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RESEARCH PAPER

EFFECT OF HEAVY METALS (CU, ZN AND CR) ON GROWTH OF LEAFY VEGETABLES- *LACTUCA SATIVA* AND *CORIANDRUM SATIVUM*

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Abstract

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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 lettuce (Lactuca sativa) 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 proportion of heavy metal contamination in above mentioned leafy vegetables. Results showed that lettuce leaves contain Cu, Zn and Cr at all the sampling points. Cr was under the secure value limit recommended by FAO/WHO at P1, P2, P5. Cr was detected at P1,P2 and P3 areas, but at experimental area P2 Cr in lettuce (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 contamination was due to pesticides and industrial exhaust.

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1.Introduction:-

In today scenario we can see that majority 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 can pose a significant health risk to humans, particularly in elevated concentrations (Gupta & Gupta, 1998). Dietary exposure to heavy metals like , cadmium, lead, zinc and copper has been identified as a risk to human health through the vegetables consumption(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. Waste water irrigation not only pollutes the soil but also results in mineral absorption in edible tissue of the leafy vegetables. Metals also play a very positive role in various biological processes such as homeostasis and enzyme catalysis but higher concentration of these metals tends to have toxic effects to our food chain. 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 house hold, 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

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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, lettuce, red beet, cabbage and spinach.

2.Materials and Methods:-

Description of the study Area.

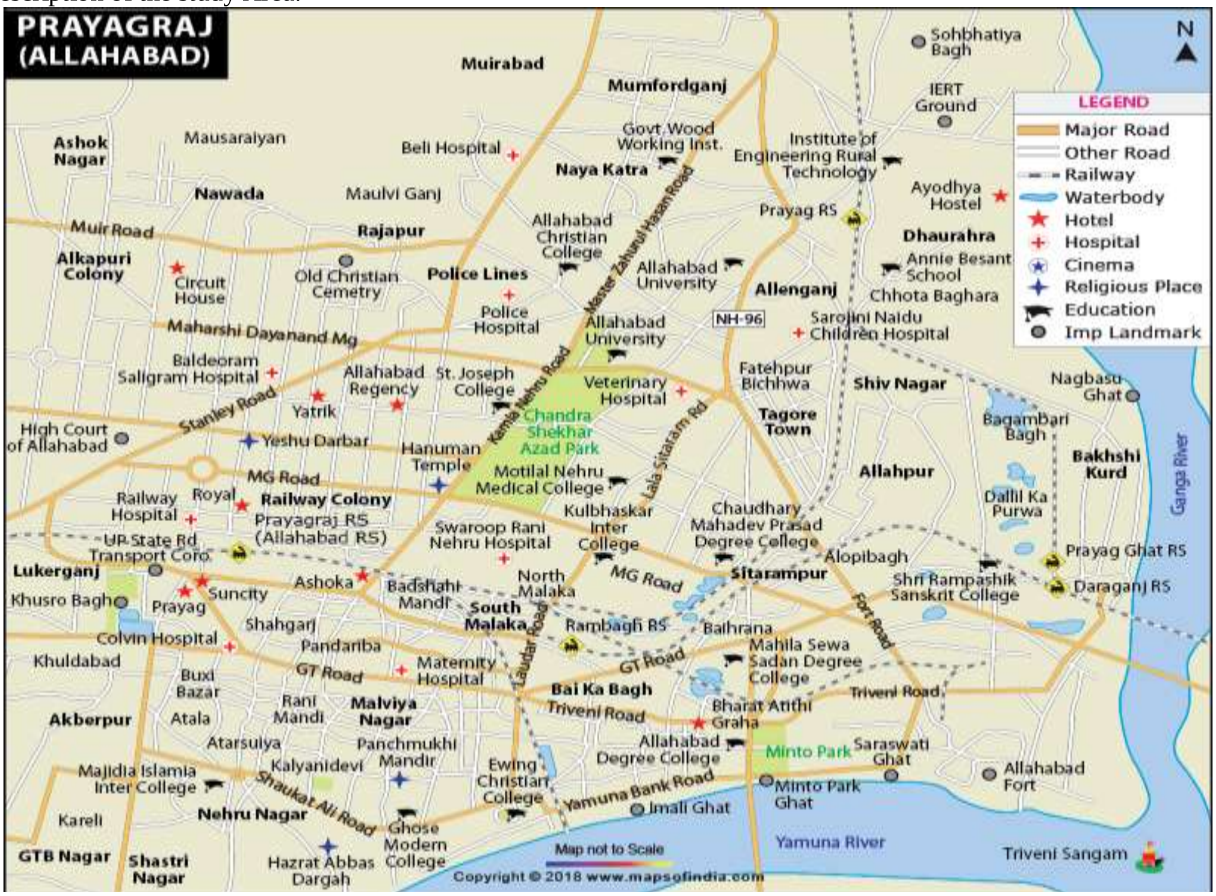

Fig 1:- Study areas in Allahabad.

