Concentration of Metals in the Green Leafy Vegetables Grown in Peshawar, Swat and Kohat Region (NWFP)

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Summary: The metals investigated were Fe, Zn, Cu, Mn, Cr, Cd, Pb. The level of Fe was found to be highest. The maximum concentration of Fe, Zn, Cu, Mn, Cr, Cd, Pb were found to be 20.51 (*Malva parviflora*), 03.56 (*Lepidium chalepense*), 00.88 (*Brassica campestris rapa*), 6.15 (*Lepidium chalepense*), 00.58 (*Malva parviflora*), 00.03 (*Malva parviflora and Brassica campestris rapa*), 00.08 (*Lepidium chalepense, Brassica campestris rapa* and *Malva parviflora* respectively) while lower concentration were 10.20 (*Trigonella foenum*-graecum), 01.30 (*Brassica campestris rapa*), 00.20 (*Brassica campestris rapa*), 01.00 (*Trigonella foenum*-graecum), 00.05 (*Trigonella foenum* graecum), 00.00 (*Trigonella foenum*-graecum and *Malva parviflora*), 0.00 (*Lepidium chalepense* and *Malva parviflora* respectively) respectively. The overall contents of these metals investigated were found to be within permissible limits. The result of this study showed that the accumulation of metals in these vegetables is of nutritional interest.

Introduction

Contamination of the environment by heavy metals is of major concern because of their toxicity. The metals found in cultivated soils are of natural or anthropogenic origin. Examples of potential sources of anthropogenic soil pollution with heavy metals are industrial and traffic dust emitted into the atmosphere, residues of sewage sludge and other waste materials applied to the soil, mineral, mainly phosphorrous, fertilizers and some crop protection chemicals [1,2].

The metal accumulation was found more in leafy vegetables due to adsorption of the metal at the surface of the plants and translocation of metal from the roots of the plants. Further, more surface area may also contribute to high accumulation of metals in the plants. There are many reports where the significantly high accumulation of metals in leafy vegetables of the plants was reported [3,4].

There are various reports [5,6], where wastewater is being used for the irrigation of edible plants and is a matter of concern due to the presence of pollutants particularly, toxic metals. Thus, introducing these pollutants into the plants growing therein through roots, which are translocated to foliage and even to edible fruit parts [7,8]. The heavy metal ions like Fe, Cu, Zn, Mn *etc* at appropriate concentrations are required for structural and catalytic components of proteins and enzymes as cofactors, essential for normal growth and development of plants. However, supra optimal concentrations of these plant micronutrients and other heavy metals in plants operate as stress factors [9,10].

Nowadays it has become clear that mobility, bioavailability, storage, retention and toxicity of the metals in living organisms, food and the environment depend on the chemical forms in which they enter the ecosystems and the final forms in which they are present therein [11].

In the present investigations, an attempt has been made to study the distribution pattern of metals (Fe, Zn, Cu, Mn, Cr, Cd, Pb) in four leafy vegetables *(Brassica campestris rapa, Trigonella foenum graecum, Lepidium chalepense, Malva parviflora)* grown in agricultural fields of Peshawar, Swat and Kohat.

Results and Discussion

The effects of metals on human health are given in Table-1 [12], while data of metal concentration in leafy vegetables are given in Tables-2 to 7. Tables-2 to 4 represent the data of unwashed leafy vegetables while Tables-5 to 7 represent the data of washed leafy vegetables where as, Table-8 shows the soil analysis of the selected agricultural areas to determine the pathway of metals. Daily dietary

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Table-1: The effects of metals on human health.

S. No.	Elements	Physiological significance of Element	Dietary Intake Limits	Effects
1.	Iron (Fe)	Essential component of hemoglobin	200 ppm	Low iron content in diet causes gastro intestinal infection, nose bleeding and myocardial infarction.
2.	Zinc (Zn)	It is essential for animals and human beings	100 ppm	It plays an important role in wound healing and its addition to diet accelerates the growth of delayed sexual development. Its deficiency causes loss of sense of touch and smell.
3.	Copper (Cu)	Enrichment and depletion both cause disease	75 ppm	It accumulates in liver, brain cell, in the cornea of the eyes and leads to neurological and liver disease.
4.	Manganese (Mn)	62 % of diabetic patients are at risk with higher Mn content	35 ppm	Deficiency of Manganese causes myocardial infarction.
5.	Chromium (Cr)	Essential for animals but not for plants	0.24 ppm per day	50 ppm of chromium in diet has been found to induce growth depression together with liver and kidney damage.
6.	Cadmium (Cd)	Not present at birth but increases with age	0.5 ppm	Excess of Cadmium affects arteries of human kidneys, causes cancer, incurable vomiting, nausea and diarrhea.
7.	Lead (Pb)	Lead has been known to have neurotoxic effects for a long time	3mg per week	Lead causes neurological symptoms ranging from peripheral nerve dysfunction to acute encephalopathy, memory loss and death.

