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Analysis of Heavy Metals Present in Roadside Soils in Lagos State Using Inductively Coupled Plasma Spectrophotometry

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Abstract
The heavy metals in soil have been a serious problem to the environment and one of the most pressings threat in the world today. The toxic heavy metals in roadside soil samples were collected randomly from three different sites for a period of four weeks between the months of June to October, 2021 and were taken through the digestion method, cooled and filtered. The filtrate was quantified using inductively coupled plasma optical emission spectrophotometry (ICP-OES). The pH ranged between 7.07 – 7.20 with soil sample recording the highest value of 7.20 with Lagos state university roadside soil while the percent moisture content value of the sample ranged from 10.7 % - 11.93 % for isheri and Iyana iba. The high moisture in Iyana-Iba area could be attributed to the reconstruction work going on along the Badagry expressway. The heavy metals (Zn, Ca, Fe, K, Na, Mg, Si) present in soil samples collected from the three different locations in Lagos State are (47.60, 41.29, 29.16, 34.41, 51.89, 8.25 and 11.95) Mg / L. The concentrations of the soil samples revealed the chemical composition of heavy metals present in the soil samples of Isheri area with the highest concentration for Zn, K, and Na while Iyana-Iba area had the highest concentration for Ca, Fe, Mg, and Si. The high level of heavy metals in the two locations could be as a result of the fact that Iyana-Iba area route is an international route to Republic of Benin. However, the concentrations of all the toxic heavy metals except Ba are higher than the World Health Organization (WHO) maximum permitted levels but they are toxic even at their lowest concentration they are toxic to the soil, man, and their environment (WHO, 2011).

Keywords: *Soil, heavy metals, digestion, inductively coupled plasma spectrophotometry (ICP-OES)*
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I. Introduction

Heavy metal is linked with pollution and toxicity that affects the environment [1]. Heaviness and toxicity are associated because they include metalloids, such as arsenic, which are very toxicity at low concentration [2]. They may also include some elements which are very essential for living organisms and also known to be of serious hazard to plant and animals as listed by the European Commission. Examples are; As, Cd, Cr, P, Cu, Pb, Hg, Ni, Al and Zn, Al e.t.c all these are very harmful at a lower concentration. Heavy metals in general have no basic function in the body but highly toxic [3, 4]. It is largely due to anthropogenic activities such as mining and processing of metal ores, burning of fossil fuels, the use of fertilizers including sewage sludge and pesticides, transport, and many other industrial processes [4, 5]. Some physiochemical properties such as pH, some soil granularity, organic matter, [6, 7, 8]. Environmental pollution from mining activities causes environmental and social problems. Heavy metal pollution in mining areas has caused damage to the health of some local people as well as damage to soil health [9]. The condition of the soil has a good impact on the soil quality of the environment [10]. Some natural sources include weathering of metal-bearing rocks and volcanic eruptions, while anthropogenic sources include mining, tailings, occupational exposure, paints, treated timber and various industrial and agricultural activities. Heavy metals in the environment include geogenic, industrial, agricultural, pharmaceutical, domestic effluents, and atmospheric sources [11, 12]. Industrial sources include metal processing in refineries, coal burning in power plants, petroleum combustion, nuclear power stations and high-tension lines, plastics, textiles, microelectronics, wood preservation and paper processing plants [13]. Heavy metal pollution does not only lead to adverse effects on man but also relating to plant quality and also cause changes in the size [15]. Therefore, heavy metals are considered as one of the major sources of soil pollution [14, 16]. Heavy metals exhibit toxic effects towards soil biota by affecting microbial processes and decrease the number and activity of soil microorganisms. The aim of the study is to determine the level of heavy metal in soils collected from three different location in Lagos State. Iyana Iba, Lasu-Isheri road and Igando. The Objectives of this project work are to collect the sample from three sample locations, digest the sample and finally quantify for the level of heavy metals in soil samples using inductively coupled plasma optical emission spectrophotometry.

II. Materials and Methods

2.1 Study Area

The soil samples were collected in three different areas (Isheri, Igando and LASU Iyana-Iba) in Lagos State. The first two areas are under Alimosho local government (LG) while the Iyana-Iba area is in Ojo LG. Alimosho LG is the most populated LG in Lagos State. All these three areas are highly populated. The map of the sample is presented in Figure 1.

