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HEAVY METALS IN VEGETABLES GROWN IN KORANGI AREA, KARACHI, PAKISTAN

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Abstract

Karachi is the most congested city of Pakistan where a big part of vegetables is irrigated by waste water of two main rivers *i.e.* Malir and Lyari Rivers. This study was conducted to see the presence of heavy metals in samples of vegetables cultivated by waste water of Malir River. This contained mainly sewerage water and very small portion of industrial effluent.

The levels of the six different heavy metals *i.e.* cadmium (Cd), lead (Pb), cobalt (Co), iron (Fe), manganese (Mn), zinc (Zn) were determined in various vegetables. Turnip (*Brassica Rapa*) and its leaves, radish (*Raphanus sativus*) and its leaves, fenugreek leaves (*Trigonelle sp.*) and anethumsowa (*Abelmoschus moschatus*) and spinach (*Spinacia oleracea*) were collected from Sharafi Goth in Korangi during winter season and brought to the Federal Urdu University of Arts Science & Technology Gulshan-e-Iqbal Campus for analysis.

Atomic absorption spectrophotometer was used to determine the concentration of heavy metals in each vegetable. The amount of Cd, Mn, Fe, Zn in the vegetables samples were below the permissible values as per EU standards. In case of lead and cobalt, some of the vegetable contained more than permitted values. Turnip (*Brassica Rapa*) leaves had maximum concentration of lead i.e. 8.45ppm which was 28 times higher the allowed limit.

It is concluded that since excessive accumulation of heavy metals in vegetables effect the food quality. Therefore, it is highly recommended that efforts should be made to control the irrigation of vegetables using contaminated Malir river water.

Introduction

Food safety is a major public concern worldwide. During the last decades, the increasing demand for food safety has gained momentum. High level of heavy metals in the environment has created apprehension and fear in the public due to the presence of heavy metal residues in their daily food. The public is confused and alarmed about their food safety. The vegetables which contain heavy metals are a health hazard. This has stimulated the risk associated with the consumption of vegetables contaminated by heavy metals or toxins (D' Mello, 2003). Vegetable constitute essential components of the diet by contributing protein, vitamins, iron, calcium and other nutrients which are usually in short supply (Thompson and Kelly, 1990). Vegetables also act as buffering agents for acidic substance obtained during the digestion process. Human beings are encouraged to consume more vegetable and fruits, which are a good source of vitamins, minerals and fiber. However, these vegetables contain both essential and toxic metals over a wide range of concentrations.

Contamination of vegetable with heavy metal is due to irrigation with contaminated waste water, the addition of fertilizers and metal based pesticides, stack emissions from industries, transportation, the harvesting process and storage. Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on parts of the vegetables exposed to the air from polluted environments (Zurera-Cosano *et al*., 1989; Khariah *et al*., 2004; Chojnacka *et al*., 2005).

Keeping in mind the potential toxicity and persistent nature of heavy metals and the frequent consumption of vegetable and fruits, it is necessary to analyze these food items to ensure that the level of contamination meets agreed standards requirements (Radwan and Salama 2006.)

According to Bahemuka and Mubofu (1999) metals such as lead chromium, cadmium and copper are cumulative poisons. Lead is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield. The introduction of Pb into the food chain affects human health, and thus, studies concerning Pb accumulation in vegetables have increasing importance (Coutate, 1992). Lead and cadmium are among the most abundant heavy metals and are toxic (Radwan and Salama 2006). Excessive content of these metals in food is associated with a number of diseases, especially of the cardiovascular, renal, nervous and skeletal diseases (Steenland and Boffetta 2000; Jarup 2003). These heavy metals are also implicated in carcinogenesis (Radwan and Salama 2006). Fraction of zinc is essential for biochemical and physiological function and necessary for maintaining health throughout life (Linder and Azam, 1996), however its increased amount is harmful.

Since the dietary intake of food may constitute a major source of long-term low-level body accumulation of heavy metals, the detrimental impact becomes apparent only after several years of exposure. Regular monitoring of these metals from effluents, sewage, in vegetables and in other food materials is essential for preventing excessive buildup of the metals in the food chain (Bahemuka and Mubofu, 1999).

Therefore, the aim of this study was to determine the concentration of heavy metals in selected vegetable grown in the Korangi main farmlands using mainly mixture of sewerage and little industrial waste water.

