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Analysis of heavy metals in different vegetables in various areas of Indore city (Madhya Pradesh, India)

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Abstract

Soils contain various metals in style of inorganic compounds or they will stay secure with organic matter, clays or as oxides. The spreading of urban waste and waste sludge in agricultural fields has been a standard apply since decades. The focus was to work out analysis and compare the heavy metals concentration level in 2 elite vegetables (chilies and potatoes) at ten numerous vegetable study areas in Indore in Madhya Pradesh (India). Results of heavy metal determination in elite vegetables and the corresponding soil samples of pot experiments disclosed a transparent dependence on the concentrations of metals more to the pots. Correlation reflects that the uptake trend is close to same because of solutions were more in increasing metal concentrations. Percent uptake of various metals from soil to the plant components additionally show that the pots wherever p.c uptake was higher, were at risk of uptake of that metal and even a smaller increase in level of these metals in soil will cause abundant higher uptake. The physiochemical conditions of soil also are of nice concern for the uptake of heavy metals by the plants.
Keywords: heavy metal, vegetable areas, physiochemical conditions

1. Introduction

Heavy metals measure vital each industrially and biologically. Natural Processes like weathering, erosion take away tiny amounts of metals from the bedrocks and permit them to flow into in water and air. Injury to vegetation caused by heavy metals has been well recognized in several botanical and chemical investigations throughout past years. The overall concentration of heavy metals in soil and water but varies from native to regional and any to continental level. Soils contain these metals in form of inorganic compounds or they will stay secure with organic matter, clays or as oxides. The spreading of urban waste and waste sludge in agricultural fields has been a standard apply since decades. Waste sludge, livestock manure, wastewater irrigation measure possible alternatives for reutilization of residual resource of high nutrient and organic matter contents representing a fertiliser or soil conditioner for plants and soil. The wastewater could contain differing kinds of pollutants together with heavymetals that can cause metal contamination within the vegetation. Convenience of heavy metals to plants is due to mining activities, industrial exhausts & effluents, part depositions, waste disposals, agro-chemicals. Heavy metal contamination of fruits and vegetables cannot be underestimated as these foodstuffs measure vital parts of human diet. It has thus felt necessary to assess the degree of trace parts concentration in numerous forms of fruits and vegetables. Different techniques were utilized by very different researchers to work out heavy metal contents together with analytical techniques like AAS and ICP-AES, but there is no established quantitative technique for deciding directly the precise quantity of metals that are bio-available to plants. Several factors like variation in pH scale, temperature, nature ofsoil, reaction condition, plant species, maturity or plant age play vital role within the uptake of heavy metals.[1-4]

2. Methods and methodology

Selection of two vegetables and criteria for their choice Two vegetables namely *Solanum tuberosum L.* and *Capsicum annuum L.* are selected based on their wide spread use in various forms and significant food value.

2.1 Selection of Sampling Sites

The site choice for sampling is completed in such way so it provides coverage to the areas wherever the likelihood of contamination is high around Indore city, keeping in view the target of the study.

The following factors were thought-about for choice of the sample sites-

(i) Sites wherever chances of contamination are taken into account higher due to differing kinds of industries.

(ii) Areas close to the highways, to contemplate the hundreds of traffic, emission of gases and exhausts.

(iii) Sites close to the densely inhabited areas

(iv) Sites wherever likelihood of contamination is higher due to mode and supply of irrigation.

(v) Locations wherever contamination is also higher due to waste treatment plants.

(vi) Locations close to dumpsites, landfills of Municipal Corporation.

(vii) Locations of agricultural activities.

(viii)Locations wherever many anthropogony activities thought-about high.

2.2 Standard strategies Used for Sampling

To assess and compare the uptake of heavy metals by two elite vegetables, the study was allotted with stark naked & unpeeled Potatoes, Red chillies& green chillies. Total ten locations around Indore city were elite for sampling of vegetables & their corresponding soils. Zipped synthetic resin pouches of one-kilogram weight capability of fine quality were used. For deciding the physiochemical parameters five hundred gram of soil samples were unbroken in separate pouches. Each sample was coded properly, the sample luggage was marked.

