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Assessment of Ni and Cd Bioavailability in soils around selected Automobile Workshops of Kaduna, Nigeria.

Mohammed, S.S.,Abdulmalik, I. A, Yusuf, H.

Department of Applied Science, College of Science and Technology, Kaduna Polytechnic P.M.B 2021 Kaduna – Nigeria.

Abstract: *The identification of the chemical forms or phases of Ni and Cd in soil is necessary for estimating their biological availability, physico-chemical reactivity and transport in the environment and into the food chain. In the study, the Ni and Pb concentrations of soil samples obtained from selected automobile workshops were determined using Flame Atomic Absorption Spectrometry (FAAS). A modified Tessier extraction procedure was employed for the digestion and extraction of the soil samples using different digestion and extraction media. The results showed that the concentrations of Ni and Cd in the samples varied from one workshop to another. The Ni concentration bound to the residual phase was found out to be highest followed by that bound to exchangeable phase. The Ni distribution in the various media followed the pattern: HNO_3: H_2O_2> $MgCl_2$> EDTA > Oxalic acid. Similarly, Cd concentration bound to carbonate/ organic phase was found to be highest followed by that bound to oxide phase. The pattern of distribution is EDTA > Oxalic acid >HNO_3 : H_2O_2> $MgCl_2$.*

***Keywords**: Bioavailability, metal content, soil, Automobile workshop.*

I. INTRODUCTION

Nickel is a nutritionally trace metal for at least several animal species, micro- organisms and plants, and therefore either deficiency or toxicity symptoms can occur when respectively, too little or too much Nickel is taken[1]. Although Nickel is vital for the function of many organisms, concentrations in some areas from both anthropogenic release and naturally varying levels maybe toxic to living organisms [2].Nickel is generally distributed uniformly through the soil profile but typically accumulates at the surface from deposition by industrial and agricultural activities. Nickel can exist in soils in several forms such as inorganic crystalline minerals or precipitate, complexes and absorbed on organic cations surface or on inorganic cations exchange surfaces, water soluble, and free-ion or chelated metal complexes in soil solution [3].Cadmium is emitted into the atmosphere from natural sources mainly volcanic activities and from anthropogenic sources. Metal production(drying of Zinc concentrate and roasting, smelting and refining of ores) is the longest sources of anthropogenic atmosphere cadmium emissions, followed by waste incineration. Other sources, include the production of nickel-cadmium batteries, fossil fuel combustion and generation of dust by industrial processes such cement manufacturing[4]. The largest sources of cadmium in Landfills are smelters, iron, steel plants, electroplating wastes and battery production[5]. Cadmium is used as anticorrosive coating in electroplating, as a pigment and as a component of nickel-cadmium batteries[4], Health effects have been demonstrated in industrial workers heavily exposed to cadmium oxide fumes and dust [5]. Bronchitis, emphysema, anaemia and renal stones have been reported [4]. Much researches have been conducted on heavy metals contamination in soils from various anthropogenic sources such as industrial wastes[6,7,8]automobile emission[9,10], mining activity. In this research, Ni and Cd concentrations in soil samples were determined by Flame Atomic Absorption Spectrometry (FAAS). The soil samples were extracted using chemical reagents such as the mixture of HNO_2/H_2O_2, $MgCl_2$, oxalic acid and EDTA.

II. MATERIALS AND METHODS

A flame atomic absorption spectrophotometer model 8010 Young Lin was used for the Ni and Cd determination. In the extraction procedures, HNO_3/H_2O_2 (2+1), 1.0M $MgCl_2$, 1.0M Oxalic acid and 0.05M EDTA were used.

Preparation of Samples

The research covered four different automobile workshops in Kaduna Metropolis, Nigeria. The sites are Poly Road, (PR), Tudun Wada Cinema Road (TWC), Oriapala Mechanic Village (OMV) and Hamdala Swimming Pool Road (HSP). The samples were collected in November, 2012. Triplicate samples were collected from each automobile workshop randomly at a distance of 100meter depth of 10cm from soil surface [11].

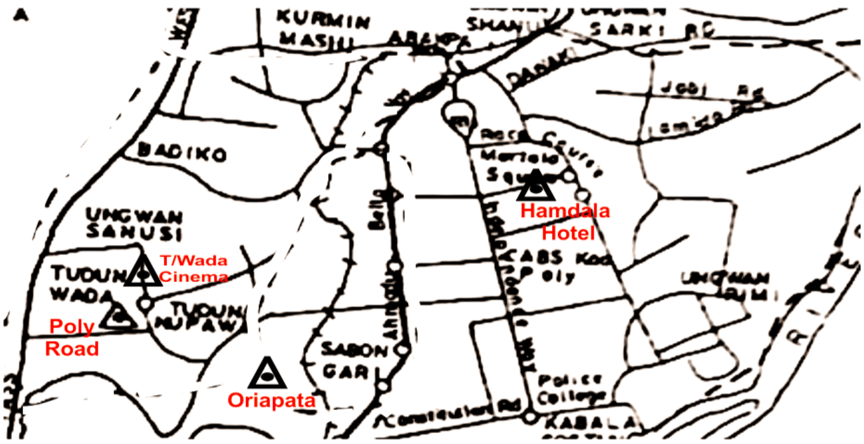

Fig. 1: Map of Kaduna Metropolis showing sampling sites

Digestion and Extraction of Soil

Soil extracts from automobile workshops were obtained by shaking separately 5g of soil sample with 10ml of HNO_3/H_2O_2(2:!), 0.05M(for residual phase). 0.05M Na_2 EDTA (for carbonate and organically bound phase), 1.0M Oxalic acid (for oxide phase) and 1.0M Magnesium Chloride (for exchangeable phase). The mixture was evaporated with occasional shaking on a hot plate. Four cm^3 of 1.5M nitric acid was added to the remainder and centrifuged. The digest was diluted to $60cm^3$ with distilled water and filtered. The resultant solution was analysed for Ni and Cd using FAAS model 8010 Young Lin. A blank digest was prepared in the same way.

