

Heavy metal accumulation in vegetables irrigated with surface and ground water in Srinagar, Jammu & Kashmir

Shamsul Haq, Shoukat Ara, Asma Absar Bhatti*

**Division of Environmental Sciences, SKUAST-Kashmir, Jammu and Kashmir, India-190025*

ABSTRACT

*The present study was carried out to assess levels of different heavy metals like iron, manganese, copper and zinc in three vegetable crops viz, tomato (*Solanum lycopersicum* L. variety: Local), radish (*Raphanus sativus* L. variety: Japanese long) and kale (*Brassica oleracea* var. *acephala* L. variety: Khanyari) irrigated with surface and ground water in commercially grown vegetable belt of Srinagar, Jammu and Kashmir. Accumulation of all the four metal ions were higher in ground water irrigated crops compared to surface water irrigated ones. The concentration of Fe was highest followed by Mn, Zn and Cu in both surface and ground water irrigated vegetables. The accumulation of Fe ($150.7 \pm 4.0 \text{ mg kg}^{-1}$) was highest in kale irrigated with ground water, whereas that of Mn ($85.01 \pm 5.19 \text{ mg kg}^{-1}$), Zn ($35.82 \pm 2.04 \text{ mg kg}^{-1}$) and Cu ($18.84 \pm 1.08 \text{ mg kg}^{-1}$) was higher in ground water irrigated tomato. The concentration of metals in vegetable crops irrigated with both the surface and ground water were found well below the permissible limits of Indian standards. However, the regular monitoring of levels of these metals from irrigation water, in vegetables and in other food materials is essential to prevent excessive build-up of these metals in the food chain.*

Keywords: Heavy metals, Ground water, Vegetable crops, Copper, Iron, Tomato

I INTRODUCTION

Heavy metal contamination of ground, stream and river water ecosystem is a worldwide environmental problem [1] and between the wide diversity of contaminants affecting water resources, heavy metals receive particular concern considering their strong toxicity even at low concentrations. Heavy metals are persistent environmental contaminants, and are at least five times denser than water. As such, they cannot be metabolized by the body and are stable and bio-accumulative [2]. Heavy metals are very harmful because of their non-biodegradable nature, long biological half-lives and their potential to accumulate in different body parts. Most of the heavy metals are extremely toxic because of their solubility in water. Even low concentrations of heavy metals have damaging effects to man and animals because there is no good mechanism for their elimination from the body. Nowadays heavy metals are ubiquitous because of their excessive use in industrial applications. Wastewater contains substantial amounts of toxic heavy metals, which create problems [3], [4]. Excessive accumulation of heavy metals in agricultural soils through various sources of irrigation, may not only result in soil contamination, but also affect food quality and safety [5].

Food and water are the main sources of our essential metals; these are also the media through which we are exposed to various toxic metals. Heavy metals are easily accumulated in the edible parts of leafy vegetables, as compared to grain or fruit crops [6]. Vegetables take up heavy metals and accumulate them in their edible and inedible parts in quantities high enough to cause clinical problems both to animals and human beings consuming these metal-rich plants [7]. A number of serious health problems can develop as a result of excessive uptake of dietary heavy metals. Furthermore, the consumption of heavy metal contaminated food can seriously deplete some essential nutrients in the body causing a decrease in immunological defenses, intrauterine growth retardation, impaired psycho-social behavior, disabilities associated with malnutrition and a high prevalence of upper gastrointestinal cancer.

The present study was conducted with an aim to compare the heavy metals (iron, manganese, zinc and copper,) accumulation potential of some of the commonly grown vegetables in Srinagar, Jammu and Kashmir, India. The effect of irrigation with surface and ground water is also studied in these crops to observe the concentration of accumulated metals to which human beings are exposed.

