.16	17.79	16.77
BIS	135-270	300	-
WHO	-	600	-

Table 5 Physicochemical specification of waste water

Parameters	S1	S2	S3	S4	S5
pH	5.54	7.11	5.15	5.70	5.38
Electrical conductivity	1340Mv	1213Mv	1690Mv	1278Mv	1362Mv
Total Hardness(mg/l)	330	551	341	210	370
Calcium (mg/l)	60	143	75	56	59
Magnesium(mg/l)	43.2	45.4	35	16.8	28.4
Total Dissolved Solids (mg/l)	545.2	904.0	691.3	513.3	616.28
Dissolved oxygen ppm	5.6	5.4	5.5	6.2	5.9

V. CONCLUSIONS

The main source of wastewater contamination are human and animal waste. Presence of phosphorus and nitrogen has also resulted in eutrophication of water resources and also has resulted in high amount of heavy metals in soil and vegetation resulting in potential health hazards. From the present study we conclude that heavy metals in spinach showed higher presence than in coriander. This study may also help other researchers to study more affected areas of Allahabad. Heavy metals showed their presence because of waste water irrigation system practiced in the selected areas. Heavy metals showed their presence could be due to following reasons i.e agricultural practices, geographic position and ability of the plant to absorb heavy metals. Suggested measure may include regular examination of heavy metals in all the food commodities grown in and out.

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