Figure 1: Map of the sample location

2.2 Sample Collection and Preparation

One sample each of the soil were collected from three (3) different location of Lagos state using soil auger randomly for the period of four weeks between the months of June to October, 2021 and placed in plastic bags transferred to the laboratory for analysis.

2.3 Sample Treatment

The samples collected were transferred into a polyethylene bag and 3 g each were dried in an oven temperature of 55 ^{o}C for 7 days to constant weight to remove moisture. The dried samples were later converted to uniform size with the aid of clean ceramic mortar and pestle, sieved and transferred into a desiccator for further analysis. A 2.0 g of the sample was weighed using electronic weighing balance into a conical flask and with ratio 3:1 of hydrogen chloride and nitric acid ($HCl + HNO_3$) were added into the weighed samples, kept on the hot plate and was heated gently on a hot plate in a fume chamber until a brown fumes of nitrogen oxides evolved and finally a clear solution was observed with the evolution of white fumes [17 -18]. The flask was then removed from the hot plate and allowed to cool. Distilled water was added to the solution in the flasks and later filtered using Whatman No 1 filter paper and funnels into 100 cm^3 volumetric flask and was made up to mark. All metals were measured using inductively coupled plasma optical emission spectroscopy (ICP-OES). All determination was done in triplicates.

III. Results And Discussion

3.1 Percent Moisture Content

The results of the percentage of moisture analyzed in the soil samples collected from three different location sites in Lagos State are presented in Figure 2.

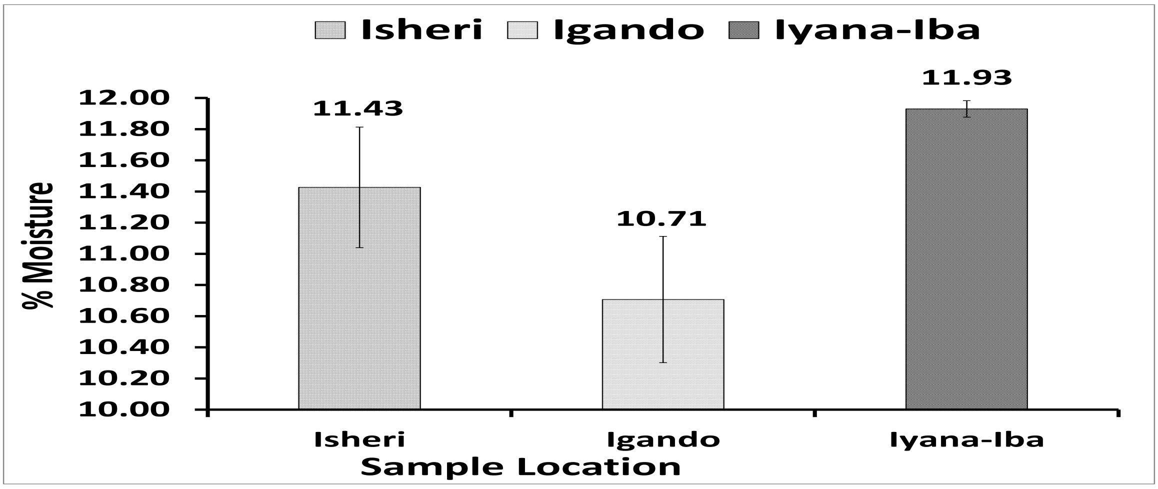

Figure 2: % moisture content of soil samples collected from three locations

Figure 2 presents the moisture content of the soil samples and the result shows that the percent moisture of Igando was the least (10.7%) while Isheri was (11.43%) and Iyana-Iba had the highest moisture content (11.93%). The high percentage moisture content for Iyana-Iba area can be due to the reconstruction work going on along the Badagry expressway.

3.2 Toxic Heavy Metals

This results of the chemical composition of some toxic heavy metals present in the three different soil samples. The composition of toxic heavy metals such as As, Ba, Cr, Pb, Th, and U present in the soil samples are presented in Figure 3.

