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Levels of Pb, Fe, Cd and Co in Soils of Automobile Workshop in Osun State, Nigeria

ABSTRACT: The disposal of waste of all kinds in auto-repair workshop areas in Nigeria is becoming alarming. The study looks into the contribution of different sections in auto-repair workshop to heavy metal pollution in soil. Thirty-two soil samples were collected at an auto-repair workshop in Osogbo, Ikirun, Iragbiji and Iree in Osun State for their cobalt, iron, lead and cadmium level at different sections namely: auto-mechanic unit, auto welding unit, auto electrician unit and auto painting unit using atomic absorption spectrophotometer. The highest cobalt concentration was obtained in Iree at the auto welding unit, (17.25±1.10mg/kg), iron had its highest level in Ikirun at the auto-mechanic unit (43937±35mg/kg), lead had its highest concentration in Iree at the auto welding unit (2460±16mg/kg) and cadmium with the highest in Iree at the auto welding unit as well (2.02±1.01mg/kg). Sites studied had higher levels of heavy metals compared to control areas. The general trend of dispersion of metal contamination within the soil profile is iron>>lead>>cobalt>>cadmium. Statistical analysis reveals correlation between lead/iron \( r = 0.636 \) at \( p<0.01 \). This work reveals the individual contribution of various allied artisans to soil pollution in automobile workshop. The research serves as an important contribution to the database on the baseline qualities of Nigerian soil.

MATERIALS AND METHODS

Study area: The study was carried out in Osogbo, Ikirun, Iragbiji and Iree town, Osun state, Nigeria. Osogbo (Latitude 7°46.110’N, Longitude 4°32.379’E), Ikirun (Latitude 7°55.899’N, Longitude 4°39.929’E), Iragbiji (Latitude 7°53.652’N, Longitude 4°37.813’E) and Iree (7°56.878’N, Longitude 4°44.052’E) are located on altitude of 288.5m, 396.4m, 382.1m and 454.0m respectively.

Sample collection and preparation: Soil samples for the study were collected in an automechanic workshop in four towns in Osun State, Nigeria. Soil automotive service and repair shops are the largest small quantity generators of hazardous waste. Autorepair shops create many different types of waste during their daily operations. These include used oil and fluids, dirty shop rags, used parts, asbestorses from brake pads and waste from solvents used for cleaning parts. All of which are expensive to dispose of and sometimes hazardous. The most dangerous waste commonly created in autorepair shops is from the solvents used to clean parts. Many of the chemicals that make up the solvents are extremely dangerous to human and the environment (Imevbore and Adeyemi, 1981). If not handled properly these chemicals can find their way into the air we breathe, the water we drink, our soil, lakes and streams (Adeniyi and Afolabi, 2002). Many parts cleaners and solvent are dangerous to workers health. “Used oil may contain components such as lead, cadmium, barium and other potentially toxic metals (Edehiri and Nwanokwale, 1981; USEPA, 2001; Vazquez-Duhalt and Bartha, 1989).” Heavy metals are of considered environmental concern due to their toxicity and accumulative behavior (Dahmani-Muller et al., 2000; Omgbu and Kokogbo, 1993). Advancement in technology had led to high level of industrialization leading to discharge of heavy metals into our environment. “Graft (1984) noted that various activities by man in recent years have increased the quantity of distribution of heavy metals in the atmosphere, land and water bodies.” The worldwide demand for lubricating oil for processes, passenger and heavy goods vehicles stands at about 3.5 million tons (Szranka, 1995).

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The levels of Pb, Fe, Cd and Co in the samples were collected at different units of the automobile workshop which comprise the automechanic unit, auto welding unit, auto electrician unit and auto painting unit. Thirty-two soil samples were collected from the four different units in the four towns at 1 cm depth with a plastic spoon to avoid cross contamination and labeled. The samples were sundried and sieved. Samples for analysis were kept in a labeled polythene bag and then used for heavy metals determination. The control samples collected were also sundried, sieved, and labeled. The codes used for each town and each unit are as shown in Table 1 and 2 respectively.