2.3 Standard strategies adopted for process

To determine heavy metal concentrations, a wet digestion technique of the dried samples was adopted. Onegram of every dry and sieved sample was ashen in an exceedingly muffle chamber at 460°C for four hrs. The ash was digestible in ten mlaqua-regia (1 part conc. HNO_3 + three parts conc. HCl) at totally different temperatures for a complete of 9 hrs spreading over 2 hrs at 250°C, 2 hrs at 600°C, 2 hrs at 1050°C and 3 hrs at 1250°C. Once digestion done, the residue was cooled, filtered and transferred to a 100ml volumetrical flask. The solution was made up to the mark with double distilled water. A blank digestion solution was created for comparison. A regular solution for every component below investigation was ready for standardisation. To work out physiochemical parameters needed solutions were also made in double distilled water.

2.4 Standard strategies Adopted For Analysis

Heavy metals were determined by numerous methods i.e. gravimetric, titrimetric, and colorimetric, ion exchange chromatographic, polarographic, induced coupled plasma, flame photometric method and atomic absorption spectrophotometrically etc. Sixty-eight parts were determined directly with AAS over a good vary of concentrations mg/L (ppm) to μg/L (ppb) levels with exactness. The instrument is first graduated with the standard solutions of metal, to be analyzed, using corresponding hollow cathode lamp of that metal. Metal measurements were performed with AAS, double beam and deuterium background correction. Physicochemical parameters and methods adopted for their determination Organic matter, density, body & water holding capability were determined by adopting customary techniques of soil analysis and pH potentiometrically using glass calomel electrode (pH meter digital (Systronics India Ltd type-361). Conductivity was measured using conductivity bridge (Toshniwal). Chemical analysis for nitrate, phosphate, sulphate, potassium calcium and magnesium has been carried out following customary analysis methods titrimetrically/ spectrophotometrically [UV photometer (Systronics India Ltd type-118)]. Atomic Absorption photometer (Schimadzu, AA-6300)/ Flame Photometer (systronics-128) (251). Only AR grade chemicals were used for analysis.

3. Result

The percent uptake of heavy metals by plants from soil is calculated simply multiplying the relation of metal concentration in plants to metal concentration in soil with hundred. Significant variations in levels of various metals and positive correlations with metal contents of corresponding soils square measure determined on analysis of the

samples of the two chosen plants together with their corresponding soils from ten different sites around the Indore city, Madhya Pradesh representing varied sources of pollution.

Results of heavy metal determination in chosen vegetables and thus the corresponding soil samples of pot experiments discovered a clear dependence on the concentrations of metals supplementary to the pots. Correlation reflects that the uptake trend is about same as results of solutions were supplementary in increasing metal concentrations. Percent uptake of assorted metals from soil to the plant parts in addition show that the pots where percent uptake was higher, were in danger of uptake of that metal and even a smaller increase in level of those metals in soil can cause abounding higher uptake. The chemistry conditions of soil are of nice concern for the uptake of heavy metals by the plants.

Table 1. Results of analysis of soils of different sites from where samples of potato tubers are collected for different heavy metal concentrations (mg/kg) in year 2018.

Metal	Sites										Average	Standard acceptable limits
	1	2	3	4	5	6	7	8	9	10		
Pb	10.32	6.25	5.26	8.94	11.85	13.64	8.25	14.36	13.84	10.77	10.34	10-70
Cd	1.74	1.12	1.67	1.97	2.46	2.29	2.94	2.39	2.94	2.63	2.21	0.07-1.10
Zn	5.01	5.94	4.36	4.51	4.68	7.47	6.08	7.15	9.45	8.21	6.28	10-300
Fe	23.74	25.37	26.14	29.21	37.36	36.14	33.14	41.32	36.45	30.14	28.58	30-50
Cu	3.44	13.17	5.39	6.14	13.74	13.65	13.46	10.69	14.95	12.36	10.69	6-60

Table 2. Results of analysis of soils of different sites from where samples of potatotubers are collectedfor different heavymetal concentrations(mg/kg) in year 2019

Metal	Sites										Average	Standard acceptable limits
	1	2	3	4	5	6	7	8	9	10		
Pb	8.80	5.35	5.23	8.69	9.02	10.25	8.02	10.22	12.64	10.55	8.77	10-70
Cd	1.22	1.68	1.84	1.55	1.65	1.94	2.01	1.33	2.09	2.44	1.77	0.07-1.10
Zn	5.62	5.32	4.69	5.63	4.98	8.24	7.61	7.02	11.77	9.24	7.01	10-300
Fe	22.99	26.35	27.27	24.36	31.98	30.28	36.17	44.31	32.63	38.14	31.44	30-50
Cu	4.36	11.96	4.21	6.28	13.46	12.46	13.47	10.07	11.63	13.15	10.10	6-60