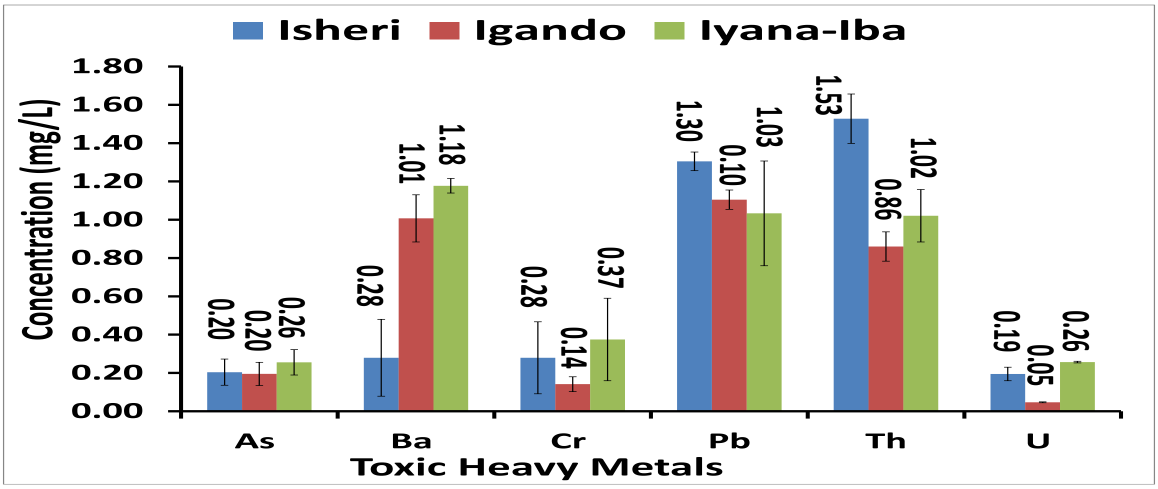

Figure 3: Toxic heavy metals of soil samples collected from three locations

The composition of toxic heavy metals in the soil samples collected from three locations is present Figure 3. The results of the toxic heavy metal composition in the soil samples collected from three different locations showed that Iyana-Iba area had the highest concentration for the following toxic heavy metals: As, Ba, Cr, and U while Isheri area had the highest concentrations for the remaining two toxic heavy metals: Pb and Th. It really means that Iyana-Iba location is more polluted with toxic heavy metals than the other two soil samples which can be attributed to the fact that Iyana-Iba area route is an international route to Republic of Benin. However, the concentrations of all the toxic heavy metals except Ba are higher than the World Health Organization (WHO) maximum permissible level, but they are toxic even at their lowest concentration to the soil, man, and their environment (WHO, 2011).

3.3 Trace Heavy Metals

The results of the chemical composition of some of the trace heavy metals such as Zn, Ca, Fe, K, Na, Mg, Si, V, Mo, Sr, Sb, B and Se present in soil samples. The composition of these trace heavy metals in the soil samples are presented in Figures 4 and 5.

