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Comparative Study of Heavy Metals in Selected Vegetables Collected from Different Sources

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Abstract. In present study two types of vegetables, one irrigated with tap and other with sewage water, were analyzed with respect to heavy metals. The concentration of heavy metals was high in sewage, soil, and vegetables than in house source. All metals were not detected except iron (0.07 mg/l) in tap water. The accumulation of Cr in sewage ranged 0.1- 14.1 mg/kg that was maximum in Carrot and minimum in Reddish, while Cd was not detected in Carrot. The concentrations of Mn, Fe and Zn in sewage-irrigated vegetables were more than house holds samples.

Keywords: heavy metals, vegetables, sewage water

Introduction

Presence of heavy metals in ecosystem particularly their accumulation in biosystem including soil has far–reaching implications for the humans. However their impact depends upon the chemical composition of contaminated soil, its physical characteristics, cultivated vegetables, irrigation water and the consumption rate (Morton-Bermea *et al*., 2002; Govil *et al*., 2001; Cobb *et al*., 2000). Soil acts as temporary storage for heavy metals and as their source under certain conditions.

Untreated municipal sewage is generally used for irrigation of urban agricultural soil in many parts of the world, particularly in developing countries (Qadir *et al.* 1999), owing to low sewage disposal cost and reclamation of nutrients and water from it (Wang, 1984).

Use of polluted water for irrigation is a matter of major concern due to the presence of toxic metals and other pollutants in it, which contaminate the soil and plants growing in the effluent receiving areas (Singh *et al*., 2004; Oudeh *et al*., 2002; Armienta *et al*., 2001; Samantaray *et al*., 2001).

Present study was carried out to compare the concentration of heavy metals in selected vegetables namely radish, turnip, carrot, and beetroot growing in home gardens and sewage-water-irrigated areas of Lahore city.

Materials and Methods

Samples of selected vegetables (radish, turnip, carrot, and beetroot) were collected from two different sites; home gardens of Lahore and site of Rohinallha in Lahore, using random sampling technique with the hand sorting method. Vinyl gloves were used for picking the vegetables and samples were carefully packed in polythene bags.

A total of three hundred samples, (including tap water, sewage water, soil at 0-30 cm depth and vegetables) were collected. Each sample of vegetable and soil weighed 1.5 kg on fresh weight basis and those of tap water and sewage water measured 1.0 litre. Five replica of each vegetable along with the soil samples were taken and sampling was performed four times during the study period. Water samples were also taken on the same pattern.

Vegetables were washed thrice with distilled water, finally with deionized water and dried in oven at 65-70 °C; samples were then ground using a ceramic-coated grinder.

Soil samples were air dried at room temperature, powdered and sieved through 2 mm mesh to remove large stones, sand, pebbles etc. For metal analysis soil samples were dried at 105 °C for 2 h and ground to pass through 60 mesh sieve and homogenized.

The representative samples of tap and sewage water were collected in plastic containers previously rinsed with distilled water, and stored at 4 °C in icebox.

Digestion of samples. For metal estimation, nitric-perchloric acid digestion was performed, following the procedure recommended by AOAC (1990). Soil sample (1 g), was taken in 250 ml digestion flask and 10 ml of con. HNO_3 was added. The mixture was boiled gently for 30-45 min and then cooled. After cooling, 5 ml of 70% perchloric acid was added and the mixture was boiled gently until dense white fumes appeared.

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After cooling, 20 ml of distilled water was added and the mixture was boiled further to remove any remaining fumes. The solution was again cooled, filtered through Whatman No.42 filter paper and < 0.45 um millipore filter paper and transferred to 25 ml volumetric flask by adding double distilled water.

Concentrated nitric acid (4 ml) and 2 ml of conc. hydrogen peroxide were added twice to the vegetables samples (1.0 g). The mixture was heated until a clear solution was obtained. It was made up to 5 ml with 1M HNO_3. (Tokalioglu and Kartal, 2006).

Concentrations of metals (Zn, Cd, Mn, Fe, Cr) in the solution were determined using atomic absorption spectrometer (AAS, Varian-240, Australia).

All reagents were of analytical reagent grade (Merck, Germany). Deionized and double distilled water was used for preparing solutions and dilutions. Standard solutions, prepared for the study of elements, were stored in polyethylene containers.

Results and Discussion

Heavy metals were not detected in tap water except iron (0.7 mg/litre), while in sewage water all the metals were present within the permissible limits of National Environmental Quality Standards (NEQS) except Cr and Cd whose amount ranged between 0.9-1.3 and 0.012-1.06 mg/litre, respectively (Table 1).

