Heavy Metal Content of *Mentha piperita* Samples Irrigated with Wastewater and Appraisal of Human Health Risk

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Abstract

The aim of the present research was to determine the trace metal accumulations in water, soil and *Mentha piperita* samples irrigated with three different water regimes. The analysis was conducted by AAS. Metal concentrations in water samples ranged from 0.84 to 1.67, 0.42 to 0.72, 0.45 to 0.85, 2.51 to 9.99, 1.21 to 1.92, 1.82 to 9.98 and 0.64 to 0.91 mg/kg for Cd, Cr, Cu, Fe, Ni, Zn and Mn, respectively. Concentrations in soil samples were determined as 0.79, 0.166, 0.218, 10.01, 0.46, 1.34 and 0.34 mg/kg for Cd, Cr, Cu, Fe, Ni, Zn and Mn, respectively. Accumulations in *M. piperita* samples ranged from 0.48 to 1.06, 0.11 to 0.35, 0.15 to 0.29, 1.43 to 8.39, 0.39 to 0.54, 2.1 to 3.05 and 0.42 to 0.47 mg/kg, respectively. The metal accumulation in plant samples was lower than the permissible limits except for Cd.

Keywords

Trace metal • Vegetable • Wastewater • Health risk

1 Introduction

Unnecessary deposition of heavy metals in soil due to wastewater irrigation not only causes soil pollution, but also disturbs the safety and nutritional value of food (Ahmad et al. 2019; Bouaroudj et al. 2019; Khan et al. 2018a,b, 2019a,b). Uptake of heavy metals occurs in vegetables and accumulates in their different eatable and inedible parts (Khan et al. 2018c; Ahmad et al. 2018; Rak and Pietrucha-Urbanik 2019; Nadeem et al. 2019; Dogan and Ugulu 2013; Dogan et al. 2014a,b); the quantity of these toxic compounds is so high that it causes health problems in human beings (Dogan et al. 2013; Durkan et al. 2011; Erkol and Ugulu 2014; Ugulu 2012,2015a,b,c; Ugulu et al. 2009a, b, 2012,2016; Ugulu and Baslar 2010; Unver et al. 2015; Yorek et al. 2016; Khan et al. 2018d).

The present study was performed to determine the accumulation and translocation of trace metals in water, soil and vegetables, and also health risk index by *M. piperita* irrigated with sugar mill water.

2 Materials and Methods

This study was conducted in Khushab, Punjab, Pakistan. Seeds of *M. piperita* were grown at the end of October 2016 in 60 small plastic pots. Ten seeds of vegetable were sown in each plastic pot. One liter of the water samples was applied in experimental pots for irrigation purpose. Different treatments used for this experiment were: T-I: groundwater irrigation (GWI), T-II: canal water irrigation (CWI) and T-III: mill water irrigation (MWI). Vegetable leaves were harvested at the end of April 2017. The samples were dried and ground in a domestic grinder. Fine powder of vegetable samples was kept in the oven for three days at 75 °C and digested. The analysis was conducted by AAS (Shimadzu model AA-6300). Health risk index (HRI) is defined as ratio of daily intake of metals in food crops to the oral reference dose (Khan et al. 2018d).

HRI = *Daily intake of metals/oral reference dose.*

An HRI < 1 for any metal in vegetable means that the consumer population faces serious health risks. However, HRI > 1 does indicate a considerable health risk to the organisms consuming these vegetables.

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3 Results and Discussion

Trace metal concentrations in water samples ranged from 0.84 to 1.67, 0.42 to 0.72, 0.45 to 0.85, 2.51 to 9.99, 1.21 to 1.92, 1.82 to 9.98 and 0.64 to 0.91 mg/L for Cd, Cr, Cu, Fe, Ni, Zn and Mn, respectively. Among three treatments, the mean values of Fe and Zn were higher than other metal accumulations for all treatments (Fig. 1).

Maximum permissible limits (MPL) of the Cd, Cr, Cu, Fe, Ni, Zn and Mn in water were reported as 0.01, 0.5, 0.2, 5, 0.2, 2 and 0.2 mg/L, respectively, by USEPA (Khan et al. 2018d). Except for Mn, the heavy metal accumulation values in the present study were higher than these permissible maximum limits in water. According to these results, it can be mentioned that there is a water pollution in the study area.

Trace metal concentrations in soil samples were determined as 0.79, 0.166, 0.218, 10.01, 0.46, 1.34 and 0.34 mg/kg for Cd, Cr, Cu, Fe, Ni, Zn and Mn, respectively. Among three treatments, the mean concentrations of Fe, Zn and Mn were higher than other metal accumulations for all treatments (Fig. 2).

The MPL of the Cd, Cr, Cu, Fe, Ni, Zn and Mn accumulation in soil were reported as 3, 100, 50, 21,000, 50, 200 and 2000 mg/kg by USEPA (Khan et al. 2018d). All metal concentrations in the present research remained below these limits.

