CIBTech Journal of Biotechnology ISSN: 2319–3859 (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/cjb.htm
2015 Vol. 4 (4) October-December, pp.55-59/Sujatha and Kumar
Research Article

DETERMINATION OF HEAVY METAL CONTENT IN INDUSTRIAL AREAS OF VISAKHAPATNAM

Sujatha B. and *Prasanna Kumar M.V.V.
Department of Botany, Andhra University, Visakhapatnam
**Author for Correspondence*

ABSTRACT
Heavy metals in the soil refers to metals of biological toxicity which includes mercury (Hg), Cadmium (Cd), lead (Pb), Chromium (Cr), Arsenic (Ar). Heavy metal contamination refers to the excessive deposition of these toxic heavy metals in the soil caused by human activities. The main Objective of this paper is to determine the level of soil pollution with heavy metals in the vicinity of Visakhapatnam city industrial area. Soil samples were collected from NTPC industrial region (Site 1) and Coramandal fertilizers (Site 2), Visakhapatnam. The analyses show that soil samples collected from polluted areas have more concentrations of heavy metals than non-polluted areas.

Keywords: *Heavy Metals, Soil Pollution, Visakhapatnam, Atomic Absorption Spectroscopy*

INTRODUCTION
Metals are persistent pollutants that can be biomagnified in the food chains, becoming increasingly dangerous to human life and therefore assessing pollutants in different components of ecosystem has become an important task in preventing risk to natural life and public health. The metals are classified as "heavy metals" if in their standard state they have a specific gravity of more than $5g/cm^3$. Due to urbanization and industrialization the risk of contamination of soils with excess metals have raised many fold because of atmospheric metal depositions, pesticides or fertilizers deposition. Heavy metals (Fe, Mn, Ni, Co, Zn, Cu, Cr, V, Ti, Cd, Hg, Mo and other trace metals) as well as As, Se and F occur naturally in soils, which are formed by geological processes, such as alteration and erosion of the geological underground materials (Moor *et al*., 2001).
Industrialization and urbanization that were been carried out during the past decade have given rise to serious problems of environmental imbalances in and around Visakhapatnam. The major industries in Visakhapatnam are Steel Plant, Hindustan Petroleum Corporation Limited, Hindustan Polymers, Hindustan Zinc Limited's Zinc-Lead smelter, Visakhapatnam Port and Coromandal Fertilizers Limited. Studies were carried out to find out heavy metal concentration on the top soils near these industrial areas to check the level of soil pollution and contamination due to industrial effluents and its activities. Carter (1993) stated that high levels of civilization-related soil pollution have recently become a major issue and the chemical analysis of soils is important for environmental monitoring and legislation. Since these heavy metals are highly hazardous to the environment and organisms, proper monitoring regarding their concentration levels is very essential. Excess heavy metals in the soil originate from many sources, which include atmospheric deposition, sewage irrigation, improper stacking of the industrial solid waste, mining activities, the use of pesticides and fertilizers (Zhang *et al*., 2011).

Review of Literature
During recent years, soil is polluted more and more seriously by heavy metals because of mining, smelting, irrigating with sewage and also due to human activities. Heavy metals adversely affect soil ecology, agricultural production, product quality and ultimately interrupt human food chain. Moreover, adverse environmental effects are closely related to the biological availability of these heavy metals. Various researchers reported on heavy metal contents present in the soil in the premises of industrial areas. Some reports showed permissible levels but in some areas it was observed that the levels were alarming. Researchers also worked on various techniques to analyze heavy metals. There are a number of methods determining the free metal ion concentration, but each method has its advantages and limitations (Florence, 1986; Apte and Batley, 1995; Mota and Correia, 1995).

The free metal ion concentration not only depends on the total metal content in soils, but also on the metal species that exist in the soil. In addition, some environmental conditions (e.g., pH, concentration of competing ions, concentration of complexing ligands in solution, and the soil colloid) and characteristics of organism in soil may play an important role (Temminghoff *et al*., 2000).