Five experimental sites selected for sewage water contamination were Saraswati ghat (P1),Bai ka bagh(P2), Civil lines(P3),Allahapur(P4),Jhalwa(P5)

Collection And Preparation Of Water Samples

Water samples were collected from five different areas of Allahabad in precleaned 100ml polythene bottles and 2ml of nitric acid was added as preservative. Water samples should be kept in insulated field kit containing ice and will be brought to laboratory. 10ml of water sample was taken in Teflon tubes and 1 ml conc.HNO_3 was added. Vessel is closed and the valve is tightened. System was pre-programmed using Ethos D control terminal for 5 min of digestion.. Control samples were collected from experimental area where normal water was used for irrigation.

Collection and Preparation of Soil Samples

The soil sample were dried at 40°C for 48hrs in the hot air oven and crushed to pass through 2mm sieve. The available Cd , Cr ,Pb ,Fe,, Mn, Cu And Zn in soil were determined by extracting the soil with D- acid digestion. The digestion mixture for soil sample was a di-acid mixture. The mixture comprises of conc.HNO_3 and is $HCLO_4$ to 1gm of soil; 5ml of conc HNO_3 was added and kept overnight. Next day 12ml of di-acid mixture (conc.HNO_3+$HCLO_4$ in thr ratio 3:1) was added and digested in hot water plate till reddish brown fumes of perchloric acid comes out. After few hour the soil samples dissolved completely in the digestion mixture and the solution was then evaporated until only about 2ml was left in the flask. The digested samples were then transferred and filtered into small tubes and were analyzed by Atomic Absorption Spectrophotometer(Perkin Elmer) in Soil Science Lab at Allahabad

Daily intake of metals.

The FAO/WHO have set a limit for the heavy metal intake based on body weight for an average adult, i.e 60 kg body weight. The average diets per person per day of vegetables and fruits are 98 and 78 g, respectively. If the mean levels of Pb (0.473 mg/kg), Cd (0.071 mg/kg), Cu (2.63 mg/kg), Zn (3.7 mg/kg), Co (0.58 mg/kg), and Ni (1.49 7 mg/kg) found here are consumed daily, the contribution of heavy metal intake for an average human being from the fruit diet is 36.89 μg, 5.54 μg, 0.205 mg, 0.288 mg, 45.24 μg, and 0.116 mg, respectively. In case of vegetables, if the consumed daily mean levels of Pb, Cd, Zn, Cu, Co, and Ni are 0.25, 0.14, 8.15, 3.36, 0.51 and 0.24 mg/kg, respectively, the corresponding estimated daily intake will be 24.8 μg, 13.3 μg, 0.8 mg, 0.33 mg, 49.7 μg, and 0.0231 mg, respectively.

Experimental Methodology

Water samples were collected from five different areas (P1- P5) and control P6) to analyze heavy metals. Heavy metal analysis was carried out using atomic absorption spectrophotometer at soil science department.

3.Results and Discussion

Copper (Cu)

Copper concentration varied considerably ranged between 7.29ppm(P1) to 34.70ppm(P2). P2(34.70ppm),P4(34.66ppm) and P5(34.56)ppm areas have crossed the permissible limits (30ppm). In P1,P3 and control areas Cu concentrations was far below the permissible limits of Indian Standard.

In coriander, highest accumulation of Cu was recorded at P2 (60.77ppm) and in other areas far below critical level and ranged from P5(3.58ppm) to P1(19.29ppm) and control showed 2.19ppm. In P2 area there is twofold increase in the concentration of Cu(Table 1& 2.). Demirezen & Ahmet (20060 reported, Cu concentration (22.19-76.50mg kg-1) was found higher in leafy vegetables when compared to non leafy vegetables in Turkey and it may be due to richness of chlorophyll. Fytianos et al., (2001) analysed various leafy vegetables including spinach and coriander from industrial areas and found no significant differences in metal concentration. Present study revealed that , leafy vegetables accumulated below critical level and when compared to coriander, lettuce showed highest Cu concentration , control values were found to be much lesser than soil irrigated with waste water and present results are in conformity with the findings of Debopam Banerjee et al., (2010).

