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DETERMINATION OF HEAVY METAL ACCUMULATION IN *Lycopersicon esculentum* GROWN ON CONTAMINATED SITES

RENU TYAGI[*] and S. KALPANA[a]

Department of Chemistry, J. D. B. Govt. College, KOTA (Raj.) INDIA
[a]Department of Chemistry, Govt. College, KOTA (Raj.) INDIA

ABSTRACT

A monitoring study has been carried out to assess the levels of toxic heavy metals in *Lycopersicon esculentum*, a vegetable widely used belonging to family solanaceae. Since the average daily intake of tomato is around 200 g in various forms, the presence of heavy metals would be a health hazard for human consumption and thus it is a matter of great concern. Five sites with high probability of metal contamination around the Kota city were chosen for the collection of samples. The levels of heavy metals in the aerial parts of the plant and the corresponding soils have been determined spectrophoto-metrically using atomic absorption spectrophotometer. Metal transfer factors from soil to vegetable parts is found to be significant and the sequence of accumulation is in the order of leaf > stem > fruit.

Key words: Heavy metals, *Lycopersicon esculentum*, Atomic absorption spectrophotometer.

INTRODUCTION

Kota is a well known industrial and educational city of Rajasthan in India located in between 25.18^0N Latitude and 75.83^0E longitude. Due to the river Chambal, the area is agriculturally rich. Rice, wheat, soya bean are some of the common crops grown extensively. A wide variety of vegetables are also grown in this area.

The most common agricultural activities are formal and informal community gardens, kitchen gardens, institutional gardens etc.[1], despite serious environmental and public health effect. Due to extensive industrialization and anthropogenic activities, the presence of organic wastes, use of sewage and drain water as a cheap source of irrigation, is increasing the contamination of the agricultural soils.

As a result of this, heavy metal pollution of soil, water and air is a growing environmental problem affecting food, food quality and human health. In case of uptake by

[*]Author for correspondence; E-mail: tyagirenu18@gmail.com

plants the heavy metals may enter the food chain through the edible parts of the plants. Thus the determination of heavy metals in such a sample is very important[6]. The concentration of heavy metals in tomato edible and non edible parts is directly associated with their concentration in the soil. However the level significantly differs depending on the plant species and also on the genotypes within the same species[4]. Many other factors like climate soil pH, organic matter content, atmospheric deposition, nature of soil, degree of plant maturity may be responsible for the bio-accumulation of heavy metals[5,7]. Heavy metals like lead, copper, cadmium are cumulative poisons. Crops and vegetables grown on contaminated soils may lead to the uptake of heavy metals producing adverse effect on human health, plants and animals[12].

Since the major route for the entry of heavy metals into the animals system is the food chain thus it is a matter of great concern. Vegetables may accumulate heavy metals in their edible as well as in the non-edible parts. Some of the heavy metals like zinc, manganese, nickel, copper, and iron act as micronutrients at lower concentrations but become toxic at higher concentrations. Bioavailability of lead, cadmium, copper and zinc in the human gastrointestinal tract from edible parts of vegetables were also assessed earlier[8]. Health risk due to heavy metals, because of the contamination of soils has been widely reported[13,14].

The purpose of the present study deals with the quantification of heavy metals in the aerial parts of tomato plants and the respective soils form the cultivation sites of the suburban areas of Kota to assess the health risk of their production on such contaminated sites.

EXPERIMENTAL

Material and methods

The tomato plants were collected from the five suburban areas of Kota; each area included 4-5 cultivation sites, where it was grown widely. The plants were washed thoroughly with tap water followed by double distilled water to avoid any contamination due to pesticides, fertilizers or dust. Subsequently the plants were separated into its various parts i.e. edible fruits and non-edible stems and leaves. All the parts were separately sliced/ chopped and initially sun-dried followed by drying at 105^{o}C for 18 hrs[9].

Organic matter of the edible and non-edible parts of the plants was destroyed by dry ashing method. A preliminary comparison between wet and dry ashing procedures on the sample showed no difference in the results obtained. 5 g of the each dried sample were separately placed in the crucibles, few drops of conc. HNO_3 was added to the solid as an ashing aid. Dry ashing was carried out in the muffle furnace by heating gradually and increasing the temperature upto 550^{o}C leaving the ash for 4 hrs at the same temperature. The ashed samples were allowed to cool and then digested with 20 mL aqua-regia. (3 : 1 HCl : HNO_3). The solution was filtered into a 50 mL volumetric flask and made upto mark with de-ionized water. Concentrations of the heavy metals in the various parts were measured using AAS. The set up, standardization and determination procedures were done as stipulated in the AAS manual for analytical methods[10]. Calibration was done by preparing a standard solution for each element under investigation.

