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Soil-plant system and potential human health risk of food plants growing in soils from Mn- and Fe-abandoned mines: Microcosm assay

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Around abandoned mine areas, soils are often used for agriculture independently of their total hazardous elements concentrations. Contamination can be the main source of potentially toxic elements in soils. The elements behavior in the soil-plant system is affected by soil properties. Elements accumulation in edible parts of plants represents the principal entry of elements in the food chain. Soils in the vicinity of two Mn- and Fe-abandoned mines (Ferragudo and Rosalgar, South of Tagus River, Portugal) were collected to cultivate, in greenhouse and under controlled conditions, two different food species (Chinese cabbage - Brassica rapa subsp. pekinensis (Lour.) Hanelt and oregano - Oreganum vulgare L.). Chemical characterization of soil-plant system and the potential human health risks of the plants associated with soil contamination, based on the estimation of metal daily intake (EDI), were assessed. Soils properties were determined and plants (roots and shoots) were analyzed by ICP/OES for macro and micronutrients. In both soils, the total concentrations of Fe and Mn were above the required standards for agriculture. Rosalgar soil has lower fertility for agricultural purposes (low concentrations of Ca, P, Mg in the available fraction) compared to Ferragudo soil. Values of soil pH decrease in both soils after oregano growth but not after cabbage growth. Oregano growth contributed to an increase of the availability of most of the elements in both soils (Ferragudo and Rosalgar: Cu, K, Mg, P and S; Ferragudo: Zn). However, the concentrations of most elements in the available fraction were lower after chinese cabbage (Ferragudo: Ca, K, Mn, P and S; Rosalgar: Fe, K, Mn and Zn). This variation can be associated to specific rhizosphere conditions of each plant species and/or nutritional needs of each species. In shoots of both species, Fe and Mn concentrations were very high (g/kg; [Fe]roots: 5.4-36.2, [Fe]shoots: 0.1-1.5, [Mn]roots: 3.7-36.8, [Mn]shoots]: 0.4-0.9 depending on species and soil). Brassica rapa exhibited a better growth in Ferragudo soil (2.8 g FW) than in Rosalgar soil (7.5 g FW) and it behaved as excluder of Cu, Mn, Fe, S and Zn in both soils. Besides, oregano growth (0.7-1.0 g FW) was similar independently of the soils. The EDI for Mn in chinese cabbage plants grown in both soils was higher than the provisional tolerable daily intake values indicating that its consumption might not be safe and could lead to serious health problems. On the contrary, the consumption of Oreganum vulgare would not represent any health risks. This study shows the need of further studies with different food crops before cultivation in the soils located in adjacent areas from mining sites to assess health risks associated with high amounts of potentially toxic elements intake.

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