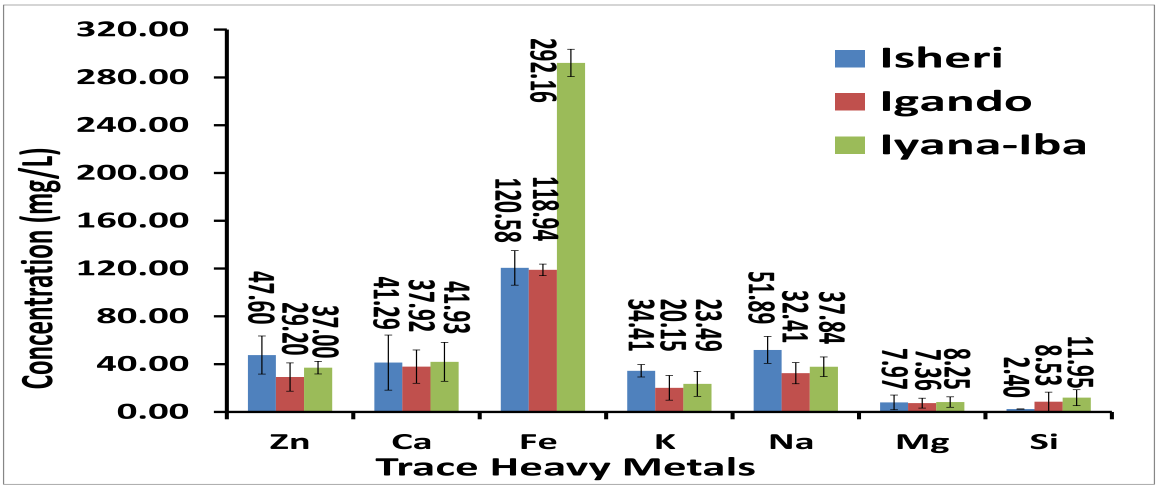

Figure 4: Trace heavy metals of soil samples collected from three areas

Figure 4 presents some trace heavy metals such as Zn, Ca, Fe, K, Na, Mg, Si present in soil samples collected from the three different locations in Lagos State. The concentrations of the soil samples revealed the chemical composition of heavy metals present in the soil samples of Isheri area had the highest concentration for Zn, K, and Na while Iyana-Iba area had the highest concentration for Ca, Fe, Mg, and Si. The concentrations of these trace heavy metals (K, Na and Mg) falls within the WHO permissible limits while Zn, Ca, and Fe are above the permissible limits, and that of Si is not available.

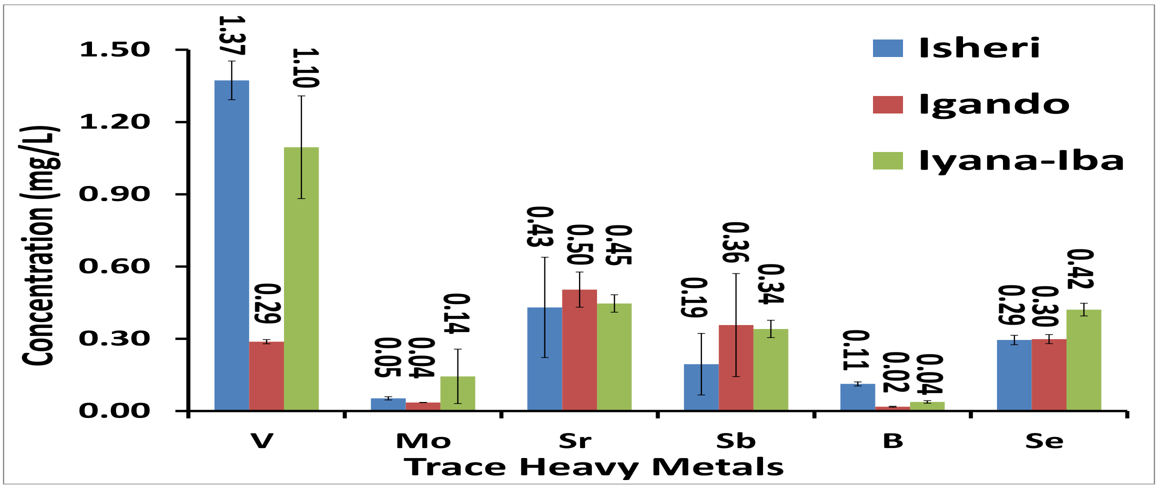

Figure 5: Trace heavy metals of soil samples collected from three areas

Figure 5 presents the concentration of trace heavy metals in the soil samples collected from three different locations in Lagos State. The results revealed the chemical composition of trace heavy metals (V, Mo, Sr, Sb, B, and Se) present in the soil samples. Isheri area had the highest concentration for V, and B while Iyana-Iba area had the highest concentration for Mo, and Se. Also, the concentration of Sr and Sb was highest for Igando area. The concentrations of B falls within the WHO permissible limits while V, and Se were far above the permissible limits while the WHO permissible limits for Mo, Sr, and Sb are not available. Crops or vegetables planted along the road sides by some farmers in these areas in Lagos State are being exposed to some of the toxic and trace heavy metals that are absorbed by the plants which can be injurious to man if it finds its way into the plants in food chain. Agricultural plant products contaminate soils and is a route through which heavy metals enters the food chain (Ali et al., 2019; Amiri et al., 2019). It has been reported that the concentrations and pollution levels of soil contaminated with toxic and trace heavy metals were assessed to evaluate the environmental quality of some soils in the Lagos State urban roadside farms and the potential risks the residents or consumers will face (Chen et al., 2005). Studies have shown that heavy metals in urban soils may come from various anthropogenic activities such as industrial and energy production, construction, vehicle exhaust, waste disposal, as well as coal and fuel combustion (Martin et al., 1998; Li et al., 2001).

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