In 1992, Davis *et al*., reported on bioavailability of arsenic and lead in soils from the Butte, Montana, minting district. In 1993, Katbata-Pendias reported on behavioral properties of trace metals in soils. In 1995, Alloway reported on heavy Metals in Soils. In 1996, Parker and Pedler reevaluated the free ion activity model of trace metal availability to higher plants. In 2000, Temminghoff *et al*., determined the chemical speciation of trace metals in aqueous systems by Wageningen Donnan Membrane Technique. In 2001, Weng *et al*., determined the free ion concentration of trace metals in soil solution using a soil column Donnan membrane technique. In 2003, Cances *et al*., reported on metal ions speciation in a soil and its solution. In 2005, Ge *et al*., worked on modeling of Cd and Pb speciation in soil solutions by WinHumic V and NICA-Donnan model. In 2007, Li *et al*., worked on determination of free heavy metal ion concentrations in soils around a cadmium rich zinc deposit. In their study, free heavy metal ion concentrations of Cu^{2+}, Zn^{2+}, Ni^{2+} and Cd^{2+} were studied at different soil to soil solution ratio (SSR) to discuss metal bioavailability and toxicity. Donnan Membrane Technique (DMT) and ECOSAT program were used to determine the free heavy metal ion concentration.

Brumelis *et al*., (1999) worked on risk assessment of Zn deposition around a metal smelter in Latvia. Cortes *et al*., (2003) reported on biological treatment of industrial liquid effluent in copper production industry. Razo *et al*., (2004) reported on Arsenic and heavy metal pollution of soil, water and sediments in a semi- arid climate mining area in Mexico. Guo and Zhou (2006) evaluated heavy metal contamination in Phaeozem of northeast China. Suciu *et al*., (2006) monitored the heavy metals concentration in the soil in the Campia Turzii area. Duzgoren-Aydin *et al*., (2006) reported on heavy metal contamination and distribution in the urban environment of Guangzhou, China. de Vries *et al*., (2007) reported on critical soil concentrations of cadmium, lead, and mercury in view of health effects on humans and animals. In 2007, Boukhalfa reported about heavy metals in the water and sediments of Algeria.

Asonye *et al*., (2007) reported on physico-chemical characteristics and heavy metal profiles of Nigerian rivers, streams and waterways. Vaalgamaa and Conley (2008) reported on detecting environmental change in estuaries regarding nutrient and heavy metal distributions in sediment cores in estuaries from the Gulf of Finland. Pandey *et al*., (2008) reported about accumulation of heavy metals in dietary vegetables and cultivated soil horizon in organic farming system in relation to atmospheric deposition in a seasonally dry tropical region of India.

In 2011 Adelekan and Abegunde reported on Heavy metals contamination of soil and groundwater at automobile mechanic villages in Ibadan, Nigeria. In 2014, Chiroma *et al*., done comparative assessment of heavy metals in soil, vegetable and urban grey waste water used for irrigation in Yola and Kano, Nigeria. They investigated on concentration of heavy metals in grey waste water used in urban irrigation sites.

In 2014, Su *et al*., reported on heavy metal contamination in the soil worldwide. The situation, impact and remediation techniques were also discussed. They compared and analyzed soil contamination of heavy metals in various cities/countries, and reviewed background, impact and remediation methods of soil heavy metal contamination worldwide.

In 2015, Nazir *et al*., reported on Accumulation of Heavy Metals (Ni, Cu, Cd, Cr, Pb, Zn, Fe) in the soil, water and plants and analysis of physico-chemical parameters of soil and water of anda Dam, Kohat, Pakisthan. About 13 samples of water and 13 soil samples were collected at random and four wild plants namely Xanthium strumarium, Acacia modesta, Dodmea viscosa and Tamarix aphyda were collected. Plants samples were analyzed separately for their root, stem and leaves. Flame absorption spectrometer was used for analyzing the samples. Results showed that concentrations of cadmium, chromium, iron and lead in water were recorded above the permissible limits set by WHO while zinc and copper were recorded below the permissible limits and no concentration of nickel was recorded in water samples. pH of all water samples was recorded below the normal range while hardness and electrical conductivity of all water samples were recorded above the normal range set by WHO.