Materials and Methods

Vegetables were collected from the main farmland of Sharafi Goth beneath the main bridge connecting Shah Faisal and Korangi industrial area. The samples were collected in the month of December. These were turnip (*Brassica Rapa*) with leaves, radish (*Raphanus sativus*) with leaves, fenugreek leaves (*Trigonelle* ***sp.*****)** and anethumsowa (*Abelmoschus esculentus*) and spinach (*Spinacia oleracea*) were plugged from the ground and brought to the Federal Urdu University of Arts Science & Technology Gulshan-e-Iqbal Campus for analysis. The fresh vegetables were washed and air dried. The leaves of turnip (*Brassica Rapa*) and radish (*Raphanus sativus*) were separated. Immediately, fresh weights were recorded. The plants were then carefully placed in small bags made from recycled papers. Air dry weights were noted after passage of almost a month. The difference between the fresh and dry weight is equal to weight of moisture in the plant. The plants were then crushed into fine particles by means of grinder. Approximately 5 grams of each sample was selected and put in crucible for further investigation. The samples were heated in oven, up to temperature 500 centigrade and maintained for an hour. Organic matter burned leaving behind ash and minerals in the sample.

The residue obtained after heating was dissolved in 30 to 50 ml distilled water in a conical flask. Aqua regia solutions were made. HNO_3 (2.5ml) and HCl (7.5ml) were mixed in the ratio of 1:3 in a conical flask having distilled water and the solution was heated up to 110 centigrade. It was then kept for 24 hours. Digested samples were filtered by cellulose nitrate membrane filter paper and the volume was increased to 100ml with distilled water. These solutions were stored in bottles and the samples were analyzed by atomic absorption spectrophotometer (PG990).

Dilution factor = aqua regia volume/weight of sample*make up volume solution. It is the factor which is multiplied with the concentration recorded using atomic absorption spectrophotometer. The result is ppm (mg/kg) concentration of the mineral under consideration.

Results and Discussion

Table 1 shows fresh and dry weights, moisture and organic contents and heavy metals concentration in the vegetables. The farmers at Sharafi Goth use industrial and sewerage waste water from Malir River. Farmers assume that better growth of vegetables is obtained using this waste water, while our results do not agree showing highly lethal and toxic nature of the Malir river water. The waste water used in our previous tests was directly collected from waste water treatment plant at Korangi, where waste water contained toxic chemicals. These farmers also using tube well water mixed with Malir river water. Therefore it seems that harmful chemicals and toxic element which were in concentrated form in our previous water samples were highly diluted and harmless in waste water used for cultivation in this area. In addition presence of minerals contents in waste water promoted healthy growth of vegetables. These were turnip (*Brassica rapa*) with leaves, radish (R*aphanus sativus*) with leaves, fenugreek leaves (*Trigonelle sp.*), annethumsowa (*Abelmoschus esculentus*) and spinach (*Spinacia oleracea* L.).

Leaves of turnip (*Brassica rapa*), turnip and radish (*Raphanus sativus*) leaves contained maximum moisture content and it was more than 50%. Spinach (*Spinacia oleracea*) contained the maximum content of heavy metals equal to 40% approximately. Radish (*Raphanus sativus*) contained the maximum amount of organic contents (87%).

The Table 1 shows concentration of heavy metal in selected vegetables. These included turnip (*Brassica rapa*) and its leaves, radish (*Raphanus sativus*) and its leaves, fenugreek leaves (*Trigonelle sp.*), anethumsowa (*Abelmoschus esculentus*) and spinach (*Spinacia oleracea*). Samples did not contain cadmium at all and all the results were below detection limit. The range of cobalt was 5.51ppm to 9.6ppm. Fenugreek leaves (T*trigonelle sp.*) contained the maximum amount of cobalt (9.6ppm) and turnip (*Brassica rapa*) had the minimum concentration (5.51ppm).

The range of manganese was 1.55ppm in anethumsowa (*Abelmoschus esculentus*) to 62.11ppm.in radish (*Raphanus sativus*) leaves. These values were within the allowed limits.

Table 1. Moisture, organic contents and concentration of heavy metals in vegetables.

