PHYSICOCHEMICAL ANALYSIS AND HEAVY METALS CONCENTRATION IN SOIL AROUND DANGOTE CEMENT MANUFACTURING INDUSTRY, IBESE, OGUN STATE, NGERIA

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ABSTRACT:

The *Assessment of heavy metals and physico-chemical parameters in soil samples from various locations around Dangote Cement Factory, Ibese, Ogun state was analysed. Top soil samples at depth of 0-15cm were taken from the north, south, east and west around the factory. The soil characterization was carried out for pH, cation exchange capacity, organic matter, and heavy metals (copper, iron, lead, zinc and cadmium.) In this study, all the reagents used were of analytical grade, samples for heavy metals were prepared using acid digestion method, the concentration in the samples were determined using Atomic Absorption Spectroscopy (AAS). At the end of the study, it was revealed that the concentration of heavy metals ranged from 2.28ppm to 3.25ppm for Iron, 0.21ppm to 0.28ppm for Cu, 0.01ppm to 0.22ppm for Zn, 0.05ppm to 0.88ppm for Cd and 0.10ppm to 0.18ppm for Pb, with the pH ranging from 5.8 to 7.5. Although, the heavy metals concentration in the samples were below the standard limits set by the United State Environmental Protection Agency, but were found to be higher when compared with the control samples, taken from industrial-free area. Conclusively, the influence of the cement factory on the soil at the time of the study was below the USEPA limit.*

***Key words**: Heavy metals, soil, Ibese*

Introduction

Anthropogenic pollution is a serious problem the world and its inhabitants are suffering, soil being a sink for this waste. Soil is a natural body consisting of layers (soil horizons) that are primarily composed of minerals which differ from their parent materials in their texture, structure, consistency, colour, chemical, biological and other characteristics. It is the unconsolidated or loose covering of the fine rock particles that covers the surface of the earth (Ayedun et al., 2102).

Soil is the end product of the influence of the climate (temperature, precipitation), relief (slope), organisms (fauna and flora), parent materials (original minerals) and time. (Birkland, 1999).

Purely theoretically, every 1000kg of "normal" soil contains 200g of Chromium, 80g of Nickel, 16g of Lead, 0.5g of mercury and 0.2g of cadmium. Therefore, it is not always easy to assign a definite cause for increased heavy metal content (ICRL, 1987). Toxic metals are daily ingested by humans either through air, food, water and soil (Onweremadu et al., 2007).

However, the term "heavy metal" is often used to cover a diverse range of elements, which constitute an important class of pollutants. With industrial development like cement factory, the production and emission of heavy metals have increased. Some metals e.g. Mn, Cu, Pb, Mo and Ni, are essential or beneficial micronutrients for micro-organisms, plants and animals, but at high concentrations, all these metals have strong toxic effects and poses environmental threats (Nodelkoska and Dora, 2012).

Heavy metals can be defined as an undesirable change in the physical, chemical or biological characteristics of land, water and air that may have harmful effect on animals and plants (Odun and Saunder, 1991).

Heavy metals have received the attentions of the researchers all over the world, mainly due to their harmful effects on plants, especially those on vegetative and generative part of the plants (Chaney et al., 1999).The presence of heavy metals in food substances constitute serious health hazards, depending on their relative levels. For examples, cadmium and mercury injure the kidney and cause symptoms of chronic toxicity, including impaired kidney functions, poor reproductive capacity, hypertension, tumors and hepatic dysfunction (Lucky et al., 1994) and (Ismail,2006). A number of chemical reactions control the behavior of heavy metals in soil. In technical terms, these reaction mechanisms include cation exchange, specific adsorption, co-precipitation and organic chelation (Alloway, 1995). These reactions control the exchange of heavy metals between soil particles and soil water. Most heavy metals are stored in the soil, usually attached to organic matter and clay.

Once in the soil water, heavy metals may move within the soil profile and are available to plants and can be leached into ground water. Large concentrations of heavy metals in the soil present a number of concerns to local citizen (Begun and Ramaiah, 2009).

Therefore, assessing the concentration of pollutants in the ecosystem has become an important task in preventing risks to natural life and public health. This study therefore, led to sampling of soil at different locations around Dangote cement manufacturing area, Ibeshe, Ogun state, to determine the extent of heavy metals pollution and physico-chemical parameters of the soil.

