Ain Shams University
Faculty of Science
Chemistry Department

EFFECT OF CHEMICAL REMEDIATION ON THE BEHAVIOUR OF HEAVY METALS IN COMTAMINATED SOILS

A Thesis Submitted by

Eman Abdel Latife Mohammed Abdel Rahman

M.Sc. (Physical Chemistry), Faculty of Science
Minufya Univ. 2012

For
The award of Ph.D degree in Chemistry
(Physical Chemistry)

To
Department of Chemistry
Faculty of Science
Ain Shams University

(2017)

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Supervised By

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Dedication

I dedicate this work to Spirit of ***Dr Adel Abd Elaleem Hassan,*** *Water treatment and desalination unit, Hydrogeochemistry Department, Desert Research Center who suggested the subject of this study with Prof. Salah. A. El Enein for all the support he lovely offered during my thesis and I wish* ***Allah*** *to give him mercy*

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PUBLICATION

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Impact of some soil amendments on controlling heavy metals toxicity in some contaminated soils.

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ABSTRACT

A pot experiment was conducted under laboratory conditions at Desert Research Center, Cairo, Egypt. The aim of this experiment is to study the role of three soil amendments; i.e. rock phosphate, nano-hydroxy apatite and poultry litter manure on reducing the hazard effects of some heavy metals in contaminated soils and wheat plants grown in it. The investigated soils were alluvial silt clay and alluvial clay soils from El Salam canal and Bahr El-Baker drain areas, respectively as well as calcareous sandy clay loam from Ras Sudr. Sequential extraction was used to fractionate heavy metals, i.e., Cd, Pb and Zn to evaluate their mobility and bioavailability in such soils.

Results indicated that cadmium was predominantly associated with the crystalline Fe oxides fraction, while lead and zinc were predominantly associated with the residual fraction. By applying the modified degree of contamination index, it can be noticed that El Salam soil suffering from a high degree of contamination and Bahar El Bakar soil suffering from a very high degree of contamination, while Ras Sudr soil sample has a moderate degree of contamination.

Results also indicated that the application of rock phosphate, nano-hydroxy apatite and poultry manure reduced Cd, Pb and Zn mobility in all the investigated soils through metals transformation from non-residual to residual forms.

Mobility factor of heavy metals reduced due to the applied soil amendments and the efficiency of amendments on reducing such factor was in the following order: nano-hydroxy apatite > rock phosphate > poultry manure.

The present data showed that the addition of all the applied materials reduced the concentration of Cd, Pb and Zn in wheat roots and shoots.

It can be concluded that the toxicity of heavy metals does not depend only on its concentration in soil, but also depends on different forms in which metals are present. The applied soil amendments, especially nano hydroxy apatite have high effects on decreasing chemically available heavy metals in soil as well as decreasing their concentrations in wheat plant. Most of these materials are available in large amounts, So the application of such materials can be used as effective strategy to remediate soils polluted with heavy metals.

Key Words

Soil contamination, heavy metal fractionations, soil amendments, mobility factor, heavy metal immobilization.

Introduction

The contamination of soils with heavy metals is now worldwide concerned due to its hazard to ecosystem including soil, water, plant, animal and human life. Pollution and agriculture can be seen from two aspects; one is pollution by agriculture practices. The other is pollution to agriculture. Fields are often affected by offsite pollution, especially those, which lie near industrial zones and roads, FFTC (2002).

Heavy metals are found naturally in the soil mostly in its complexes or bound form. They enter the environment by human activities such as mining, purification of Zinc, lead and cadmium, steel production, coal burning, burning of wastes, discharges from industrial effluents, excessive use of fertilizer, pesticide application and use of raw sewage waste in farming, Okoronkwo et al. (2005).

The accumulation of heavy metals in surface soils is affected by many environmental variables, including parent material and soil properties, as well as by human activities, such as industrial production, traffic, farming, and irrigation. Accumulation of these metals in soils can degrade soil quality, reduce crop yield and the quality of agricultural products, and thus negatively impact the health of human, animals, and the ecosystem, Nagajyoti et al. (2010). Such metals are a real threat to the environment because they can not be naturally degraded like organic pollutants and persist in the ecosystem having

accumulated in different parts of the food chain, Igwe et al. (2005). Therefore, it is an urgent necessity to develop effective strategies for lowering their risk on the environment.

Among various remediation techniques, in situ chemical immobilization technology is the relatively more operative and cost-effective remediation approach for the reduction of the mobility and bioavailability of heavy metals in contaminated soils, Basta et al. (2001). It was demonstrated that this method is considered to be feasible, more economically and gives very promising results without the need for soil removal, Yang et al. (2001). Immobilization of metals can be accomplished by the addition of soil amendments such as organic matter, phosphates, alkalizing agents, and biosolid to reduce contaminant solubility or bioavailability to the plants, Khan et al. (2012). The addition of such amendments is effective in lowering the metal toxicity of the soil and provides slow release of nutrient sources such as N, P. K to support plant growth, Chin et al. (2006). Moreover, nanoscale particle HAP (n-HAP) has been proven to be an extremely effective remediation material in heavy metal-contaminated soils since it has strong ability to fix heavy metals, Wang et al. (2012). Poultry waste materials also have been successfully employed in immobilizing heavy metals in contaminated soils. It may decrease the available concentrations of heavy metals in soils by precipitation, adsorption, or complexion processes, Hashimoto et al. (2008). The aim of the present study is to evaluate the role of some local soil amendments on reducing the hazard effects of some heavy metals in different soil types grown with wheat plants.

MATERIALS AND METHODS

Surface soil samples (0 - 20 cm) of three contaminated sites, i.e. alluvial silt clay soil of El-Salam Canal, alluvial clay soil of Bahar El-Bakar and calcareous sandy clay loam soil of Ras Sudr were sampled. These samples were air dried, crushed by mortar, passed through 2 mm sieve and stored for chemical and physical analyses and use in pot experiment. Table (1) depicts some physical and chemical properties of such soils.

It is clear that the differences in CEC and clay content between the three contaminated soils could imply that Bahar El-Bakar soil has a potentially stronger adsorption of heavy metals than El-Salam and Ras Sudr soils. Also, the concentration of chemically