The codes used for each town and each unit are as follows: For Osogbo, sample codes for towns and control sites are HVO and CHVO respectively, for Ikirun, HVK and CHVK for sample and control respectively. For samples at Iragbiji, HVG and CHVG for sample and control. For Iree, HVR and CHVR for sample and control respectively. The labeling codes used for locations where samples were collected at each unit of autorepair workshop are as follows: 1,2 for auto-mechanic unit, 3,4 for auto-welding unit, 5,6 for auto-electrician unit and 7,8 for auto-painting unit.

Digestion of the sample: 2g of each sample was accurately weighed into a washed and dried kjeldhal flask. 10ml of nitric/perchloric acid was added to each sample and the tubes were placed in a digestor for about 10 minutes at 100-150 °C, the temperature of the digester was then increased to 230°C. The samples were then brought out and allowed to cool. 5ml of deionized water was added to each sample and then transferred into volumetric flask and excess deionized water was added to make it up to 100ml mark. The digest was then used for heavy metal (Co, Fe, Pb, and Cd) determination using atomic absorption spectrophotometer of model Buck 210 GVP.

RESULTS AND DISCUSSION
The levels of Co, Fe, Pb, and Cd found in soil samples and control samples are as shown in Tables 1-4. The levels of heavy metals obtained in Osogbo are as shown in Table 1. Cobalt had its highest concentration in HVO8 (11.0±5.00 mg/kg) with the least concentration in HVO6 (4.00±0.10 mg/kg) in the auto-electrician unit. This might be due to the fact that electrical materials used here contribute low cobalt content which get leached into the soil. The auto-painting unit however had the highest cobalt level in Osogbo. The information on cobalt content of soil in auto-mechanic workshop is sparse in literature. The range of iron concentration obtained in Osogbo was 32938±12-11125±28 mg/kg. The highest was obtained in HVO8 (32938±12 mg/kg) at the auto-mechanic unit. This result was however higher than the result obtained by Adewole and Uchegbu (2010) (1564-1238 mg/kg). The increase in iron content of the soil might be as a result of waste generated in this unit which includes solvent, hydraulic fluid, spent lubricants most of which are dumped into the soil directly. The range of level of lead in table 1 was 703±25-16.0 ±12.0 mg/kg). The highest lead concentration obtained in HVO2 was (703±25 mg/kg) , this could be as a result of lead containing compounds being used by auto-mechanics. The result obtained shows a higher soil lead level as compared to what was obtained by Osu and Okereke ( 2010). The level of heavy metals in soil of auto-mechanic workshop depends again on how long the workshop was established. The site used in Osogbo had being in existence since 1999. No cadmium was detected in all samples analysed in Osogbo. The levels of these metals in the control site(CHVO) were lower to values obtained in Osogbo. This difference in values suggested soil contamination.

| Sample | Cobalt   | Iron     | Lead     | Cadmium |
|--------|----------|----------|----------|---------|
| HVO1   | 6.25±3.50| 32938±12 | 61.0±16.9| nd      |
| HVO2   | 6.50±4.00| 30625±15 | 703±25   | nd      |
| HVO3   | 8.00±3.00| 17500±21 | 26.3±2.3 | nd      |
| HVO4   | 5.00±5.00| 13063±16 | 17.3±14.0| nd      |
| HVO5   | 4.00±2.10| 12125±22 | 26.5±11.3| nd      |
| HVO6   | 4.00±0.10| 14250±19 | 16.0±12.0| nd      |
| HVO7   | 5.00±0.90| 11125±28 | 68.0±10.0| nd      |
| HVO8   | 11.0±5.00| 15563±30 | 91.0±29  | nd      |
| CHVO   | 1.02±0.85| 262±9    | 10.1±2.5 | nd      |