Zinc (Zn)

Zinc concentration in lettuce in all the three areas varied considerably and except at P4(61.42ppm) in other areas it does not exceed the permissible limits of Indian Standard (50ppm). Availability of Zn ranged from 24.32ppm to 48.31ppm compared to control (21.11ppm) In coriander, Zn concentration exceeded the permissible limits at P2(73.72ppm) and P5(99.56ppm) areas, whereas P1(30.82ppm),P3(35..23ppm), P4(9.98ppm) and control (10.21ppm) showed values far below the permissible limits (Table 1 & 2). Zinc is an essential mineral that is naturally present in some foods, added to others and available as a dietary supplement. Zinc is involved in numerous aspects of cellular metabolism. It is required for the catalytic activity of enzymes and plays a role in immune function, protein synthesis and wound healing. Zn also supports normal growth and development .Zn is present in appreciable amounts in leafy vegetables and appears to have higher uptake from continued sewage irrigated land in Bellandur, Banglore urban district(Lokeswari &chandrappa 2006).

Chromium(Cr)

Chromiumn content in lettuce samples ranged from non- detectable (P5 and control) to 28.59ppm (P3) and P2(70.79ppm) it was exceeded permissible limit (20ppm) and in P1(0.39ppm) and P4(13.31ppm) areas Cr level was far below the permissible limit. In coriander,Cr concentration was high atP2(127.27ppm) and low at P5 and P1 areas. In other areas below detection level(BDL). Cr concentration in lettuce and coriander varied considerably,highest in lettuce at P3(28.59ppm) and in coriander at P2(127.2ppm) areas. Table 1&2). Present findings revealed Cr in lettuce and coriander at P2 are really a panic situatin and urgent measures are required to thwart the condition. Chromium was not detected in P5 and control and values observed were well within the permissible limits of Indian Standard(Awashthi,2000). Exposure to chromium may occur through breathing air, drinking water, or eating food containing Cr or even through skin contact. In human beings and animals, it is considered to be an essential metal for carbohydrates and lipid metabolism within a certain range of concentrations (up to 200μg/day).. However exceeding normal concentrations leads to accumulation and toxicity that can result in hepatitis, gastritis,ulcers and lung cancer (Garcia, E. et al., 2001).

Soil

Cu was found in the soil with concentration ranging from 7.39ppm to 35.32ppm.Zn concentration was low in all the areas and maximum at P3(32.58ppm) and minimum at P2 (10.13ppm) compared to control (17.79ppm) and values hardly crossed to permissible limit and Cr was not detected.

Water

Chromium was not detected. Zinc at P1 to P5 was not detected except at P1 (<0.05 Copper exceeded the WHO standard in all stations (Table 4). Water pH at P1 (5.24), P3 (5.16), P4 (5.70) and P5 (5.39) stations was acidic and at P2 (7.10) station alkaline in nature. Primary water quality criteria laid down by Central Pollution Control Board is 6.5-8.5 and water samples at all stations found below desirable limit compared. Electrical conductivity varied considerably, highest at P3 (1690Mv) and least at P2 (1214Mv). Total hardness was maximum in P2 (550mg/l) followed by P5 (370 mg/l), P3 (340 mg/l), P1 (330 mg/l) and least at P4 (210mg/l) and desirable limit of total hardness is (300mg/l). Except at S4, other samples crossed permissible limits. Calcium was recorded varying results with highest concentration atPS2 (144mg/l) and least at P4 (56mg/l). As per the characteristics of drinking water prescribed by BIS, it is found to be 75mg/l. Concentration of calcium aPS1 (60mg/l), P4 (56mg/l) and P5 (59mg/l) were found to be within prescribed limit. Magnesium was least at SP4 (16.8mg/l) and maximum at P2 (45.6mg/l) stations. At P4 (16.8mg/l) and P5 (28.4mg/l) stations found below desirable limit and P2 (45.6mg/l), P1 (43.2mg/l), P3 (36mg/l) stations exceeded prescribed drinking water limits. TDS found highest at P2 (904.1mg/l) and lowest at P4 (513.40mg/l). Total dissolved solids exceeded desirable limits in all the sampling stations P1 (545.1mg/l), PS3 (691.4mg/l) and P5 (616.30mg/l).

