

RELATIONSHIP OF SOIL PROPERTIES TO Cr AND Cd MOBILITY FROM VIEWPOINT OF RISK TRANSFER INTO THE PLANTS

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Summary

The total chromium and cadmium content was determined after mineralization of soils by the atomic absorption spectrophotometry method. The chromium and cadmium content in soil by the same method after its extraction with 2M HNO₃, 0,05M EDTA and 0,01M CaCl₂ were determined. Achieved data were compared to allowed limit values. In model conditions the reaction of soil on Cr and Cd loading was observed. Also the extent of Cd and Cr sorption in soils was tested. The Cr compounds in majority of tested soils are relatively fast fixed, only small risk of soil contamination by Cr was in this work confirmed. The Cd compounds in majority of tested soils are bounded in light released forms. This fact presents enhanced risk for ecosystems with possibility contamination of food chain.

Key words: Cr and Cd forms in soils; Cr and Cd content in various soil extracts

Introduction

Heavy metals are perhaps most troublesome toxic components introduced into the environment. One of the sources of soil and water pollution on large areas are atmospheric dust of anthropogenic origin. Power industry and non-ferrous metals industry are the main sources of pollution of the atmosphere. One of important sources of pollution of the environment are industrial and municipal sewages and chemical substances leaching from dumping grounds of various wastes.

Heavy metals going into soil and water are fixed by the solid phase, and therefore it is not possible neither to remove them nor reduce their amount. An important thing is that soils and bottom sediments cumulating underground waters from pollution and reducing the intake by plants. Ecological role of soil as a heavy metals can be very adsorbed by soil is decided first of all by its sorption capacity, determined by the quantity and quality of colloids creating so called soil sorption complex. Other factors are soil reaction, salinity, redox potential, as well as concentration and the form in which the metals occur (1).

Chromium occurs in inorganic systems in several chemical forms and valences. Only Cr³⁺ and Cr⁶⁺ are significant in biological systems. Trivalent chromium, (Cr³⁺) is an essential nutrient for animal and human glucose and lipid metabolism. Chromium deficiency in humans mimics diabetes mellitus and causes the formation of arteriosclerosis in rats. The average human ingests from 0,03 - 0,10 mg of chromium (in all valences) each day. Deficiencies in chromium also lead to an increasing of lead toxicity, while excess chromium (VI) in biological systems has been implicated in specific forms of cancer (5)

Cd gets into the soil by atmospheric deposition, application of sewage sludge and industrial fertilizers. Phosphate fertilizers with enhanced Cd contents are one of the important sources of Cd input into the soils (6). Despite of improvement of situation because of phosphates with low Cd content and decreasing of industrial fertilizer doses this problem still exists. The Cd contents in soils are often higher than maximal allowed concentrations under Vestník MP SR (7).

The input of Cd into the plants by roots from soil and by leaves from atmosphere is risky for food chain of the man because of negative influence of Cd on living organisms (4). Cd in form of its cation is cumulated in arable horizon of soil. Mobility of Cd is increased with enhanced pH, by application of organic matter in soil (3). Cd also forms complexes with organic and inorganic ligands, whose are one of causes of enhanced Cd mobility. Cd can substitute Zn in some enzymatic systems, whose are by this way inactivated (1).

Total Cr and Cd contents, their mobile forms in extracts of 2M HNO₃, 0,05M EDTA and 0,01M CaCl₂ were determined in tested soils. In model conditions the reaction of soil on Cr and Cd loading was observed. Also the extent of Cd and Cr sorption in soils was tested.

Material and methods

The chromium and cadmium content in tested soils were determined after their draining, finish and decomposition by HF + HClO₄ mixture by AAS (atomic absorption spectrophotometry) method with instrument PYE Unicam SP9. The Cr and Cd content in soil by the same method after its extraction with 2M HNO₃, 0,05M EDTA and 0,01M CaCl₂ mobile forms were determined.