Trace metal accumulations in *M. piperita* samples gathered from where soil samples were taken are as follows: The contents of Cd, Cr, Cu, Fe, Ni, Zn and Mn ranged from 0.48 to 1.06, 0.11 to 0.35, 0.15 to 0.29, 1.43 to 8.39, 0.39 to 0.54, 2.1 to 3.05 and 0.42 to 0.47 mg/kg, respectively. Among three treatments, the mean concentrations of Fe and Zn were higher than the other metals (Fig. 3).

The MPL of the Cd, Cr, Cu, Fe, Ni, Zn and Mn accumulation in plants were reported as 0.1, 5, 73, 425, 67, 100 and 500 mg/kg, respectively, by WHO (Khan et al. 2018b). The metal accumulation in *M. piperita* samples was lower than the permissible limits except for Cd. In the present study, all HRI values were less than 1 except for Cd (Table 1). If Cd is continuously deposited in human body through food, it causes fatal diseases of kidneys and many other tissues. High Cd values may be due to its usage in industrial parts (Belabed et al. 2017).

4 Conclusions

Environmental pollution by trace metals released from industrial effluent is one of the major challenging issues in many countries. In this framework, Cd, Cr, Cu, Fe, Ni, Zn and Mn accumulation in *M. piperita* samples irrigated with sugar mill water was investigated in this study. The metal accumulation in plant samples was lower than the permissible limits except for Cd. On the other hand, the recorded health risk index values were lower than 1 except for Cd.