nd = not detected
Table 2 reveals the result in all the units studied in Ikirun. The soil cobalt content in Ikirun had highest value in HVK2 (13.75±3.00 mg/kg). This might be due presence of cobalt in the materials being used by the auto-mechanics. As these materials are used, some of it get leached into the soil and contaminate it. The auto-electrician unit had some cobalt in its soil (9.50±0.90 mg/kg) and the least cobalt level. Runoff water during rain or wind can wash or disperse soil particles from one place to the other and contaminate the soil. The soil in the auto-welding unit also had cobalt content of 12.75±6.20 mg/kg next to the auto-mechanic unit here. The highest level of iron was obtained in the auto-mechanic unit (43937±35 mg/kg) and very high compared to what was obtained by Adewole and Ucheagbu (2010). Iron is a plant micronutrient, which is needed for physiological plant growth in small amount but has been grossly increased due to improper disposal of spent engine oil. Fossil fuel products are used leading to excess accumulation of heavy pollution (Aiyesanmi, 2005). The auto-mechanic workshop within Ikirun and disposal of waste into open vacant plots and water body which pose an environmental risk. Soil lead level here was highest in HVK5 (325±10 mg/kg) at the auto-electrician unit and least lead level obtained in HVK6 (69.8±9.9 mg/kg). The levels of lead obtained was higher than the values obtained by Ano (1994) and Nwoko and Egunjobi (2002). The values obtained were above the permissible level for soil as recommended by USEPA (1986) and this is a serious environmental concern which needs urgent attention. Cadmium was not detected in all soil samples analysed in Ikirun too.

Table 2. Concentration of Co, Fe, Pb and Cd in Ikirun (mg/kg)

| Sample | Cobalt   | Iron     | Lead     | Cadmium |
|--------|----------|----------|----------|---------|
| HVK1   | 12.00±1.00 | 43937±35 | 160±15   | nd      |
| HVK2   | 13.75±3.00 | 1685±20  | 294±20   | nd      |
| HVK3   | 12.75±6.20 | 1358±17  | 128±11   | nd      |
| HVK4   | 11.00±0.90 | 1213±28  | 173±28   | nd      |
| HVK5   | 11.75±1.50 | 1358±10  | 325±10   | nd      |
| HVK6   | 9.50±0.90  | 1313±18  | 69.8±9.9 | nd      |
| HVK7   | 11.5±10.0  | 895±71   | 234±32   | nd      |
| HVK8   | nd        | 1357±27  | 134±10   | nd      |
| CHVK   | 0.81±0.60 | 401±9    | 20.9±1.3 | nd      |

nd = not detected

Table 3 illustrates the levels of these heavy metals in Iragbiji. No cobalt was detected in HVG1 here. HVG2 however had a concentration 10.00±0.61 mg/kg of cobalt. This discrepancy could be attributed to the fact that the auto-mechanic carry out most of their work in HVG2 as compared to HVG1 where they only hang their clothes. HVG1 (8.00±0.90 mg/kg) had cobalt level next to HVG2. Cobalt was not detected in HVG6. The auto-painting unit had the least cobalt content as shown in table 3. The range of level of iron obtained was 20250±20 – 10563±41 mg/kg which happens to be the auto electrician unit. Wastes from these workshops are indiscriminately dumped in every available space thus contaminating the soil causing substancial alteration in the chemical composition and pH of the soil and will have a major effect on plant growth, microbial population and human. The highest level of lead was obtained in HVG5 (1068±10 mg/kg) at the auto-electrician unit and least lead content in HVG6 at the auto-painting unit. Cadmium was not detected in soil analysed in Iragbiji.

Table 3. Concentration of Co, Fe, Pb and Cd in Iragbiji (mg/kg)

| Sample | Cobalt   | Iron     | Lead     | Cadmium |
|--------|----------|----------|----------|---------|
| HVG1   | nd       | 10563±41 | 144±30   | nd      |
| HVG2   | 10.00±0.61 | 11125±23 | 109±5    | nd      |
| HVG3   | 8.00±0.90 | 15000±10 | 145±10   | nd      |
| HVG4   | 5.50±0.50 | 13625±15 | 160±11   | nd      |
| HVG5   | 6.50±1.10 | 20520±20 | 1068±10  | nd      |
| HVG6   | nd       | 19562±16 | 753±5    | nd      |
| HVG7   | 1.75±1.20 | 12250±13 | 38.3±11.0| nd      |
| HVG8   | 3.75±0.80 | 11375±35 | 36.8±1.9 | nd      |
| CHVG   | 0.72±0.30 | 728±15   | 12.5±4.9 | nd      |

nd = not detected
Levels of Pb, Fe, Cd and Co in....