Names	Fresh weight grams	Dry weight grams	Moisture contents grams	Sample weight grams	Organic contents grams	Cobalt ppm	Cadmium ppm	Iron ppm	Manganese ppm	Zinc ppm	Lead ppm
Turnip leaves	198.2	90.5	107.7	5.1	3.67	6.6	bdl	210.38	28.36	1.51	8.45
Anethumsowa	39.6	31.48	8.12	4.98	3.89	5.69	bdl	21.43	1.55	1.81	3.07
Turnip	34.02	15.6	18.42	5.02	3.93	5.51	bdl	161.01	16.19	1.81	4.46
Fenugreek leaves	39.9	32.75	7.15	5.03	3.96	9.6	bdl	bdl	6.97	1.51	2.94
Radish leaves	145.9	62.1	83.8	4.7	3.37	7.24	bdl	4.39	62.11	2.35	3.31
Spinach	45.0	25.45	19.55	4.96	2.98	6.68	bdl	69.66	8.24	2.47	4.43
Radish	83.43	57.42	26.02	5.03	4.37	6.15	bdl	4.2	44.55	2.08	4.79

Cd=0.2ppm, Co=0.5ppm, Fe=1000ppm, Mn=1000ppm, Pb=0.3ppm, Zn=50ppm
bdl=below detection limit

The least value of iron was 4.39ppm in radish (*Raphanus sativus*) leaves whereas maximum concentration 210.38ppm was recorded in turnip (*Brassica rapa*) leaves. Iron content was not detected in fenugreek (*Trigonelle sp.*) leaves. All the values were below the permissible level

Lead was detected in all the samples. Turnips (*Brassica rapa*) leaves had highest value equal to 8.45ppm.The least content 2.94ppm was recorded in fenugreek (*Trigonelle sp.*) leaves and these were well above the allowed limit. Lead concentration found in turnip *(Brassica rapa*) leaves, anethumsowa (*Abelmoschus esculentus*), spinach (*Spinacia oleracea*), radish (*Raphanus sativus*) and its leaves crossed, the permissible values. Pb accumulation can exceed several hundred times the threshold of maximum level permissible for human (Wierzbicka, 1995). According to our study lead in turnips (*Brassica rapa*) was 28.2 times the allowed limit. Zinc values ranged from 1.51ppm in turnip leaves (*Brassica rapa*) to 2.47ppm in spinach (*Spinacia oleracea*). Lead and cadmium are among the most abundant heavy metals and are toxic (Radwan and Salama 2006). In our case cadmium was below the allowed limit while lead concentration exceeded the required amount.

The profile of metal content of turnip (*Brassica rapa*) leaves, annethunsowa (*Abelmoschus esculentus*) and turnip (*Brassica rapa*) were found in the order Fe > Mn > Pb > Co > Zn >Cd, Fe > Co > Pb > Zn > Mn >Cd and Fe > Mn > Co > Pb > Zn >Cd, respectively. The profile of metal contents in fenugreek leaves (*Trigonelle sp.*), radish (*Raphanus sativus*) leaves and spinach (*Spinacia oleracea L.*) was in the order of Co > Mn > Pb > Zn > Cd = Fe, Mn > Co > Fe > Pb > Zn > Cd, Fe > Mn > Co > Pb > Zn > Cd, respectively. The metal profile for radish (*Raphanus sativus*) was Mn > Co > Pb > Fe > Zn > Cd. The permissible values for cadmium, lead, cobalt zinc, manganese, iron are 0.2ppm, 0.3ppm, 0.48ppm, 50ppm, 1000ppm, and 1000ppm respectively as per EU standards. (Muchuweti *et al.*, 2006; EC 2001). The mean concentration for cobalt for plants is 0.48ppm (Bowen, 1966).

Therefore it is concluded that though the vegetables grown in the waste water look fresh and healthy, they are not suitable for human consumption due to the presence of heavy metals. It seems that heavy metals in highly diluted water may also accumulate in plants. Therefore it is recommended the polluted water should not be used for irrigation purposes.

Recommendations

It was observed that vegetables collected from the Sharafi Goth were affected by using waste water. The concentration of heavy metals i.e. cadmium, iron, manganese and zinc were well below the allowed limits. However cobalt and lead were found to be prominent and the values were above permissible limit. This has to be checked regularly because the vegetables are likely to affect the food chain and in the long run will have adverse impact on health of the users.

Regular monitoring of these metals in effluents, sewage, vegetables and in other food materials is essential for preventing excessive buildup of the metals in the food chain Therefore it is concluded that though the vegetables grown in the waste water look fresh and healthy, they are not suitable for human consumption due to the presence of heavy metals.

The use of wastewater for plantation is possible but with some limitations. Wastewater can be used for those plants which are not consumed by either human being or animal. Therefore before making any suggestions regarding polluted water to be used for irrigation, further research is required regarding both the rivers of Karachi.

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