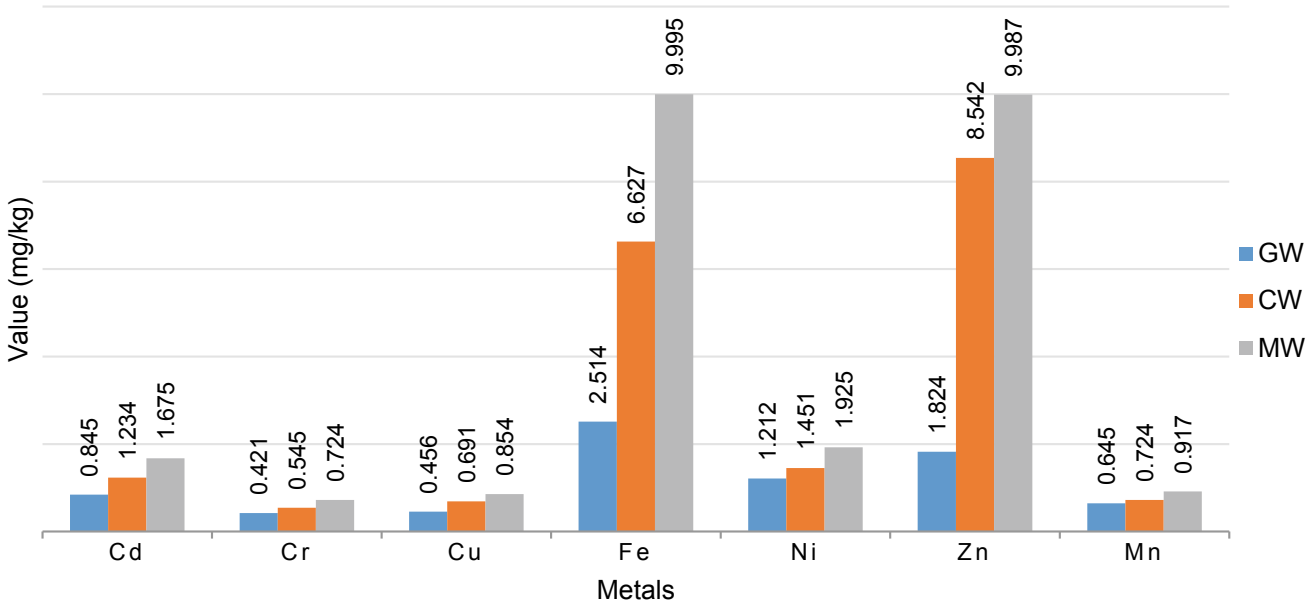

Fig. 1 Trace metal concentrations in irrigation water

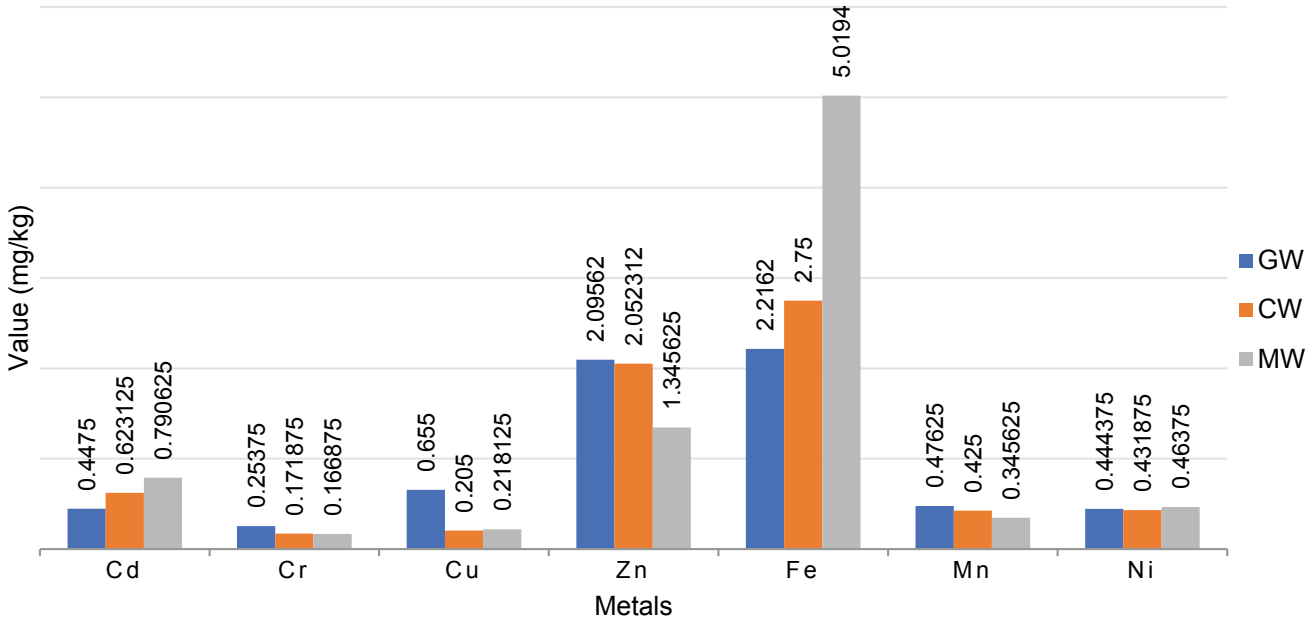

Fig. 2 Trace metal concentrations in soil

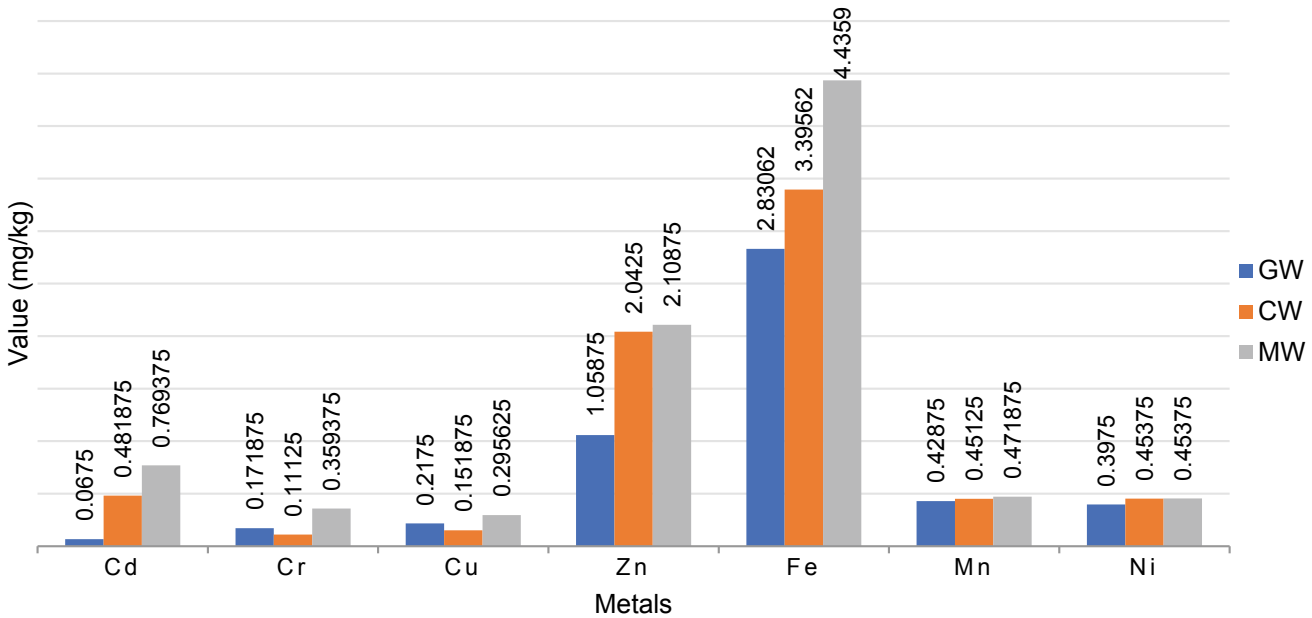

Fig. 3 Trace metal concentrations in vegetable

Table 1 Health risk index for *M. piperita*

Irrigation	Metal						
	Cd	Cr	Cu	Fe	Ni	Zn	Mn
I	6.138	0.000	0.031	0.039	0.114	0.058	0.060
II	2.770	0.000	0.021	0.068	0.130	0.048	0.063
III	4.423	0.001	0.042	0.011	0.130	0.040	0.066

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