Materials and Methods

Study Area: Ibese is located in Egbado (Yewa) North of Ogun State, Southwest Nigeria. It lies on latitude 6^{o} 58' 0" N and longitude 3^{o} 2' 0" E. The inhabitants are mainly farmers and traders. The cement factory (Dangote cement) is situated at Ibese and has commenced production since 9^{th}, February 2012. The geology of Ibese and its environs consists of Ewekoro formation, which is marine and paleoceneage. It consists of a limestone unit several meters in thickness which is overlain by a shale unit almost three times as thick as the limestone (Ayedun et al., 2012).

Sample collection and Preparation: Four samples were collected randomly each from four different points around the four cardinal points of the cement factory and a sample at the control site(about 4km away from the sample site) using stainless van-veen grab, polyethylene bag and plastic spoon from total number of twenty points at the depth of 0-15cm.

Treatment of Samples: The soil samples were air-dried, cleaned and sieved to remove unwanted substances other than the soil particles. The physico-chemical tests were then performed on the aggregate samples (i.e. composite samples) prepared by mixing thoroughly equal amount of soil samples from each point.

Analysis of Samples: The following physico-chemical analyses were carried out on the properly stored and preserved soil samples.

pH: The soil pH was determined using an electronic pH meter.

Exchangeable cations: CEC were extracted using ammonium acetate method**.**

Organic Matter: Organic matter content of each soil sample was done using loss of weight on ignition method [16].

Determination of Heavy Metals (Cd, Pb, Zn, Cu and Fe) Concentration: The determination of heavy metals concentration in the soil samples was carried out based on acid digestion using AAS to determine the concentration.

Results and Discussion

Results: The results of the physico-chemical properties are shown in **Table 1** and those of the heavy metals in the samples taken from North, South, East and West of the cement factory are shown in **Table 2 – 5.Table 6** shows the results of physico-chemical parameters of the samples, the mean and standard deviation values of the heavy metals concentrations, and the results of the control sample (CS).

Table 1: Physicochemical parameters of the soil

Location	Organic matter %	CEC $CmolKg^{-1}$	pH
N	4.19	2.82	7.5
E	2.09	2.78	6.5
W	2.59	2.25	7.3
S	1.99	3.22	5.8
CS	8.50	6.2	5.7

***N: North of cement factory, *E: East of cement factory, *W: West of cement factory, *S: South of cement factory, *CS: Control Sample**

Table 2: Heavy metals content of samples collected at the north of Dangote cement factory, Ibese.

Soil Samples	Cu (ppm)	Fe (ppm)	Zn (ppm)	Cd (ppm)	Pb (ppm)
N1	0.21	2.61	0.08	0.03	0.09
N2	0.20	2.58	0.13	0.07	0.13
N3	0.23	2.64	0.09	0.04	0.14
N4	0.24	2.64	0.11	0.07	0.07
Mean	0.22	2.62	0.18	0.05	0.11
S.D	0.018	0.029	0.022	0.021	0.033

Table 3: Heavy metals content of samples collected at the south of Dangote cement factory, Ibese.

Soil Samples	Cu (ppm)	Fe (ppm)	Zn (ppm)	Cd (ppm)	Pb (ppm)
S1	0.20	3.20	0.09	0.85	0.10
S2	0.18	3.27	0.12	0.87	0.13
S3	0.22	3.18	0.15	0.90	0.12
S4	0.24	3.29	0.15	0.89	0.10
Mean	0.21	3.25	0.13	0.88	0.11
S.D	0.026	0.053	0.0289	0.025	0.015

Table 4: Heavy metals content of samples collected at the east points of Dangote cement factory, Ibese.

Soil Samples	Cu (ppm)	Fe (ppm)	Zn (ppm)	Cd (ppm)	Pb (ppm)
S1	0.23	2.30	0.24	0.06	0.19
S2	0.30	2.26	0.20	0.10	0.16
S3	0.32	2.26	0.22	0.12	0.20
S4	0.25	2.31	0.21	0.05	0.17
Mean	0.28	2.28	0.22	0.08	0.18
S.D	0.042	0.026	0.017	0.033	0.018

Table 5: Heavy metals content of samples collected at the west points of Dangote cement factory, Ibese.