Table-2: Concentration of metals (μg/ g) in unwashed leafy vegetables of Peshawar.

Botanical name of vegetable	Family	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Brassica campestris rapa	Cruciferae	20.00	01.43	00.88	03.04	00.14	00.01	00.07
Trigonella foenum graecum	Papilionaceae	11.12	01.97	00.38	01.08	00.05	00.01	00.04
Lepidium chalepense	Brassicaceae	20.22	02.50	00.27	03.71	00.21	00.02	00.08
Malva parviflora	Malvaceae	20.12	02.05	00.41	02.80	00.13	00.03	00.08

Table-3: Concentration of metals (μg/ g) in unwashed leafy vegetables of Swat.

Botanical name of vegetable	Family	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Brassica campestris rapa	Cruciferae	15.28	02.33	00.21	02.39	00.19	00.01	00.05
Trigonella foenum graecum	Papilionaceae	14.05	02.61	00.33	02.65	00.18	00.02	00.07
Lepidium chalepense	Brassicaceae	17.80	03.30	00.31	03.77	00.22	00.01	00.03
Malva parviflora	Malvaceae	20.51	02.47	00.43	03.58	00.58	00.01	00.06

Table-4: Concentration of metals (μg/ g) in unwashed leafy vegetables of Kohat.

Botanical name of vegetable	Family	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Brassica campestris rapa	Cruciferae	18.86	01.40	00.86	03.00	00.11	00.01	00.06
Trigonella foenum graecum	Papilionaceae	10.20	00.98	00.29	01.00	00.05	00.00	00.04
Lepidium chalepense	Brassicaceae	20.20	01.99	00.27	03.68	00.18	00.01	00.08
Malva parviflora	Malvaceae	19.86	02.01	00.40	02.63	00.13	00.02	00.07

Table-5: Concentration of metals (μg/ g) in washed leafy vegetables of Peshawar.

Botanical name of vegetable	Family	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Brassica campestris rapa	Cruciferae	19.00	01.30	00.78	02.04	00.12	00.03	00.08
Trigonella foenum graecum	Papilionaceae	19.89	01.92	00.49	05.46	00.20	00.01	00.03
Lepidium chalepense	Brassicaceae	20.22	03.56	00.40	06.15	00.15	00.02	00.00
Malva parviflora	Malvaceae	20.24	02.58	00.58	03.28	00.17	00.01	00.00

Table-6: Concentration of metals (μg/ g) in washed leafy vegetables of Swat.

Botanical name of vegetable	Family	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Brassica campestris rapa	Cruciferae	15.18	02.25	00.20	02.39	00.17	00.01	00.03
Trigonella foenum graecum	Papilionaceae	14.00	02.61	00.29	02.65	00.16	00.02	00.07
Lepidium chalepense	Brassicaceae	17.60	02.89	00.29	03.53	00.18	00.01	00.03
Malva parviflora	Malvaceae	18.85	02.24	00.42	03.44	00.48	00.00	00.02

Table-7: Concentration of metals (μg/ g) in washed leafy vegetables of Kohat.

Botanical name of vegetable	Family	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Brassica campestris rapa	Cruci-ferae	18.86	01.25	00.69	02.00	00.12	00.03	00.08
Trigonella foenum graecum	Papilion-aceae	19.33	01.86	00.49	05.32	00.18	00.00	00.03
Lepidium chalepense	Brassica-ceae	20.18	03.52	00.38	06.01	00.13	00.01	00.00
Malva parviflora	Malva-ceae	19.66	02.49	00.44	03.28	00.15	00.01	00.00

Table-8: Concentration of metals (μg/ g) in soil samples of the selected agricultural areas of NWFP.

Area	Fe	Zn	Cu	Mn	Cr	Cd	Pb
Peshawar	197.00	5.36	0.80	28.76	2.26	2.30	0.69
Swat	205.00	6.31	0.76	20.75	1.98	3.10	0.66
Kohat	218.00	5.18	0.89	19.63	2.18	2.25	0.50

Data collected from Agriculture University Peshawar.

Table-9: RDA and estimated safe daily intake of metals (National Research Council, USA).

