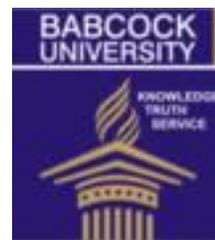




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Research

Lead Contamination of Soils, Leaves, Stems and Roots of Plants in Agbara Industrial Estate Ogun State Nigeria.

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Abstract

The determination of lead in soil, leaves, stem and roots of plants located in different parts of an industrial area was successfully carried out. Lead was determined spectrophotometrically as dithizone complex. It was compared to a calibration curve prepared in standards similarly from lead. The calibration curve is linear from 0, 2, 4, 6, 8 and 10mls, whose absorbance are 0.01ppm, 0.260ppm, 0.391ppm, 0.515ppm and 0.558ppm. The relative lead concentration of sample A (sand, leaves, stem and roots) are 8.6ppm, 6.00ppm, 8.20ppm and 3.60 respectively, sample B (sand, leaves, stem and roots) are 4.4ppm, 2.2ppm, 3.6ppm and 4.8ppm respectively and sample C (sand, leaves, stem and roots). These results were determined spectrophotometrically using AAS220GF at 440nm with 0.01nm accuracy. These results indicate higher levels of lead in soils and plants in the industrial areas. It is suggestive that the heavy metal content of effluents coming directly from the neighboring industries be monitored to ensure that water and plant bodies are bared from high risk of exposure to lead and other heavy metals.

KEY WORDS: Lead, dithizone, spectrophotometry, soil, leaves, water

Introduction

The present magnitude of the world's population demands an increased application of technology to explore and exploit natural resources, more food, seeds and services. This situation translates into increased industrialization, which inevitably results to the release of various types and amounts of industrial wastes into the environment. According to Voutsinou (1987) and Prodi (1986), heavy metals are important sources of pollution not just because they are toxic above a relatively low concentration but also because they are persistent and non biodegradable, remaining in the environment long after the sources of pollution has been removed. Observation has also shown that heavy metals are bio-accumulated in one or more compartments of the food web Craig, (1983). Many metals form organometallic compounds, which are more toxic than their elemental or ionic forms in the environment. Toggel, (1998).

Although industrial effluents are not the only source of heavy metals in the environment, they are possibly the most important single source contaminating or polluting the environment. Schroedor (1988) estimated that up to 600 tonnes of mercury is introduced into Minimata bay in Japan annually. In Nigeria, Cidding, (1988) and Hodges, (1990) identified effluent from textile industries as one of those introducing heavy metals along with other pollutants into the environment. Similarly, Akinola, John and Titiloye, (1981) analyzed industrial effluents from Lagos, Ogun, Kwara and Sokoto States and found that they contained heavy metals ranging in concentration from Nil to 15.4, 4.2, 6.6 and 8.3ppm respectively, for Zn, Cu, Fe and Mn. However, none of these authors related their measurements to the amount of metals present in the recipient drainage water as well as the bodies of natural waters into which the drainage empty. Over 85% of all industries are situated in the Lagos metropolitan area. Thus there is the need to carry out a chemical survey of effluents of urban industries and determine their contribution to the load of heavy metals pollution in Ogun state. The biological effect of most prominent types of heavy metals in terms of distribution and concentration can then be meaningfully undertaken to facilitate proper control and management.

The heavy metals which by definition are element having a density greater than five in their elemental form and comprises of some 38 elements in which 12 are used and discharged by industries i.e. Cd, Cr, Co, Cu, Fe, Hg, Mn, Mo, Ni, Pb, Sn, and Zn. The heavy metals considered most important as environmental pollutants are Cd, Pb, Cu, Hg, As, Zn, and Ni. The term heavy metal is least satisfactory for those metals

involved in biochemical and toxicology processes, Philips (1981). Lead has only one common allotrope, which is face-centered cubic, with the lead-lead distance being 349 pm. At 327.5 °C (621.5 °F), lead melts; the melting point is above that of tin (232 °C, 449.5 °F), but significantly below that of germanium (938 °C, 1721 °F). The boiling point of lead is 1749 °C (3180 °F), which is below than those of both tin (2602 °C, 4716 °F) and germanium (2833 °C, 5131 °F). Densities get simply bigger down the group: the Ge and Sn values (5.23 and 7.29 gcm⁻³, respectively) are significantly below that of lead: 11.32 gcm⁻³ Lide, (2004).

