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Assessment of Heavy Metals Concentrations around Automobile Mechanic Workshops in Ilaro, Ogun State.

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Abstract

This research study was carried out to assess the heavy metals in soils around Automobile Mechanic Workshops in Ilaro, Ogun State, Nigeria. The concentration of Chromium, Zinc, Copper, Cobalt, Lead and Nickel were measured within the study area, the samples were collected from the environment of the automobile mechanic workshops and cultivated farmland. The Farmland samples serve as a control. A total of 10 samples were collected, three samples from the farmland and seven from the selected Automobile Mechanic Workshops. At the laboratory, the wet digestion method was used for the samples preparation. Thereafter, Atomic Absorption Spectrophotometry (AAS) was employed in determining the level of heavy metals concentrations in the soil samples. The values of the measured concentration from soil samples of the automobile mechanic workshops for Zn, Cr, Cu, Pb, Co and Ni ranged from 62.416 to 81.163 mg/kg, 8.314 to 12.678 mg/kg, 15.078 to 18.402 mg/kg, 81.697 to 84.128 mg/kg, 12.070 to 14.112 mg/kg and 28.162 to 30.456 mg/kg respectively having mean values of 70.115 mk/kg, 10.315 mk/kg, 16.470 mk/kg, 82.731 mk/kg, 12.739 mk/kg and 29.361 mk/kg respectively. The results show that the mean values of concentration of the heavy metals were below the WHO/FAO standard values, except for Zn which is higher than the WHO/FAO standard value of 60 mg/kg. The result of the study calls for strict regulations from concerned health authorities as regard waste management strategies to checkmate the disposal of these harmful wastes in form of used oils within the mechanic workshop and its environs to prevent further contamination of the environment.

Keywords: automobile mechanic workshops, heavy metals, concentration, contamination

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1. Introduction

Metals referred to as heavy metals are naturally occurring, environmentally stable, non-biodegradable and can be injurious to the wellbeing of living organisms (Huang, et al., 2020). They are known to also significantly accumulate in both plant and animals which consequently cause an adverse effect on the wellbeing of man (Masindi and Muedi, 2018). Heavy metals can be introduced in the soil in the environment through agricultural runoffs, transportation of dissolved metals, combustion, extraction processes etc. The domestic use and benefit of water coupled with its various industrial applications can be hampered by its contamination by heavy metals (Avni et al., 2020). Further inquiries on the use of heavy metals contaminated water in agricultural fields show that it leads to soil pollution. Different studies have revealed that the presence of heavy materials like iron, lead, mercury reduce soil fertility.

Global industrialization and unsystematic agricultural activities have taken their toll on the natural environment and ecosystem contamination with heavy metals, which significantly surged following the revolution of industrialization (Masindi et. al., 2018). Various researches and records have been made in both developed and developing countries showing contamination of the soil by heavy metal. The group of metals usually referred to as heavy are those with which have a specific gravity of more than 5g/cm^3 (Duffus, 2002). It is assumed that 1000kg of normal soil is known to hold 200g of Chromium, 80g of Nickel, 16g of Lead, 0.5 of Mercury, and 0.2g of Cadmium, metal poisoning arising from heavy metals that have toxic properties leading to an adverse effect on human and ecosystem health (Akintunde et al., 2015).

The heavy metal contents in new motor oil and used motor oil are the major distinguishing factor. This distinguishing factor is of utmost relevance as the majority of these metals are toxic to the well-being of living organisms. These metals originate from fuel and motor wear. Used oils contain a high level of lead, zinc, copper, chromium and Nickel. (Scott et al., 2018). Oil spillage is gradually becoming a matter of environmental concern as it plays a significant part in the environmental contamination with heavy metals whether in its refined or crude form. The adverse effect of oil spillage on the soil, water resources, animal life and consequently human life due to the toxic nature of chemicals discharges cannot be overemphasized (Isaac, 2018). Hence, the basic scope of this research is to assess the concentration of some selected heavy metals in soils around auto mechanic workshops.

Prolonged exposure to heavy metals may be associated with various diuturnal health problems which include; serious haematological and brain damage, anaemia and kidney problems (Sonayei et al., 2009). Heavy metals such as Pb and Cd are lethal even in minuscule dose, lead (Pb) has a negative influence on somatic development, and decreases visual acuity and auditive thresholds (Simeonov et al., 2010). Toxic heavy metals in the food chains at relatively high concentration pose a serious health risk to the body, the toxicity of the heavy metals can be so detrimental to human health to the extent that they can cause damage or reduce mental and/or central nervous functions, they can also cause lungs, kidney, liver, brain and other vital organs damage in the body (Isaac et al., 2018). There are different pathways through which heavy metals can enter the human body some of which include dermal contacts, ingestion, through the food chain and inhalation.

