

Assessment of Trace Elements in Soils and Vegetables from Urban Home and Allotment Gardens in Bratislava, Slovakia

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Urban gardens offer health benefits like access to locally grown vegetables and increased physical activity, which can enhance mental well-being. However, health risks may arise from soil or groundwater contamination, long-term pesticide use, and unknown site histories. In the capital of Slovakia (Bratislava), historical wine production has led to copper accumulation in soils, and various industrial activities have resulted in potentially contaminated brownfields currently used as urban gardens.

In total, 384 soil and 94 vegetable samples from 151 urban gardens were collected, and concentrations of many trace elements, including arsenic (As), antimony (Sb), barium (Ba), cadmium (Cd), copper (Cu), chromium (Cr), lead (Pb), nickel (Ni), vanadium (V), zinc (Zn), etc., were measured using inductively coupled plasma mass spectrometry. Data were analyzed considering residents' questionnaires on gardening practices, soil enhancements, and irrigation water sources. Rock composition had an influence on the soil accumulation of lithophile elements like lithium (Li), beryllium (Be), and rubidium (Rb), while urbanization factors significantly influenced the concentration of typical “urban” elements (e.g., Ba, Cd, Cu, Pb, Sb, Zn).

Source apportionment was investigated using principal component analysis after the centered log-ratio transformation of the concentration data and positive matrix factorization. Two elemental groups were associated with anthropogenic sources and two other ones were related to the lithology of the area. Copper is predominantly related to viticulture tradition, while Cd, Pb, Sb, and Zn come from traffic, industrial emissions, and pesticide/fertilizer use. Higher concentrations of Li, Be, and Rb were observed in soils developed on granites of the Bratislava massif, whereas As, Cr, Ni, and V are linked to natural background.

Root vegetables generally accumulated greater amounts of anthropogenic elements than fruit vegetables. Significant differences were observed in anthropogenic element concentrations between tomatoes grown in urban and rural areas, and in original soil and raised beds. Nevertheless, no vegetable items exceeded regulatory levels for Cd and Pb effective in European Union member states.

Geology and urbanization significantly impact trace element concentrations in urban garden soils and homegrown vegetables.