As with many metals, finely divided powdered lead exhibits pyrophoricity. Toxic fumes are released when lead is burned. It is known that lead accumulates in the soil, particularly soil with a high organic content (US EPA, 1986). Lead deposited on the ground is transferred to the upper layers of the soil surface, where it may be retained for many years (up to 2000 years). In undisturbed ecosystems, organic matter in the upper layer of soil surface retains atmospheric lead. In cultivated soils, this lead is mixed with soil to a depth of 25C11l (i.e., within the root zone). Atmospheric lead in the soil continues to move into the micro-organism and grazing food chains, until equilibrium is attained.

Solid-phase extraction and determination of ultra-trace amounts of lead, mercury and cadmium in water samples using octadecyl silica membrane disks modified with 5, 5'-dithiobis(2-nitrobenzoic acid) and atomic absorption spectrometry, was carried out by Le van, (2010). A simple and fast method for pre-concentration and determination of ultra-trace amounts of lead (II), mercury (II) and cadmium (II) in water samples was presented. Lead, mercury and cadmium adsorbed quantitatively during passage of water samples (pH=7, flow rate=20mLmin⁻¹) through octadecyl silica membrane disks modified with 5, 5'-dithiobis (2-nitrobenzoic acid). The retained lead, mercury and cadmium are then stripped from the disk with a minimal amount of 1M hydrochloric acid solution as eluent, and determined by atomic absorption spectrometry

Rapid co-precipitation-separation and flame atomic absorption spectrometric determination of lead and cadmium in water with cobalt (II) and ammonium pyrrolidine dithiocarbamate, was experimented on by Xiaobin, (2009), in which a co-precipitation technique which does not require complete collection of the precipitate was proposed for the determination of trace lead and cadmium in water with flame atomic absorption spectrometry (FAAS) after pre-

concentration of lead and cadmium by using cobalt (II) and ammonium pyrrolidine dithiocarbamate (Co-APDC) as co-precipitant and known amount of cobalt as an internal standard

A sensitive and selective pre-concentration method has been developed for the determination of trace amounts of lead and cadmium ions by using naphthalene methyl-trioctyl ammonium chloride as an adsorbent Du, Yang, Wei and Chang (2002). Lead and cadmium ions were retained by the adsorbent in the mini-column as PbI_4^{2-} and CdI_4^{2-} , respectively. The column was washed by 5mL of $2mol\ L^{-1}$ nitric acid solution to elute the adsorbed cations. The collected eluents then were determined by flame atomic absorption spectrometry (FAAS). Potential factors affecting on the recovery of the analytes were investigated.

Atomic Absorption Determination of Cadmium, Lead, and Mercury in Sea and River suspensions using an electro-thermal atomizer with two vaporization zones was carried out by Oreshkin and Tsizin, (2007). It was shown that suspended forms of Cd, Pb, and Hg can be simultaneously determined in river and sea waters by direct atomic absorption spectrometry with two independent stages of the fractional evaporation of solid suspensions (at $<1000\ ^\circ C$ and $>1500\ ^\circ C$) in the system crucible (vaporizer)–core (collector).

Experimentals

Samples were collected from various industrial areas of Agbara, which were labeled A to C. The first samples comprising of soil, leaves, stem and roots labeled A_1 to A_4 respectively were collected near the dump site of a pesticide production industry. The soil sample (A_1) was collected 5cm from the soil surface, the leave sample (A_2) was collected from a growing

plant of about 15cm tall, of which it's stem and root was collected as sample A_3 and A_4 which was about 5cm deep. Second sample of soil, leaves and root, labeled respectively as B_1 , B_2 , B_3 and B_4 were collected from the back of a beverage manufacturing industry. The soil sample (B_1) was collected from 6cm from soil surface. The leaves were collected from a growing plant of about 10cm tall, in which its stem and root was collected as sample B_3 and B_4 . Third samples labeled C_1 to C_4 were collected in the opposite side of a pharmaceutical industry. The soil sample was collected from the surface of the earth. The leaves were collected from a tree plant, while the stem and root was collected from a small plant in the same vicinity.

Samples were transferred into clean, black labeled polythene bags. The leave, root and stem samples were then washed in a conical flask using 5% sodium chloride (saline) and rinsed with distilled water. The leaves, stems and roots were dried and ground to fine particle size. Standard 10ppm working solution was prepared on the day of the experiment by diluting 1ml of the stock solution to 100ml in a volumetric flask. Dithizone solution was freshly prepared by dissolving 1.5mg dithizone in 300ml of methylene chloride. The analytical method was accordingly to Christian, 2007. The chelate formation and solvent extraction were carried out in clean 10ml vials with caps. To each of the labeled vials, 0, 2, 4, 6, and 8mls of the 10ppm lead standard was added and sufficient distilled H_2O to bring the volume to 20ml. 60ml of ammonia-cyanide-sulphite solution was added and 25ml of the methylene chloride dithizone mixture were delivered via a pipette. The vial was stoppered and shaken for about 2minutes. The heavier methylene chloride layer was withdrawn with a pipette and filtered and measured with AAS220GF Atomic Absorption Spectrophotometer at 440nm.

