

Evaluating of Chemical Extractants for Assessment of Bioavailable Heavy Metals in Polluted Soils

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Abstract : Availability of a metal is characterised by its quantity transgressing from soil into different extractants or by its content in plants. In literature, the terms 'available forms of compounds' and 'mobile' are often considered as equivalents of the term 'accessible' to plants. Rapid and a sufficiently reliable method for defining the accessible for plants forms turns out to be their extraction through different extractants, imitating the functioning of the root system. As a criterion for the pertinence of the extractant to this purpose usually serves the significant statistic correlation between the extracted quantities of the element from soil and its content in plants. The aim of this work was to evaluate the effectiveness of various extractions (DTPA-TEA, AB-DTPA, Mehlich 3, 0.01 M CaCl₂, 1M NH₄NO₃) for the determination of bioavailability of heavy metals in industrially polluted soils from the metallurgical activity near Plovdiv and Kardjali, Bulgaria. Quantity measurements for contents of heavy metals were performed with ICP-OES. The results showed that extraction capacity was as follows: Mehlich 3>ABDTPA>DTPA-TEA>CaCl₂>NaNO₃. The content of the mobile form of heavy metals depends on the nature of metal ion, the nature of extractant and pH. The obtained results show that CaCl₂ extracts a greater quantity of mobile forms of heavy metals than NH₄NO₃. DTPA-TEA and AB-DTPA are capable of extracting from the soil not only the heavy metals participating in the exchange processes but also the heavy metals bound in carbonates and organic complexes, as well as bound and occluded in oxide and secondary clay minerals. AB-DTPA extracts a bit more heavy metals than DTPA-TEA. The darker color of the solutions obtained with AB-DTPA indicates that considerable quantities organic matter are being destructed. A comparison of the mobile forms of heavy metals extracted from clean and highly polluted soils has revealed that in the polluted soils the greater portion of heavy metals exists in a mobile form. High correlation coefficients are obtained between the metals extracted with different extractants and their total content in soil ($r=0.9$). A positive correlation between the pH, soil organic matter and the extracted quantities of heavy metals has been found. The results of correlation analysis revealed that the heavy metals extracted by DTPA-TEA, AB-DTPA, Mehlich 3, CaCl₂ and NaNO₃ correlated significantly with plant uptake. Significant correlation was found between DTPA-TEA, AB-DTPA, and CaCl₂ with heavy metals concentration in plants. Application of extracting methods contains chelating agents would be recommended in the future research on the availability of heavy metals in polluted soils.

Keywords : availability, chemical extractants, heavy metals, mobile forms

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