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THE INFLUENCE OF CHELATING AGENT CONCENTRATION (AC-EDTA) ON LEAD MOBILIZATION IN AN ARTIFICIAL SOIL

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Abstract

The paper presents the preliminary laboratory research concerning lead mobilization in an artificial polluted soil with $Pb(NO_3)_2$ - (1000 mg/Kg, 2000 mg/Kg, 3000 mg/Kg), by using the chelating agent AC-EDTA (ethylenediaminetetraacetic acid). The EDTA addition has as purpose to increase of lead bioaccesibility, being known from the literature that it is the lowest bioaccesible heavy metal.

INTRODUCTION

Soil contamination with heavy metals became a serious problem in high industrialized areas, but also in agriculture. This problem has an impact on human and animal health and imposes the using of soil remediation practices [1].

Lead is considered as the frequent heavy metal met as pollutant into the environment, especially in soil being very strong bound with the organic matter of the soil. Severe soil contamination with lead could have serious impact as: vegetation loss, groundwater contamination and plant, animals and human decay [2].

As a series of studied showed, there are substances named chelating agents, that are having the capacity to increase lead mobilization into the soil. The most efficient chelating agent for lead is the natrium salt of the ethylenediaminetetraacetic acid (EDTA). It is ascertained that EDTA produces not only lead mobilization, but also the shoots accumulation [3].

MATERIAL AND METHODS

The research from the present study is directed to the lead mobilization in the artificial polluted soil by using the chelating agent AC-EDTA (ethylenediaminetetraacetic acid).

The soil used in the experiment were sampled from the surface (0-20 cm), homogenized and dried at air temperature.

The soil were treated with Pb like $Pb(NO_3)_2$ – (1000 mg/Kg, 2000 mg/Kg, 3000 mg/Kg) and EDTA. The EDTA addition has as purpose to increase the lead bioaccesability, being known from the literature as the lowest bioaccesible heavy metal.

It was verified the retention degree of the lead in soil samples by the solubilization of the soil – lead azotate mix in water, in the following conditions:

- solid:liquid ratio by 1:5 and 1:10;
- contact time - 2 hours;
- continuous stirring up;
- surrounding temperature.

In the table 1, there can be observed a very easy increase of the lead extraction yield in accordance with the increase of total lead concentration in the artificial polluted soil sample.

Table 1

The solubilization yields of the lead in the soil samples artificial polluted with lead, at solid: liquid ratio by 1:5 and 1:10

Lead content in soil	**Extraction yields of lead, %**	
	Solid:liquid ratio by 1:5	Solid:liquid ratio by 1:10
1000 mg Pb/kg soil	0.05	0.05
2000 mg Pb/kg soil	0.10	0.10
3000 mg Pb/kg soil	0.15	0.15

The influence of EDTA concentration on lead solubilization

The ethylenediaminetetraacetic acid was selected from the literature data as optimum mobilization agent. In view to study the influence of EDTA concentration on lead mobilization (the tracing of lead mobilization curve), there was used the EDTA mixture, Merck quality.

It was prepared 20 mixtures from artificial pollutes soil with lead and EDTA in different concentrations, as it follows:
For the polluted soil with 3000 mg lead/kg sol were prepared 9 polluted soil – EDTA mixtures, EDTA molarities between 2–25 mmol.

For the polluted soil with 2000 mg lead/kg sol were prepared 6 polluted soil – EDTA mixtures, EDTA molarities between 3.4–20 mmol and for the polluted soil with 1000 mg Pb/kg sol were prepared 5 polluted soil – EDTA mixtures, EDTA molarities between 1.7–9.65 mmol EDTA.

For achieving the tracing of the lead mobility curve for these samples, it was adopted the following working method:

- water solubilization, solid:liquid ratio by 1:5 and 1:10;
- contact time - 2 hours;
- stirring up;
- surrounding temperature.

When the contact time is ending, the samples were filtered by solid phase separation. In the solutions obtained were determined pH and lead concentration by atomic absorption spectrometric method.

RESULTS AND DISCUSSION

As it can be observed in the table 2, the yield of lead mobilization in soil increases with the molar ratio EDTA:Pb increase, and the pH decreasing (normally, EDTA being a weak acid).