Soil Samples	Cu (ppm)	Fe (ppm)	Zn (ppm)	Cd (ppm)	Pb (ppm)
W1	0.21	2.40	0.08	0.09	0.15
W2	0.26	2.24	0.14	0.10	0.20
W3	0.22	2.50	0.10	0.08	0.18
W4	0.21	2.62	0.15	0.11	0.17
Mean	0.23	2.44	0.12	0.10	0.18
S.D	0.024	0.161	0.033	0.013	0.021

Table 6: Showing the physico-chemical parameters of soils and mean values of heavy metal concentration in soil around Dangote cement factory, Ibese.

SAMPLES	Cu (ppm)	Fe (ppm)	Zn (ppm)	Cd (ppm)	Pb (ppm)	pH	CEC ($CmolKg^{-1}$)	O.M
N	0.22	2.64	0.18	0.05	0.11	7.5	2.82	4.19
W	0.23	2.44	0.12	0.10	0.18	6.5	2.78	2.09
E	0.28	2.28	0.22	0.08	0.18	7.3	2.25	2.59
S	0.21	3.25	0.13	0.88	0.11	5.8	3.22	1.99
CS	0.14	2.11	0.08	0.01	ND	5.70	6.2	8.50

***N = North point of factory, E = East point of factory, W = West point of factory, S = South point of factory, ND = Not Detected, CS = Control sample at gbokoto, O.M=Organic Matter.**

Discussion

The soil organic matter ranged from (1.99%-4.19%),Organic matter values are considered low if less than 4%, medium from 4% to 8%, and high if above 8%,the organic matter in the sample is low. Medium levels are desirable for optimal plant growth. Benefits of organic matter in the soil include improved water and nutrient holding capacities; better soil structure which enhances root growth and increases aeration; a more hospitable environment for soil organisms; and a reserve of plant nutrients (Storer, 1984).

The pH values of the soil samples revealed that the soil varies from slightly acidic to slightly basic level which is good for most plants. The pH values ranged from (5.8 to 7.5) for soil samples. The control sample is 6.5.The optimum pH range required by most plants to survive is (5.5 to7.0). However, many plants thrive to survive at pH values outside this range.

Iron had the highest concentration in both samples form Ibese and the control sample with values ranging from (2.28ppm to 3.25ppm) and control sample 2.11ppm. It has been confirmed that natural soil contains significant concentration of iron and also suggested that iron pollution in soil cannot be conclusively linked to effluents alone but to other natural sources as well (Eddy et al., 2006).
Copper was found to be the second highest heavy metals in the soil samples with the concentration ranging from (0.21ppm to 0.28ppm) and 0.14ppm for the control sample. The concentration of copper in the study sample is greater than that of the control sample but less than the standard from (USEPA, 1993).

The concentration of lead in the samples analyzed ranged from (0.10ppm to 0.18ppm) and the metal was not detected in the control sample. The lead concentrations was lower when compared with (Odewole, 2012) and far below the regulatory limit of 420ppm by (USEPA, 1993).

The concentration of Zn in the study samples ranged from (0.10ppm to 0.22ppm) which is higher than the Zn concentration obtained from the control sample which is 0.08ppm.

The concentration of cadmium obtained ranged from 0.05ppm to 0.88ppm and the concentrations are higher than that of the control sample which is 0.01ppm.
CEC is the ability of soil to retain positively charged ion. The values ranged from 2.25CmolKg^{-1} to 3.22CmolKg^{-1} and 7.3CmolKg^{-1} for control samples. This implies that the control sample has capacity to retain positively charged ion more than the samples from area under study.

Conclusion

From the results above, it can be concluded that the heavy metals, CEC, organic matter and the pH of the soil around Dangote Cement Manufacturing industry, Ibese were higher compared to those of the control sample and lower than the regulatory limit by USEPA. The pollution level observed cannot cause harm to plants, animals and health of the people living in the area at the time of study.

Recommendation

It is therefore recommended that proper examination should always be carried out on the soil in this environment at regular interval to check for the level of heavy metals concentration in the soil in order to avoid heavy metals contamination which may eventually be harmful to man and its environ.

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