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Method Article

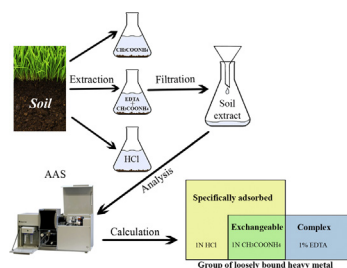
Method of determining loosely bound compounds of heavy metals in the soil



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GRAPHICAL ABSTRACT



ABSTRACT

Method of determination of heavy metals loosely bound compounds in the soil was developed using three separate extractions. The group of loosely bound compounds of metals includes exchangeable, complexed, and specifically adsorbed forms. This method is available, rapid and not expensive. Extraction takes less than 24 h. Sample procedure preparation is simple, and the analysis consists of only three steps, which can be performed simultaneously. The parallel extraction gives reliable and reproducible results and provides a relatively complete idea of the metals mobility in the soil, their availability to plants, migratory capacity, and transformation.

- Method is suitable for a wide range of heavy metals and soil types. From the obtained data, the content of loosely bound compounds of heavy metals and the coefficients of metals mobility in the soil can be calculated.
- Method is suitable for estimation of the microelement supply of uncontaminated soils. The content of elements in the 1 N $\text{CH}_3\text{COONH}_4$ extract characterizes the actual pool of elements, and their content in the 1 N HCl extract defines their potential pool in the soil.

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- The coefficient of mobility (Km) is calculated to assess the contamination of soil with heavy metals. Estimation criteria of Km for Haplic Chernozem were developed.

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ARTICLE INFO

Method name: Method of determination of loosely bound metals compounds in the soil

Keywords: soil samples, mobile forms of heavy metals, exchangeable form, complex form, specifically adsorbed form, parallel extraction, ammonium acetate buffer, ethylenediaminetetraacetic acid, hydrochloric acid

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Specifications Table

Subject area	<i>Environmental Science</i>
More specific subject area	<i>Soil science</i>
Method name	<i>Method of determination of loosely bound metals compounds in the soil</i>
Name and reference of original method	<ol style="list-style-type: none"> 1. <i>Quantitative chemical analysis of soils. Procedure for measuring the mass fractions of mobile metals: copper, zinc, lead, cadmium, manganese, nickel, cobalt, and chromium in samples of soils, grounds, bottom sediments, and sewage sludge by flame atomic absorption spectrometry (PND F 16.1:2:2.2:2.3.78-2013, Federal Service for Environmental Control, Moscow, 2013, 21 p.).</i> 2. <i>Methodological recommendations for the determination of heavy metals in fodders and plants and their mobile compounds in soils. TsINAO, Moscow, 1993, 26 p.</i>
Resource availability	<p><i>Materials</i></p> <ul style="list-style-type: none"> • <i>Soil samples (analyzed soil portions) of 5 g</i> • <i>White ribbon ashless filter papers</i> • <i>Glass funnels 60–80 mm in diameter</i> • <i>Mortar, pestle, and cups in porcelain</i> • <i>Soil sieves with a 1-mm mesh</i> • <i>Conical glass flasks of 100 mL</i> • <i>Glass jars of 100 mL to store extracts</i> • <i>Measuring flask of 1 L</i> • <i>98% CH₃COOH</i> • <i>25% NH₄OH</i> • <i>37% HCl</i> • <i>Ethylenediaminetetraacetic acid (EDTA)</i> • <i>Note: This list does not include any small generic laboratory equipment that are assumed to be available. Chemicals and other components can be used from any reliable company.</i> • <i>Distilled water</i> • <i>Analytical balance</i> • <i>Ionometer (pH-meter)</i> • <i>X-ray fluorescence spectroscopy</i> • <i>Atomic absorption spectrophotometer</i>

Method details

For an objective assessment of the degree of environmental pollution, it is necessary to study not only the total content of pollutants in soil but also their loosely bound compounds. The diversity of the heavy metal compounds in soils makes it practically impossible and unfeasible to determine all the individual metal-bearing substances that are present in the particular soils. It is more efficient to determine the groups of heavy metal compounds differing in their mobility (migration capacity) in the given soils. The analysis of the metal group composition in the soil allows one to reveal the genetic specificity of the particular soils and to trace the effects of different factors on the soil properties. The main goal of the suggested method is the determination of the mobility of heavy metals in soils based on the data of their distribution between two major groups: firmly bound and loosely bound with the

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