III. RESULTS AND DISCUSIONS

The nickel content in the soil samples obtained from the selected automobile workshops varied from one sampling location to another, which maybe due to the fact that the activities vary from one workshop to another and that some of the workshops are closer to main road as compared to other workshops. The distribution of the metal in the soil samples showed that it exists in carbonate/organic, oxide, exchangeable and residual functions. The concentration of Nickel bound to residual phase with 60% in the samples obtained from the automobile workshops as shown in Fig. 2.

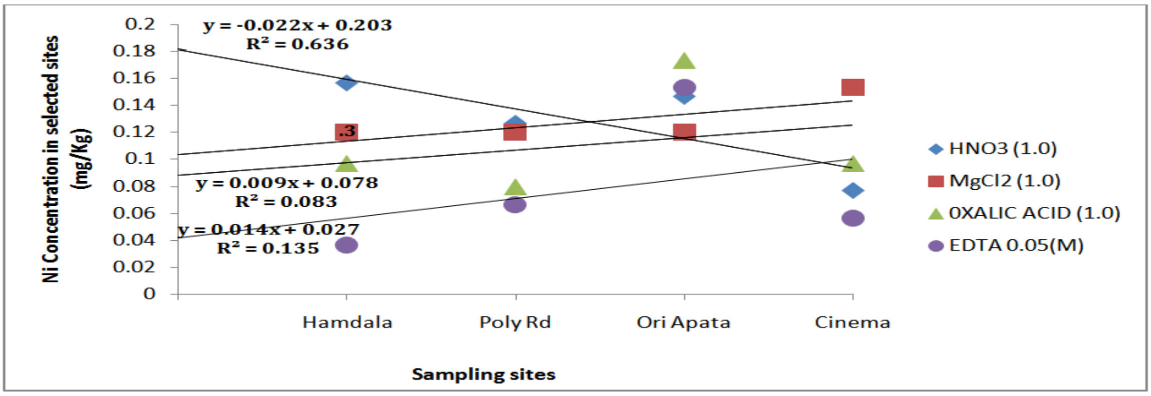

Fig. 2:Concentration of Ni against sample sites

This could be attributed to the nearness of their workshops to major roads and other anthropogenic activities such as the use of alloy steels and rechargeable batteries in these areas [12,13]. From the correlation study, Ni has the highest concentration as compared to the other metals in Hamdala and Poly road auto-mechanic workshops with correlation coefficients of 0.9827 and 0.9610 respectively. This maybe attributed to busy nature of the roads around these workshops and the serious use of motor oil and finished tyres in the workshops[14]. The cadmium distribution in the selected automobile workshops varied from one location to another which maybe attributed to charging of automobile batteries and other anthropogenic activities which vary from one workshop to another [15]. The metal existed in carbonate/organic, oxide, residual and exchangeable fractions. The concentration of cadmium was found to be highest in carbonate/ organic fraction as shown in Fig. 3.

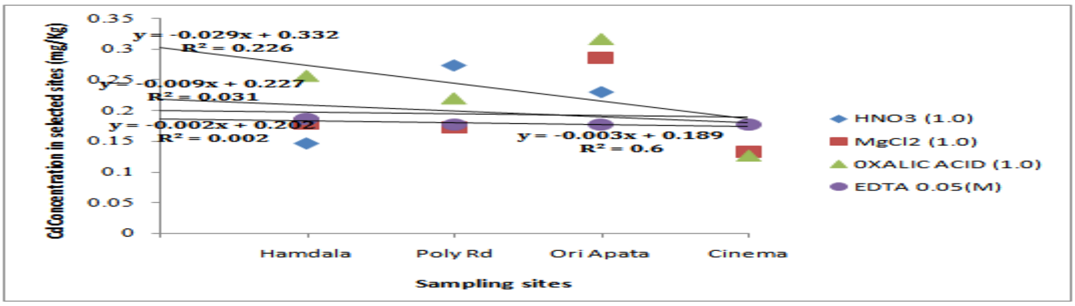

Fig. 3:Concentration of Cd against sample sites

Which shows that the metal is bioavailable and mobile in this fraction. [16]. Correlation study showed that Cadmium concentration was found to be highest in Tudun Wada Cinema workshop with a correlation coefficient of 0.7327 as compared to the other metals. This could be attributed to the specialized nature of the workshop where only diesel powered heavy dirty vehicles are repaired availability of used lubricating oils and discarded lead-cadmium batteries[17, 18, 19].

IV. CONCLUSION

The metals were distributed between residual, oxide, exchangeable and carbonate fractions. An increase of the metal concentrations in some of the sampling locations suggest higher anthropogenic activities in such areas which indicated possible soil pollution as a result of the activities carried out in such locations.

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