The knock-down columns in model kinetic conditions were used for observation of Cr and Cd sorption. The columns were full with 0,5 kg of soil, the maximal water capacity of soils was determined and then solution Cr(NO₃)₂ · 9H₂O and Cd(NO₃)₂ ·

2H₂O with double of limit value A (260 mg Cr.kg⁻¹ ev. 1,6 mg Cd . kg⁻¹ of soil) was aplicated (7). The Cr and Cd contents were determined in extraction solutions (2M HNO₃ , 0,05M EDTA, 0,01M CaCl₂) after taking to pieces by AAS method.

Results and discussion

The total Cr content in soils were 18,90-74,00 mg.kg⁻¹. The mobile forms, determined in 2M HNO₃ extract were 0,59-3,72 mg.kg⁻¹ (3,2-9,1 % of the total Cr content), in 0,05M EDTA extract were 0,09-0,70 mg.kg⁻¹ (0,1-1,3 % of the total Cr content), in 0,01M CaCl₂ were 0,00-0,14 mg.kg⁻¹ (0,0-0,6 % of the total content). The Cr compounds in majority of tested soils are relatively fest fixed , only smal risk of soil contamination by Cr was in this work confirmed.

The soil behavior towards chromium was variable but relatively similar. Different properties shown Regosol, Cambisol and Stagnic Glossisol, where chromium migration to the lower column layers were determined. Chromium content in used extracts was in range 0,01 - 57,17 % (in 2M HNO₃), 0,00 - 2,09 % (in 0,05 M EDTA) and 0,00 -0,45 % (in 0,01 M CaCl₂) of added chromium amount. The Cr compounds in majority of tested soils are relatively fest fixed, only smal risk of soil contamination by Cr was in this work confirmed (2).

The total Cd content in soils were 0,53 - 1,35 mg.kg⁻¹. The determined content of Cd were higher (75 % results) than the maximal allowed concentration (0,8 mg.kg⁻¹). The mobile forms, determined in 2M HNO₃ extract were 0,06 - 0,79 mg.kg⁻¹ (16,7 - 53,7 % of the total Cd content). The determined content of Cd were higher (41 % results) than the maximal allowed concentration A₁ 0,3 mg.kg⁻¹ (7). The mobile forms, determined in 0,05M EDTA extract were 0,08 - 0,38 mg.kg⁻¹ (12,07 - 28,3 % of the total Cd content). The mobile forms, determined in 0,01M CaCl₂ extract were 0,00 - 0,21 mg.kg⁻¹ (0,00 - 15,45 % of the total Cd content).

The soil behavior towards Cd was variable but relatively similar. Different properties shown Regosol, Albic Luvisol, Stagnic Glossisol, Haplic Chernozem and Eutric Fluvisol, where Cd migration to the lower column layers were determined. The Cd content in extract 2M HNO₃ was in range 0,00 - 4,98 mg.kg⁻¹ (0,00 - 51,6 % of added amount). The Cd content in extract 0,05M EDTA was in range 0,00 - 4,42 mg.kg⁻¹ (0,00 - 46 % of added amount). The Cd content in extract 0,01M CaCl₂ was in range 0,00 - 1,70 mg.kg⁻¹ (0,00 - 17,7 % of added amount). The experimental results signal the Cd risk for ecosystems (3 , 4).

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INPUT OF SOME HEAVY METALS INTO THE PLANTS PRODUCTION IN IMMISSION AREA OF OFZ ISTEBNÉ

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Summary

Region of Down Orava is one of problem localities of Slovakia. OFZ Istebné since 1952 as the source of polymetallic dust significantly partakes on this fact. Improvement of emission situation of this metallurgical plant calls for a actualisation of knowledges about ability of agricultural soil to give hygienic unexceptionable production. Despite of significantly decreased contamination of observed area the risk of overlimit contents of some heavy metals (Cr, Cd) still exists.

Key words: heavy metal contents, hugienic limit, polymetallic dust, soil contamination

Introduction

Immission area of Down Orava is one of the nine regions with risky agricultural soil and vegetation in Slovakia. Since 1952 Oravské ferozliatinárske závody (OFZ) in Istebné is very important source of polymetallic dust. The emission situation is significantly changed from beginning of plant working till this time. Determined values of wet and dry deposition before