Chromium and Zinc Accumulation and Translocation in Root and Leafy Vegetables Irrigated with Industrial Effluents — a Laboratory Study

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The industrial effluents and wastewaters, which are often used for irrigation purposes, contain heavy metals such as Fe, Mn, Zn, Cr, Ni, and others. Since heavy metals have the capability of translocation from soil to the edible parts of food crop, it leads to their accumulation in the food chain and can negative effect on human health. It is known that vegetables, especially some leafy vegetables grown on contaminated soils, contain higher metal concentrations than vegetables grown on uncontaminated sites. Therefore, a laboratory study was performed to assess the accumulation and translocation of chromium and zinc in the edible and non-edible parts of radish (*Raphanus sativus*), lettuce (*Lactuca sativa*) and green onion (*Allium fistulosum* L.) irrigated with filtered water and industrial effluents. The concentration of metals in effluents, soil and vegetables was determined by inductively coupled plasma optical emission spectrometry (ICP-OES).

The highest concentrations of zinc in the edible parts of vegetables were determined in lettuce (up to 833±131 mg/kg), and the minimum content (up to 396±38.5 mg/kg) - in radish. The opposite pattern was observed in the accumulation of chromium: the lowest content of metal was determined in leafy vegetables (7.50±0.16 mg/kg), and the maximum level - in the edible radish roots (12.1±3.13 mg/kg).

To study the features of metal accumulation by vegetable roots and their transfer to other parts of the plant, the bioaccumulation and translocation factors were calculated. The values of bioaccumulation factor for zinc in radish and lettuce decreased with increasing of metal concentrations in the industrial effluents. Conversely, the bioaccumulation factor of chromium for all vegetables was higher when irrigated with wastewater.

The levels of chromium and zinc in the parts of radish, lettuce and soil followed the order: soil ≥ roots > edible part. The different order of metals translocation was observed for onion: roots ≥ soil > edible part.

Since the main source of human exposure to heavy metals is via oral ingestion, the estimated daily intake (EDI) of chromium and zinc was determined based on their average concentration in the edible part of vegetables and the daily intake of radish, lettuce and onion. The maximum EDI of chromium and zinc resulted from the consumption of radish > lettuce > onion and lettuce > onion > radish, respectively, irrigated with industrial effluents. The obtained values were by an order of magnitude lower than the reference doses established for zinc (0.3 mg/kg bw/day) and chromium (0.003 mg/kg bw/day).