Table 1. Elemental analysis of tap and sewage water in (mg/litre)

Metals	Tap water	WHO standard	Sewage water	NEQS standard
Cr	N.D	0.05	0.9-1.3	1.0
Mn	N.D	0.1	0.3-1.0	1.5
Fe	0.7	0.3	1.1-5.3	8.0
Zn	N.D	3.0	0.3-4.07	5.0
Cd	ND	0.003	0.012-1.06	0.1

Total concentrations of heavy metals Cr, Mn, Fe, Zn and Cd in the home garden soil, irrigated with tap water and Rohinullah soil irrigated with sewage water are represented in Table 2. Two important heavy metals Cd and Cr were not detected in home garden soil. The range of concentration of zinc, manganese and iron in home garden soil was 0.07-0.9 mg/kg (x = 0.242 mg/kg), 0.01-0.03 mg/kg (x = 0.01 mg/kg) and 2.54-4.0 mg/kg (x = 1.635 mg/kg), respectively. In Rohinullah soil, the range of the concentration of heavy metals Cr, Mn, Fe, Zn and Cd was 2.59-17.5 mg/kg soil (x = 5.022 mg/kg), 35-106 mg/kg soil (x = 35.25 mg/kg), 230-455 mg/kg (x = 171.25 mg/kg), 54-135 mg/kg (x = 47.25 mg/kg), and 0.02-1.09 mg/kg (x = 0.28 mg/kg), respectively. The concentration of heavy metals in Rohinullah site soil samples was elevated due to the use of sewage water for irrigating the vegetation which affected the heavy metal distribution in soil (Rattan *et al*., 2005).

Table 2. Elemental analysis of home garden and Rohinullah soil samples

Metals	Metals (mg/kg)			
	Home garden soil		Rohinullah soil (mg/kg)	
	Range	x	Range	x
Cr	N.D	N.D	2.59-17.5	5.022
Mn	0.01-0.03	0.01	35-106	35.25
Fe	2.54-4.0	1.635	230-455	171.25
Zn	0.07-0.9	0.242	54-135	47.25
Cd	N.D	N.D	0.02-1.09	0.28

Comparative study of the presence of heavy metals in vegetables collected from different sites (Table 3) indicates that the concentration of heavy metals in Rohinullah samples was high as compared to home garden samples (irrigated LDA supply). Cr was not detected in all home garden samples, while in Rohinullah samples, level of Cr in beet root was 1.3-12.7 mg/kg, in carrot 1.1-14.1 mg/kg, in radish 0.1-0.9 mg/kg and in turnip1.1-11 mg/kg; the concentration of Cr varied between vegetables according to their own absorption capacity.

Mn contents in vegetables growing at different Rohinullah sites were higher than those of home garden. Maximum quantity was in beetroot (12-95 mg/kg), while in the soil samples of these sites, average value of Mn was 35.25 mg/kg.

Maximum accumulation of Fe was found in Rohinullah vegetable samples, the order being 105-210 mg/kg in beetroot > 71-110 mg/kg in turnip > 55-97 mg/kg in radish > 25-40 mg/kg in carrot; the sequence in tap water–irrigated vegetable samples was different.

Zn is essential element, required in small quantity for the growth and development of the plant, however, excessive concentration could be toxic (UNEP/FAO/WHO, 1988). Concentration of Zn ranged between 9-110 mg/kg in all the Rohinullah vegetable samples, while in home garden vegetable samples, amount of Zn was much less, the range being 0.2-11 mg/kg.

Contribution of a crop to dietary intake of Cd in human body depends on the quantity of crop consumed as food and on Cd concentration in the consumed foods. In sewage water–irrigated samples, the concentration of Cd and Cr was higher than the tap water-irrigated samples.

Table 3. Concentration of heavy metals in different vegetables from different sources

Metals	Beet Root (mg/kg)		Carrot (mg/kg)		Reddish (mg/kg)		Turnip (mg/kg)	
	Sewage	Tape	Sewage	Tape	Sewage	Tape	Sewage	Tape
Cr	1.3-12.7	N.D	1.1-14.1	N.D	0.1-0.9	N.D	1.1-11	N.D
Mn	12-95	5-7.1	15-48	3-4.5	7-78	4-53	10-78	5-11
Fe	105-210	11-75	25-40	6-18	55-97	27-81	71-110	17-21
Zn	15-110	0.2-1.5	9-60	2-11	9-55	7-11	21-49	1-7
Cd	0.01-1.01	N.D	N.D	N.D	0.1-0.09	N.D	0.01-0.12	N.D.

Concentration of different heavy metals was different in vegetables but Cd and Cr was maximum in sewage water irrigated vegetables as compared to home garden ones because these were easier to absorb and accumulate as compared to other metals (Run Sheng *et al.* 2007). This seems to imply that different types of vegetables have different abilities to accumulate the metals. In spite of the mechanism involved in the elemental uptake by roots, plant are known to respond to the amount of readily mobile type of metals in soil (Madrid *et al*., 2002).

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