RESULTS

Sample A: Soil = A_1
Leaves = A_2
Stems = A_3
Roots = A_4

Sample B: Soil = B_1
Leaves = B_2
Stems = B_3
Roots = B_4

Sample C: Soil = C_1
Leaves = C_2
Stems = C_3
Roots = C_4

STANDARDS (ppm)	ABSORBANCE (nm)
0.00	0.000
2.00	0.123
4.00	0.260
6.00	0.391

8.00	0.515
10.00	0.632

Table 1: Absorbance of lead standard

SAMPLES	WEIGHT (g)	CONC ppm	SAMPLES	WEIGHT (g)	CONC ppm	SAMPLES	WEIGHT (g)	CONC. ppm
Soil (B ₁)	5.00	4.40	Soil (C ₁)	5.00	4.40	Soil (A ₁)	5.00	8.60
Leaves(B)	0.66	2.20	Leaves (C ₂)	0.10	4.80	Leaves (A ₂)	0.17	6.00
Stem (B ₃)	0.86	3.80	Stem (C ₃)	0.53	4.60	Stem (A ₃)	0.40	8.20
Roots (B ₄)	0.99	4.80	Roots (C ₄)	0.38	6.20	Roots (A ₄)	0.55	3.60

Table 3: Absorbance of A, B and C (soil, leaves, stems, root)

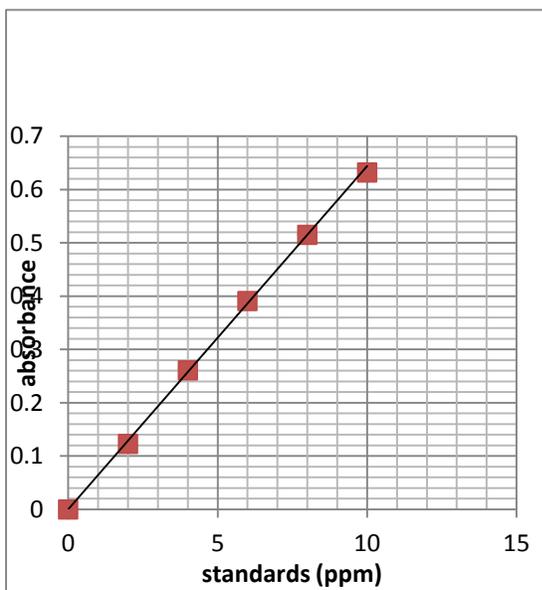


Fig. 1 Calibration curve for lead

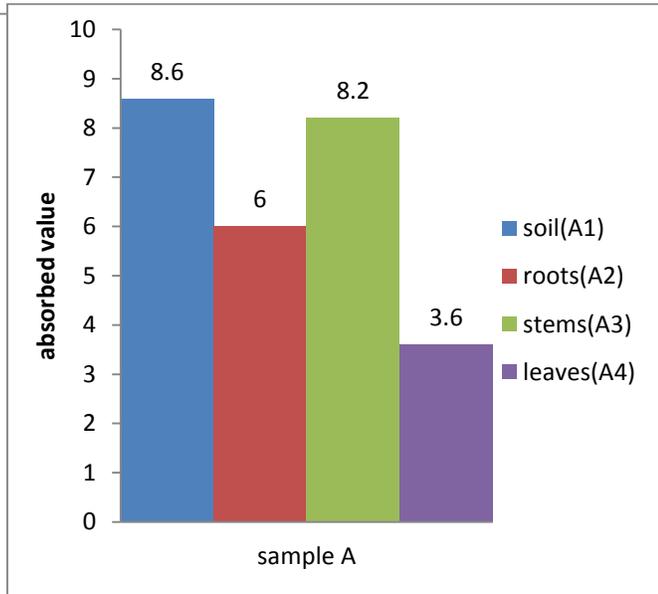


Fig. 2 Histogram of Conc. of lead in sample A (ppm)