The mobilized lead concentration (the mobilization yield from table 2) in the solutions resulted at the extraction at 1:5 solid – liquid ratio is higher than the ones obtained at 1:10 solid – liquid ratio.

Table 2

Results obtained at lead mobilization in soil samples artificial polluted with 3000 mg Pb/kg sol

Molarity EDTA Addition (mmol)	**EDTA:Pb Molar ratio**	**Extraction yield Pb (%)**		**pH of the extraction aqueous solution**	
		Solid:liquid ratio		Solid:liquid ratio	
		1:5	1:10	1:5	1:10
0	0	0.15	0.15	7.4	7.8
2	0.14	7.6	6.3	7.3	7.6
2.75	0.2	11.5	9.83	7.2	7.5
3.5	0.25	14.9	10.85	7.13	7.4
4.1	0.28	17.9	12	7.09	7.2
6.85	0.47	35.1	15.8	6.7	6.9
10	0.7	54.5	24	5.9	6.3
14.5	1	68.5	35	5.7	6.3
20	1.4	76.5	43.5	5.45	6.1
25	1.7	83.5	54.9	5.1	5.8

In the table 3, there are presented the results obtained in lead mobilization in soil samples polluted with 2000 mg Pb/kg soil, under different EDTA concentratios, at 2 extraction Solid:Liquid ratio (by 1:5 and 1:10).

Table 3

Results obtained at lead mobilization in soil samples artificial polluted with 2000 mg Pb/kg soil

Molarity EDTA Addition (mmol)	EDTA:Pb Molar ratio	Extraction yield Pb (%)		pH of the extraction aqueous solution	
		Solid:liquid ratio		Solid:liquid ratio	
		1:5	1:10	1:5	1:10
0	0	0.10	0.10	7.4	7.8
3.4	0.35	38.9	22.8	7.1	7.4
6.8	0.7	52.7	38.6	6.7	7
9.65	1	73.8	48.8	5.8	6.8
14	1.45	89.7	72.8	5.6	6.6
17	1.76	99.8	78.6	5.4	6.3
20	2.1	99.9	83.7	4.8	5.2

Analyzing the data from the table, 3 it can be observed the same behavior of the soil samples polluted with 2000 mg Pb/kg soil and 3000 mg Pb/ kg soil, namely:

- lead mobilization yield in soil increases in accordance with the increasing of EDTA:Pb molar ratio and pH decrease (normally, EDTA being a weak acid);
- mobilized lead concentration (the mobilization yield from table) in solution resulted at Solid:Liquid extraction ratio by 1:5 is higher than the one obtained at Solid:Liquid extraction ratio by 1:10.

In the table 4, there are the date obtained at lead mobilization in the soil polluted with 1000 mg Pb/kg soil.

The data presented in the table 4 allow the same observations as the soil samples polluted with 3000 and 2000 mg Pb/kg soil.

CONCLUSIONS

1. The yields of lead extraction from aqueous solutions at 1:5 soil:water ratio were higher in all cases reported to the extraction yields obtained at 1:10 soil:water ratio, probably because of hydrolysis that can appear in diluted solution causing partial coagulation of lead.
2. In the soil samples polluted with 3000 mg Pb/kg soil (hypothetical situation that do not occur in practice), the EDTA contribution needed for lead

mobilization is very high. Not even an addition by 25 mmol EDTA in soil samples do not lead to a maximum yield of lead mobilization. Theoretical, the EDTA quantity could be increased, but from economical point of view– EDTA is very expensive–but also from plant tolerance at EDTA, this is not possible.

Table 4

Results obtained at lead mobilization in soil samples artificial polluted with 1000 mg Pb/kg soil

Molarity EDTA Addition (mmol)	EDTA:Pb Molar ratio	Extraction yield Pb (%)		pH of the extraction aqueous solution	
		Solid:liquid ratio		Solid:liquid ratio	
		1:5	1:10	1:5	1:10
0	0	0.05	0.05	7.45	7.8
1.7	0.35	50.4	20	7.3	7.6
3.4	0.7	71	34.6	7	7.2
4.83	1	84.3	46	5.85	6.5
6.9	1.43	99	62	5.6	6.3
9.65	2	99.9	86.9	5.0	5.4

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