II MATERIAL METHODS

Fifteen samples of each commonly grown vegetables, i.e., tomato (*Solanum lycopersicum* L. variety: Local), radish (*Raphanus sativus* L. variety: Japanese long) and kale (*Brassica oleracea* var. *acephala* L. variety: Khanyari) were collected from Noorbagh area of district Srinagar, Jammu and Kashmir irrigated with surface and ground water. For metal analysis, only the edible parts of vegetable samples were used. All the collected samples of various vegetables were washed with double distilled water to remove airborne pollutants. The edible parts of the vegetable samples were weighed and air-dried for a day, to reduce water content. All the samples were then oven-dried in a hot air oven at 70–80 °C for 24 h, to remove all moisture. Dried samples were powdered using a pestle and mortar and sieved through muslin cloth.

For each vegetable sample (0.5 g each) were accurately weighed and placed in crucibles. The ash was digested with perchloric acid and nitric acid (1:4) solution. The samples were left to cool and contents were filtered through Whatman filter paper No. 42 [8]. Each sample solution was made up to a final volume of 25 ml with distilled water and analyzed by atomic absorption spectrophotometer.

III RESULT AND DISCUSSION

Uptake of heavy metals was higher in the vegetables grown in groundwater irrigated soils as compared to surface water irrigated ones which could be due to higher concentration of these metals present in ground water irrigated soils. Heavy metal concentration of all the three vegetable crops grown on surface and ground water irrigated soils followed the increasing trend of $Fe > Mn > Zn > Cu$ (Table 1). The concentration of heavy metals grown in ground water irrigated soils was found higher than the vegetable grown on surface water irrigated soils. In surface water irrigated tomato the mean concentration of Fe, Mn, Zn and Cu was 60.32 ± 1.81 , 58.33 ± 3.56 , 24.58 ± 1.40 and 12.93 ± 0.74 mg kg⁻¹ and in ground water irrigated tomato the concentration of these

metals was 73.02 ± 2.19 , 70.61 ± 4.31 , 29.75 ± 1.70 and 15.65 ± 0.90 mg kg^{-1} respectively. Among vegetable crops the concentration of these metals was higher in radish than in tomato and kale except Fe which was found maximum in kale. The concentration of Fe (150.7 ± 4.0) in kale irrigated with ground water was maximum and Cu (16.44 ± 0.94) the minimum. In ground water irrigated radish the concentration of Fe, Mn, Zn and Cu was found as 89.27 ± 2.68 , 85.01 ± 5.19 , 35.82 ± 2.04 and 18.84 ± 1.08 mg kg^{-1} and 75.44 ± 2.26 , 71.84 ± 4.39 , 30.27 ± 1.72 and 15.92 ± 0.91 mg kg^{-1} in surface water irrigated radish respectively. Furthermore the concentration of these micronutrients were found well below the safe limits of Indian standards and hence are fit for consumption purposes [9], [10]. Elevated levels of heavy metals in soil have been shown to increase the metal uptake tendency in the plants [11]. Heavy metal accumulation in some vegetables irrigated with surface and ground water [12]. The metal accumulation in crop tissues is generally a function of metal concentration in soil and soil texture but the level of absorption differ according to crop species and tissue. Plants are one of the principal sinks of accumulated heavy metals. Zinc is the most bioavailable metal in polluted soils and absorption of Copper by plant roots is among lowest for essential elements. The variations in the concentrations of the heavy metals in vegetables may be ascribed to the heavy metals concentrations in soil, air and water used for irrigation. The uptake of metals is higher in root crops followed by fruit and leaf crops [9]. Moreover, Heavy metal uptake by plant depends upon soil pH, plant species, cultivars, form of metal in water and application rate [13].