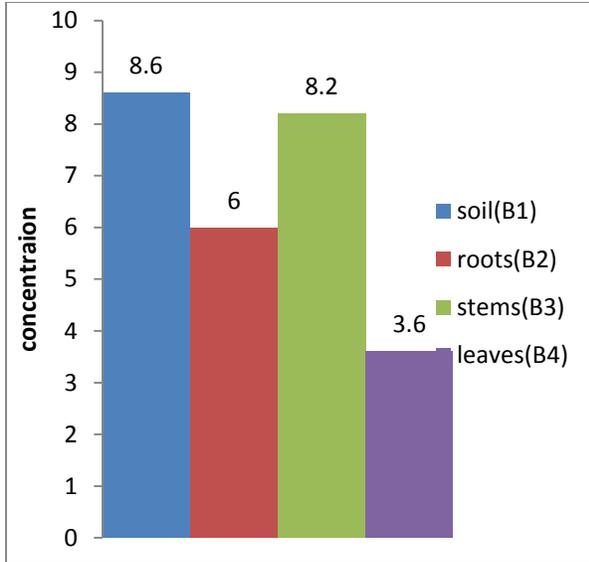


Fig 3. Histogram of Conc. of lead in sample B (ppm)

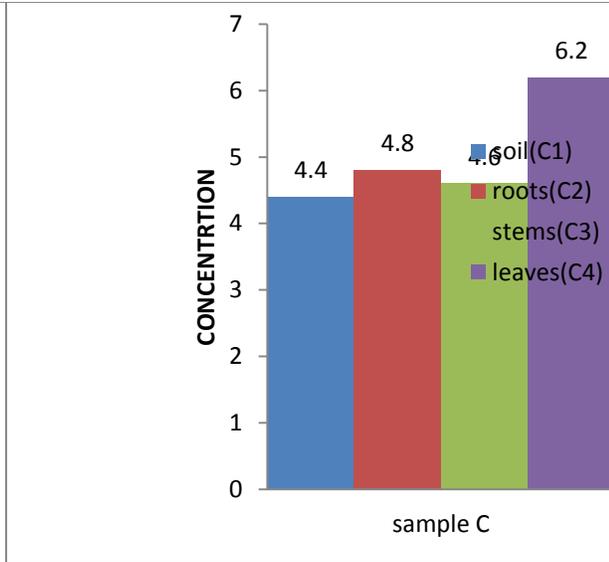


Fig. 4. Histogram of Conc. of lead in sample C (ppm)

Discussion

Results showed that all samples taken from different sites of industries around Agbara metropolis contained lead occurring in varying concentrations within and between different categories of industries. The result of lead concentration in sample A as shown in Table 2 indicates that the soil sample had the highest concentration of lead (8.6ppm) which reflected in the roots of plants (6.00ppm) and stem (8.20ppm) whereas the leaves had barely 3.60ppm. The result of lead concentration in sample B as shown in figure 3 indicates that the soil sample had the concentration of lead (4.4ppm) which reflected in the leaves of plants (4.8ppm) and stem (3.8ppm) whereas the roots had barely 2.2ppm.

Also the result of lead concentration in sample C as shown in figure 4 indicates that the soil sample had the concentration of lead (4.4ppm) which reflected in the leaves of plants (6.2ppm) and roots (4.8ppm) whereas the roots had barely 4.6ppm.

From the result obtained, it is found that lead content of samples taken from site A has the highest value compared to others. This is due to the fact that site A is the opposite side of a pharmaceutical industry close to a dumping site. These values are clearly depicted in the histograms shown in Fig 1-4.

The value of lead obtained in sites B and C are lesser because the samples were from non- refuse dumping sites. These results are in agreement with those of several earlier workers; Ciddling, (1988); Titilope, (1981) and Hodges, (1990) who have similarly shown that lead and other metals occur in trace amounts in the environment.

Conclusion

There are various ways through which lead enters the environment, from primary and secondary smelting operation; as a result of the way it is used, in the combustion of coal and other natural products and in the disposal of discarded or unwanted materials incorporating lead products.

The entering of lead into the environment from production and manufacturing processes tend to be concentrated and governed by strict regulations. On the other hand, when lead is used in such a way it is eventually released into the atmosphere though gradual and over a wide area. Lead smelting is the main source of lead release into the environment. Lead poisoning has been recognized for centuries and yet lead has been used copiously in the environment from which man gathers food, water, and the highest known exposure of human beings to lead before the age of petrol was the time when lead amphorae was used in storing syrups and wine, lead pipes used to carry water to houses, (when water is soft it dissolves lead) and lead cosmetic used by ladies. Lead poisoning was endemic among those who could afford such luxuries.

Since accumulation of heavy metals is not easily removed from the soil they thereby deplete the soil of its essential elements, therefore crops planted on the soil will be affected and which will be toxic to man when consumed in large quantity, therefore a closer monitoring of the heavy metal levels of soils is desirable.

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