Soil samples collected from the corresponding sites were analyzed according to the method described[11]. The corresponding soil samples were collected from the similar sites from where the tomato plants were collected. They were sun dried, later dried at 105^{o}C for 24 hrs. It was followed by grinding and sieving using 0.5 mm mesh size. They were sieved to remove pebbles, plant roots and to have uniform sized soil particles. The Soil collected was from 0-30 cm; it was mixed well and kept in the polythene bags until analyzed. 5 g soil sample from each individual site was taken and digested with 8 mL Aqua regia on the sand bath for 2 hrs. After evaporation to near dryness the samples were dissolved with 10 mL 2% HNO_3. It was filtered through Whatman filter paper and later diluted with de-ionized water to give final volume. Analysis was done using AAS.

RESULTS AND DISCUSSION

Heavy metals are of great concern because of their toxicity even at low levels and their tendency to accumulate in the human organs[15]. Heavy metals are present both in natural and contaminated environments. Concern for the heavy metals is due to their release into the environment because of various anthropogenic activities. These metals once deposited are not biodegradable and persist in the environment for many years, poisoning the animals & the human beings causing various abnormalities[16]. The results of the concentrations of heavy metals in the soil collected from five different sites are given in Table 1. The physico-chemical properties are given in the Table 2. It has been reported that lower pH value will favor availability, mobility and redistribution of heavy metals in various soil fractions[3]. Concentrations of heavy metals in various tissues of lycopersicon esculentum are given in Tables 3-5. The results show the accumulation in the order of leaf > stem > fruits. The overall results show that the leaves are the hyper accumulator of heavy metals as compared to the fruit. The plant did not show yellowing of leaves, low biomass or any other drastic decrease in the yields. It is also observed that high biomass yield is also another factor contributing to the increased heavy metal uptake by the plants.[2]

Table 1: Results of the analysis of soils collected from five different sites for assessing heavy metal concentration (mg/Kg)

Sites	Pb	Cd	Zn	Fe	Cu
1	17.12	2.71	1.06	124.63	2.62
2	10.44	3.02	5.46	112.72	4.24
3	12.53	1.64	3.54	99.45	5.41
4	11.79	2.94	6.85	88.25	11.68
5	10.13	1.08	4.79	115.26	9.89

Table 2: Mean soil properties sampled form 0-30 cm depth

pH	Humus (%)	N (mg/Kg)	P (mg/Kg)	K (mg/Kg)
6.45	1.48	17.7	132.5	562

Table 3: Heavy metal concentration (mg/Kg) in tomato fruit

Sites	Pb	Cd	Zn	Fe	Cu
1	5.68	0.96	0.86	30.41	1.51
2	4.34	1.12	1.40	61.04	1.24
3	4.36	0.96	0.93	135.63	2.36
4	4.01	0.90	2.80	44.05	1.89
5	3.06	0.38	1.96	93.96	2.01

Table 4: Heavy metal concentration (mg/kg) in tomato leaves

Sites	Pb	Cd	Zn	Fe	Cu
1	8.67	1.13	7.15	55.42	2.19
2	7.73	1.50	6.32	49.16	4.33
3	6.24	0.98	6.98	66.01	2.80
4	5.38	1.23	5.64	39.98	6.94
5	7.98	1.56	8.13	118.01	7.09

Table 5: Heavy metal concentration (mg/Kg) in tomato stems

Sites	Pb	Cd	Zn	Fe	Cu
1	7.20	1.01	7.01	54.01	2.10
2	6.14	0.98	6.30	44.68	4.13
3	5.80	0.89	6.18	60.36	2.18
4	4.90	1.00	5.45	38.88	6.01
5	6.44	1.13	7.07	116.68	6.98

CONCLUSION

The study revealed that as *lycopersicon esculentum* is a part of daily staple diet in one or the other form, thus its continuous consumption will inevitably result to health consequences. It is not suitable for the tomato plants to be grown on contaminated sites because the accumulation is significant. Though the heavy metal accumulation is in the order i.e. leaves > stem > fruit, but the heavy metals can enter the food chain as the plant parts one eaten by animal as fodder.

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