Table 4 reveals the highest cobalt level in HVR$_3$ (17.3±1.10 mg/kg) at the auto-welding unit. It was not however detected in HVR$_1$ here in Iree. The range of iron content was 38125±30 -4500±10 mg/kg. The level of iron spread all over the units here and could be as a result of the population in this town with few auto-mechanic workshops and so they litter and spread most of this used engine oil and spent fluid all over. The highest iron content was obtained in HVR$_8$ (38125±30 mg/kg). The highest level of lead was obtained in HVR$_7$ (2460±16 mg/kg) at the auto-welding units followed by HVR$_5$ (1685±15 mg/kg) at the auto-electrician unit. This result reveals how these arlied artisans spread their waste indiscriminately, which calls for urgent attention and awareness. Cadmium was however detected in Iree in this study at HVR$_2$ and HVR$_3$ (0.70±0.90 mg/kg and 2.02±1.01 mg/kg respectively). The result however was found to fall between the values obtained by Osu and Okereke(2010) (50.03±0.26 - 0.22±0.003 mg/kg). The high concentration of iron in these sites might be attributed to metal construction works, welding of metals, iron bending which is common practice. Virtually in every auto repair workshop there are various sections that deal with other filling of metals, welding of these metals and paveling of vehicle bodies. Iron fillings from metal works, oil spillage of gasoline, diesel, engine oil and lubricating oil coupled with rusting results in high iron concentration .The high value of iron obtained agrees with what was obtained by Shinggu et al., 2007.

| Sample | Cobalt  | Iron    | Lead    | Cadmium |
|--------|---------|---------|---------|---------|
| HVR$_1$| 6.25±0.60| 21750±52| 873±11  | nd      |
| HVR$_2$| 12.3±0.9 | 34937±35| 995±16  | 0.70±0.90|
| HVR$_3$| 17.3±1.10| 30125±19| 268±8   | 2.02±1.01|
| HVR$_4$| 8.75±1.30| 36250±25| 2460±16 | nd      |
| HVR$_5$| 6.50±0.90| 25062±17| 1685±15 | nd      |
| HVR$_6$| 6.75±0.60| 24938±16| 750±3   | nd      |
| HVR$_7$| nd      | 4500±10 | 18.0±12.0| nd      |
| HVR$_8$| 2.00±1.30| 38125±30| 12.0±0.6| nd      |
| CHVR  | 0.75±0.18| 809±21  | 6.9±5.1 | nd      |

nd = not detected

The contribution of these units in auto repair workshop to iron contamination of the soil is in the other auto mechanic unit >> auto welding unit > auto electrician unit> auto painting unit. The levels of heavy metals in all these units are however low compared to the levels obtained for the control samples. This invariably indicates a level of pollution in the study area. The levels of heavy metals can affect human, plant s and animal health (Ewers and Schlikopter, 1991; McGrath et al., 1995). Presence of high lead level can result into brain damage, brain disorder and can cause stunted growth in plants (Somer, 1995). Excessive level of iron can seriously affect flora and fauna in water bodies. To much cadmium can cause disfunctioning of the kidney.

Statistical analysis: One-way analysis of variance (ANOVA) was used to test if significance differences exist between mean concentrations of heavy metals. The result showed that there were no significant statistical differences at p<0.05 for Pb (F=0.849, p=0.494), Fe (F=0.898, p=0.470), Co ( F=1.475, p=0.271 ), and Cd ( F=0.794, p=0.521). A positive correlation was obtained between lead/iron (r = 0.636), lead/cadmium ( r = 0.666) at p<0.01 and also between iron /cadmium ( r = 0.520) at p<0.05, suggesting a linear relationship.

Conclusion: The investigation in this study revealed that the soil in the auto repair workshop comprising auto-mechanic units and other allied artisans is grossly polluted with iron and lead. Phytoremediation is however recommended so as to remove these metals from the contaminated soil.

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