Table 1: Accumulation of heavy metals in three vegetable crops irrigated with surface and ground water

Plan ts	Values (mg kg^{-1})	Surface water				Ground water			
		Fe	Mn	Zn	Cu	Fe	Mn	Zn	Cu
Tomato	Mean $\pm$ S. E	60.32 ± 1.81	58.33 ± 3.56	24.58 ± 1.40	12.93 ± 0.74	73.02 ± 2.19	70.61 ± 4.31	29.75 ± 1.70	15.65 ± 0.90
	Range	46.69-68.58	38.25-77.14	17.35-36.82	8.88-18.32	56.52-83.02	46.30-93.38	21.00-44.57	10.75-22.17
Radish	Mean $\pm$ S. E	75.44 ± 2.26	71.84 ± 4.39	30.27 ± 1.72	15.92 ± 0.91	89.27 ± 2.68	85.01 ± 5.19	35.82 ± 2.04	18.84 ± 1.08
	Range	58.39-85.76	47.10-95.00	21.36-45.35	10.94-22.56	69.10-101.48	55.74-112.42	25.28-53.66	12.95-26.69
Kale	Mean $\pm$ S. E	134.8 ± 3.6	66.38 ± 4.05	27.97 ± 1.59	14.71 ± 0.85	150.7 ± 4.0	74.18 ± 4.53	31.26 ± 1.78	16.44 ± 0.94
	Range	110.9-159.0	43.52-87.78	19.74-41.90	10.11-20.84	124.0-177.6	48.64-98.09	22.06-46.82	11.30-23.29

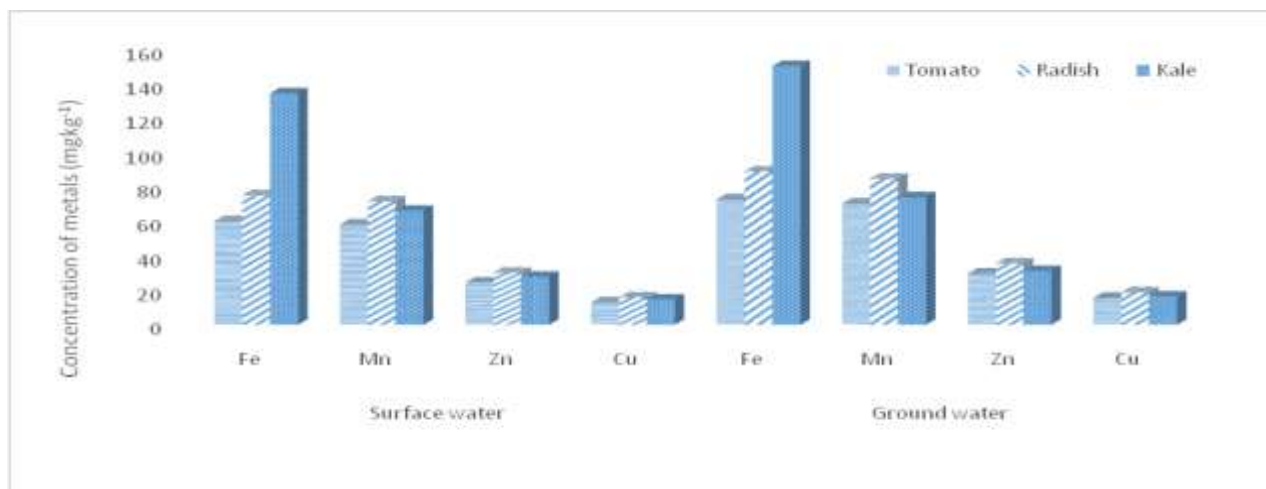


Figure: Comparison of metal uptake in vegetable crops irrigated with different sources

III CONCLUSION

Ground water irrigated vegetables has shown significantly higher uptake of iron, manganese, copper and zinc as compared to the surface water irrigated ones. Among vegetables highest accumulation of manganese, zinc and copper was found in tomato, whileas the concentration of iron was highest in kale. All the vegetables contained heavy metals were lower than the permissible limits of Indian standards, hence fit for consumption purposes. However, the regular monitoring of levels of these metals from irrigation water, in vegetables and in other food materials is essential to prevent excessive build-up of these metals in the food chain.

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