MATERIALS AND METHODS

Data Collection and Analysis

Two soil samples (three replicates) that were collected at surface level (0-10 cm in depth) from NTPC industrial region (Site 1) and Coramandal fertilizers (Site 2) industrial region Visakhapatnam. The collected soil samples were air dried and sieved into course and fine fractions. The samples were allowed to dry for 48 h at room temperature and sieved. Sieved samples were subjected to use for measurement of heavy metal analysis. Analysis of heavy metals in soil samples were carried out in triplicates.

Instrument and Apparatus

Atomic absorption spectrophotometer was used for analyzing the heavy metals. All glassware were soaked in 3 M HNO_3 for the whole night, washed with deionized water, and rinsed with double distilled water to minimize the chances of interferences.

RESULTS AND DISCUSSION

Excess heavy metals in the soil originate from many sources, which include atmospheric deposition, sewage irrigation, improper stacking of the industrial solid waste, mining activities, the use of pesticides and fertilizers (Zhang *et al*., 2011). The content of heavy metals in fertilizers is generally as follows: phosphoric fertilizer> compound fertilizer> potash fertilizer> nitrogen fertilizer (Boyd, 2010).

The results obtained during the undertaken studies are appended in Table 1**.** The Pb (Lead) contents in the soil samples were found to be 0.02 ppm for site 1 and its content was not detected for the site 2. The Cadmium content (Cd) for site 1 is 0.04 ppm and for site 2 it is 0.02 ppm. The Iron content (Fe) for site 1 is 1.6 ppm and for site 2 it is 1.4 ppm. The Copper content (Cu) for site 1 is 3.1 ppm and for site 2 it is 2.9 ppm. The Manganeese content (Mn) for site 1 is 1.3 ppm and for site 2 it is 1.2 ppm. The Zinc content (Zn) for site 1 is 3.1 ppm and for site 2 it is 2.8 ppm. The P^H for the site 1 soil sample was observed to be 7.5 and for the site 2 7.8. Slight alkalinity was observed for the soil samples. The analyses show that soil samples collected from polluted areas have more concentrations of heavy metals than non-polluted areas.

Aeliona *et al*., (2008) reported on Metal concentrations in rural topsoil in South Carolina. Arao *et al*., (2010) reported on Heavy metal contamination of agricultural soil and counter measures in Japan. Babula *et al*., (2008) reviewed on uncommon heavy metals, metalloids and their plant toxicity. Chen and Pu (2007) studied on relationship between heavy metals and basic properties of agricultural soils in Kunshan County. Zheng *et al*., (2002) studied on current situation and method of contamination of heavy metals in soil. Yabe *et al*., (2010) reported on current Levels of Heavy metal contamination in Africa. Xi *et al*., (2008) investigated and assessed on pollution caused by soil heavy metals in Changsha city, Hunan Province. Li and Huang (2007) reported on environment impact of heavy metals on urban soils in the vicinity of industrial area of Baoji city, China. Kandeler *et al*., (1997) reported on influence of heavy metals on the functional diversity of soil microbial communities. Chibulke and Oblora (2014) discussed about heavy metal polluted soils their effect on plants and bioremediation methods.

Table 1: Heavy Metal analysis of Site 1 (Koramandal Fertilizers) and Site 2 (HPCL)

Parameter	**Site 1**	**Site 2**
Pb in ppm	0.02	Not Detected
Cd in ppm	0.04	0.02
Cu in ppm	3.1	2.9
Fe in ppm	1.6	1.4
Mn in ppm	1.3	1.2
Zn in ppm	3.1	2.8
P^H	7.5	7.8

Conclusion

Soil formation is a complex and long term procedure. It is composed of mineral constituents, organic matter (humus), living organisms, air and water, and it regulates the natural cycles of these components. Heavy metals in the soil refers to some significant heavy metals of biological toxicity which includes mercury (Hg), Cadmium (Cd), lead (Pb), Chromium (Cr), Arsenic (Ar).The retention of added heavy metals to soils was often correlated with soil organic matter. Annihilation of heavy metal pollution is critical because cleaning contaminated soils is not an easy task but an extremely expensive and difficult endeavor.

Practically speaking, Prevention is the best strategy to protect the environment from the contamination of heavy metals. Once metals are introduced and allowed to contaminate the environment, they would persist and resume in the environment for a long span of time.

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