Dissolved oxygen (DO) was least at P2 (5.5ppm) and P3 (5.5ppm) followed by P1 (5.6ppm), P5 (5.9ppm) and highest at P4 (6.2ppm) stations. (Table 5). Lead concentration in water samples was highest in all stations compared to control and values were higher than permissible limits. Zinc at all the stations and Cadmium at P3, P4, P5 was not detected except at S1 (<0.05) and S2 (<0.05). Magnesium and copper exceeded the WHO standard in all stations. Tanks receive waste from different industries and concentrations vary according to the types of activities upstream from time to time (Mwegoha & Khimpa, 2010).

Highest concentration of TDS at P2 may be due to high solids loading influent stream into lake and lowest TDS obtained at P4 may be due to dilution effect. TDS are negatively charged and therefore attract more heavy metal ions, reducing their concentration in water. Higher electrical conductivity indicates higher concentrations of free metal ions in water. Rattan et al., (2005) have found higher concentrations of heavy metals in sewage effluents as compared to ground water. Many small scale industries such as dyeing, electroplating, metal surface treatment, fabric printing, battery, paints discharge their effluents into sewage water which may be the cause of elevated heavy metal. Bio-availability depends on the concentration of anions and chelating ligands present in water, pH, redox status and presence of adsorbent sediments (Prabhu, 2009).

4.Conclusions

The main source of pollution of water bodies is due to sewage and irrigation of contaminated water found to contain variable amounts of heavy metals leads to increase in concentration of metals in the soil and vegetation. Monitoring of water quality, soil and plant is inevitable to prevent potential health hazards of irrigation with sewage fed water. Results showed that, presence of heavy metals in lettuce and coriander leaves is in the order of Zn>Cu>Cr and present study would go a long way in providing a baseline data for the assessment of distribution of heavy metals in lettuce and coriander grown in Allahabad. Experiment revealed that, lethal effects of irrigated water may be attributed to the presence of heavy metals. There is considerable differences existed in the various leafy vegetables analysed and this may be due to topography and geographic position of area under irrigation and ability of the plants and their specific parts to accumulate metals as well. Therefore it is suggested that, regular survey of heavy metals should be done on all food commodities to protect the end user that might injure their health.

Study Area	Copper	Zinc	Chromium
P1	7.27	37.70	0.78
P2	33.70	48.30	70.78
P3	9.60	23.32	28.57
P4	34.61	61.41	13.32
P5	34.54	43.59	BDL

Control	16.28	21.11	BDL
Indian Standard	30.0	50.0	20.0
WHO	40.0	60.0	-

Table 1:- Heavy metal concentration (ppm) in lettuce leaves.

Study Area	Copper	Zinc	Chromium
P1	19.28	30.81	12.12
P2	60.77	73.71	127.26
P3	9.04	34.21	BDL
P4	14.47	9.97	BDL
P5	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	-

Table 2:- Heavy metal concentration (ppm) in corriander leaves.

Study Area	Copper	Zinc	Chromium
P1	0.036	BDL	BDL
P2	0.170	BDL	BDL
P3	0.025	BDL	BDL
P4	0.011	BDL	BDL
P5	0.035	BDL	BDL
Control	0.016	BDL	BDL
Indian Standard	0.05	5.0	0.05
WHO	0.20	2.0	0.10

Table 3:- Heavy metal concentration (ppm) in waste water.

Study Area	Copper	Zinc	Chromium
P1	17.05	29.26	76.88
P2	7.39	10.12	BDL
P3	35.32	32.58	116.93
P4	12.67	15.01	53.03
P5	23.70	18.98	86.98
Control	22.16	17.79	16.77
BIS-1991	135-270	300	-
WHO	-	600	-

Table 4:- Heavy metal concentration (ppm) in soil.

Parameters	P1	P2	P3	P4	P5
pH	5.54	7.11	5.15	5.70	5.38
EC	1340Mv	1213Mv	1690Mv	1278Mv	1362Mv
Total Hardness(mg/l)	330	551	341	210	370
Ca (mg/l)	60	143	75	56	59
Mg(mg/l)	43.2	45.4	35	16.8	28.4
TDS (mg/l)	545.2	904.0	691.3	513.3	616.28
DO ppm	5.6	5.4	5.5	6.2	5.9

Table 5:- Physico – chemical parameters of waste water.

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