Table 3. Results of analysis of soils of different sites from where samples of green chillies are collected for different heavy metal concentrations (mg/kg) in year 2018

Metal	Sites										Average	Standard acceptable limits
	1	2	3	4	5	6	7	8	9	10		
Pb	8.25	5.36	7.94	10.20	12.14	11.47	12.45	13.58	8.54	13.26	10.31	10-70
Cd	0.97	2.55	2.04	3.64	2.74	3.04	3.21	3.40	2.16	2.67	2.64	0.07-1.10
Zn	4.28	7.31	5.34	6.48	6.24	6.57	8.33	7.17	6.24	6.39	6.43	10-300
Fe	19.47	40.63	23.58	20.18	36.37	35.31	39.39	38.37	26.38	22.79	30.24	30-50
Cu	4.36	11.39	9.17	5.38	13.76	13.49	13.84	12.18	14.35	11.56	10.94	6-60

Table 4. Results of analysis of soils of different sites from where samples of green chillies are collected for different heavy metal concentrations (mg/kg) inyear 2019

Metal	Sites										Average	Standard acceptable limits
	1	2	3	4	5	6	7	8	9	10		
Pb	9.58	5.47	9.27	10.37	12.76	13.60	11.30	14.37	8.97	14.67	10.94	10-70
Cd	0.84	1.35	1.69	2.71	2.30	2.69	3.90	3.64	2.64	2.39	2.41	0.07-1.10
Zn	4.69	6.95	6.38	5.34	6.25	5.37	7.29	6.42	8.37	6.11	6.31	10-300
Fe	19.36	39.36	32.96	35.35	32.64	33.28	33.28	36.25	30.28	29.34	35.53	30-50
Cu	5.34	12.34	10.36	6.39	13.69	13.54	13.60	13.78	15.31	12.38	11.67	6-60

4. Discussion

Therefore, from present studies it is simply concluded that among the 10 completely different sites chosen for studies close to Indore city the chance of uptake of virulent metals in potato and in chillies varied with the conditions of the soils. Waste sludge applications, yard manures, refuge burning are the most important sources of significant metal pollution.

Table 5. General observations during pot experiments in the year 2018-2019

Name of Plants	Metal Concentration added(mg/kg)	Percent Survival (%)	Plant Growth	Quality	Yield of Product
Solanum tuberosumL.	0	93	Normal	Standard (as taken)	Standard (as taken)
	5	93	Same as normal	Equal to standard	Same as standard
	10	90	Same as normal	Equal to standard	Same as standard
	15	89	Same as normal	Nearly equal to standard	Slightly below the standard
	20	84	Slightly less than normal	Slightly lower then standard	Below the standard
Capsicum annuumL.	0	96	Normal	Standard (as taken)	Standard (as taken)
	5	95	Same as normal	Equal to standard	Same as standard
	10	92	Same as normal	Equal to standard	Same as standard
	15	91	Slightly less thannormal	Nearly equal to standard	Slightly below the standard
	20	89	Less than normal	Slightly lower then standard	Below the standard

The results reveal that the significant metal concentrations within the two studied years just in case of chillies and potatoes varied with the stage of maturity. Metals and their compounds within the soil fractions vary within the degree of quality. Cultivated potatoes and chillies in pots have shown a trend of skyrocketing metal particle uptake because the concentration of metal particle will increase in soil.

5. Recommendations

Various technologies are getting used to rectify the contaminated soil and H_2O. General and traditional approaches for the remedy embody isolation, immobilization, toxicity reduction, physical separation, extraction etc. Heavy metals might sure or accumulated by specific plants that can increase or decrease the quality and stop the natural process of significant metals into H_2O. Growing plants/weeds will facilitate to cut back heavymetal pollution. Natural processes are usually slow to revive ecosystems while not the intervention of masses and should take centuries or longer. Phyto-remediation is an advantageous technique over the normal unmoved and ex-situ processes; as it isprice effective, additional over the plants is simply monitored to make sure correct growth; and the valuable metals is saved and reused through phyto-remediation. Awareness and adopting appropriate technologies will have a check on poisoning of soil because of heavy metals before it becomes difficult. Observation and quality check of the topsoil ought to be done by the authentic agencies time to time.

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