S. No.	Elements	Maximum concentration of elements in the analyzed leafy vegetables in μg/ g	Recommended Dietary Allowances (RDA)	Estimated safe adequate daily dietary intake
1.	Fe	20.51	15 mg for female	Nil
			10-12 mg for male	Nil
2.	Zn	03.56	12-15 mg for female	Nil
			15 mg for male	Nil
3.	Cu	00.88	Nil	0.9mg
4.	Mn	06.15	Nil	11mg
5.	Cr	00.58	Nil	25-35 μg

RDA = recommended dietary allowance.

allowance for the selected metals, recommended by National Research Council, USA is presented in Table-9.

Results showed that the maximum concentration of Fe was 20.51 μg/ g in *Malva parviflora* (unwashed leafy vegetables), while lower concentration was 10.20 μg/ g in *Trigonella foenum graecum* (washed leafy vegetables).

Zn was found to be 03.56 μg/ g in *Lepidium chalepense* (unwashed leafy vegetables), while lower concentration was 01.30 μg/ g in *Brassica campestris* Rapa (unwashed leafy vegetables), while Cu was 00.88 μg/ g in *Brassica campestris rapa* (unwashed leafy vegetables) and lower concentration was 00.20 μg/ g in *Brassica campestris rapa* (washed leafy vegetables). Mn showed the higher concentration of 06.15 μg/ g in *Lepidium chalepense* (unwashed leafy vegetables), while lower concentration of 01.00 μg/ g in *Trigonella foenum-graecum* (washed leafy vegetables). Cr was 00.58 μg/ g and 00.05 μg/ g in *Malva parviflora* (unwashed leafy vegetables) and *Trigonella foenum graecum* (washed and unwashed leafy vegetables) respectively, while Cd was 00.03 μg/ g in *Malva parviflora* and *Brassica campestris* Rapa (Both washed and unwashed leafy vegetables), while lower concentration was 00.00 μg/ g in *Trigonella foenum graecum* and *Malva parviflora* (washed leafy vegetables).

Pb was found to be 00.08 μg/ g in *Lepidium chalepense, Brassica campestris rapa* and *Malva parviflora* respectively (Both washed and unwashed leafy vegetables), while lower concentration was 00.00 μg/g in *Lepidium chalepense* and *Malva parviflora* (both washed and unwashed leafy vegetables).

Tables-5 to 7 with washed leafy vegetables showed a little difference with unwashed leafy vegetables and also the concentration of metals (μg/ g) in soil samples of the selected agricultural areas of NWFP (Table-8) shows that the pathway for metal concentration is not mainly atmosphere but due to accumulation from soil.

Trace elements are present in human body in very low amounts, some elements are essential trace elements and some are not essential but have well defined evidence in human metabolism. Fe and Zn are the essential trace elements for human metabolism and have recommended dietary allowance (RDA). Where as for Cu, Mn and Cr there is evidence for being essential for human metabolism but RDA has not yet been established; only the estimated safe dietary daily intake limits have been established [13]. The recommended dietary allowance and safe daily dietary intake with our analyzed values of trace elements are given in Table-9.

Experimental

Leafy vegetables were collected from the agricultural areas of Peshawar, Kohat and Swat by hand. Some plants were washed with distilled water while others carefully packed into polythene bags without being washed and brought to the laboratory for the further analysis. Each sample was dried at

60 °C in an oven, crushed, mixed thoroughly for the processing of metal analysis and was converted into a finely powdered form. Dry ashing of the plant material was done by placing 1 gram sample in a pre-weighed porcelein crucible and was ignited for 24 hours at a temperature not exceeding 500 °C in a muffle furnace. The ashed sample was transferred to a beaker containing 10ml of 20 % extra pure grade HCl and was digested in a water bath for 20 minutes. The resulting solution was filtered through an ultra filter membrane having 0.8-micrometer pore diameter [14]. The filterate was diluted to 100ml by the addition of sufficient amount of distilled water and was run for the quantitative determination of Fe, Zn, Cu, Mn, Cr, Cd and Pb metals, using Perkin Elmer AAS, under the standard conditions of measurement [15].

Conclusions

Among the metals (in washed and unwashed leafy vegetables) investigated, iron showed the highest concentration. The overall zinc concentration remained within 4 $\mu g/$ g. The concentrations of copper, chromium, cadmium and lead were quite lower in vegetables, whereas manganese showed slightly higher concentration, but was found within permissible limits [16-18]. The data obtained from leafy vegetables as well as from soil of three different agricultural areas showed that the pathway for metal concentration is mainly from soil rather than dry deposition from atmosphere.

The study concludes that in the leafy vegetables investigated, the metal concentrations were found within acceptable limits and are safe for human consumption.

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