Due to their bioaccumulative nature, toxicity and persistence in the environment, the role played by heavy metals as environmental pollutants cannot be overemphasized (Ali et al., 2019). Our environment and diets are known to hold these elements in minute quantities but acute or chronic toxicity may result from having them in large quantities. In Nigeria, activities in automobile mechanic workshops play a significant part in raising the heavy metal concentration levels in our environment today (Adewole & Uchegbu 2011). In society today, auto mechanic workshops are established as a group of specialists in one place or in some cases an individual may decide to singlehandedly establish his workshop on his own on any available open plots of land in the vicinity. Within the group of specialists earlier mentioned are automobile electricians known popularly as re-wire, wheel and balancing experts, alignment specialists, brake experts, transmission experts, engine repairers, panel beaters, spray painters, auto battery chargers etc. The venture of these various field experts in the automobile mechanic group workshops give rise to varieties of waste materials, the most common of which are oils (gasoline, diesel, spent engine oil and paint) which are jettisoned off by casting them disruptively in bushes nearby or even open lands which sometimes can get washed up to different part of our environment due via erosion during the raining season.

It is a known fact that the activities of auto mechanic workshops produce harmful waste materials which consequently leads to soil pollution but despite, these ecosystem polluting activities have not been given adequate attention in Nigeria. Soil condition is of great importance as it a universal medium for the survival of plant (Opaluwa et al., 2012) and animal and its pollution can result in long-term cumulative health effects. These heavy metals tend to bioaccumulate and hence move along the food chain. Therefore, effort geared towards investigating the level of concentration of heavy metals in the soil around automobile mechanic workshop areas to manage the menace of continued environmental pollution necessitates this study.

2. Materials and Methods

2.1 Description of the study area

Ogun is one of the thirty-six states in the country Nigeria, and one of the six states in Nigeria's South-West geopolitical zone. It was created in 1976 and it borders the Republic of Benin to the West, Oyo and Osun State to the North, Ondo to the east and Lagos to the south. The coordinates for Ogun State lies within latitude 6.198N

and longitude 3.4737E. Ogun State consists of 20 local governments in all. One of the Local Government is Yewa South, its headquarters is known to be Ilaro town. Ilaro town in Ogun State houses about 57,850 people. The daily temperature in Ilaro ranges between an average minimum of 23^0C to a maximum of 34.2^0C (Aiyegbajeje, 2017). Ilaro and its environs are known for farming crops such as maize, yam, cassava, okra, bananas, etc. Ilaro which is the study area is known for hosting great schools, one of which is the Federal Polytechnic, Ilaro.

The selected study sites were;

- Idishin farmland along Idogo Road, Ilaro (Control)
- The mechanic village, Ilaro which houses different mechanic workshops.
- Empire mechanic workshop
- Johnson mechanic workshop, Oke-Ola, Ilaro.

2.2 Materials

The material used during the sample collection and experimental analysis is cutlass which was used for digging the soil at the depth of 0.1m to get the soil samples, well-labelled polythene bag where the soil sample collected and stored before the analysis was carried out, 2mm sieve was used to separate the coarse and fine particles, conical flask used in chemical analysis for holding and mixing chemical, heating mantle laboratory equipment used to apply heat to the container as an alternative to other forms of a heated water bath, Atomic Absorption spectrophotometer [AAS] which is quantitative spectro-analytical equipment used for the determination of chemical elements using the absorption of optical radiation by free atoms in the gaseous state. Reagents used include perchloric acid 60%AR, HNO_3 Concentration AR, HCL concentrated AR.

Soil samples were collected randomly from the study area at a depth of 0.1 meters, mixed properly and packed into well-labelled polythene bags. A total of 10 samples were collected, 3 from the farmland (used as controls) along Idogo road, 5 from mechanic village Ilaro and 1 each from the different roadside mechanic workshops.

The soil samples were air-dried before being crushed while using mortar and pestle and sieved with a 2mm sieve to separate the fine and coarse particles for homogeneity. Soil samples were digested through the wet digestion method.

2.3 Laboratory Analyses

1g each of dried, a homogenized fine soil sample was weighed into a 10 cm^3 concentrated HNO_3 contained in the clean round bottom which has been previously washed with acid. The slow evaporation of the mixture was done on a hot plate for one hour. A mixture containing concentrated HNO_3 and $HClO_4$ in ratio 2:1 was then used to digest each obtained solid residues for 10 minutes at room temperature after which it was then heated on the hot plate. For over 5 hours, the digested mixture was kept at a steady temperature of 150^{o}C by heating it occasionally till the $HClO_4$ fumes evaporated completely (Jacob et al., 2009) after which it was cooled to room temperature. The Whatman No.1 filter paper was then used to filter the solution into a 50 cm^3 volumetric flask before it was then made up to the standard mark. The digested samples were then analysed using the AAS.

3. Results and Discussion

3.1 Results

The result of the concentration of the heavy metals present in the soil samples from the study areas is presented in the following tables.

Table 1: Heavy metal concentration in the soil of the Farmland (control)

Locations	Samples No	Zn (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Co (mg/kg)	Ni (mg/kg)

Farmland (control site)	1	10.467	1.614	0.967	6.791	1.936	1.006
	2	10.311	1.596	0.942	6.922	1.892	0.981
	3	10.408	1.608	0.916	7.018	1.917	0.992
Mean		10.395	1.606	0.942	6.910	1.915	0.993

Table 2: Heavy metal concentration in the soil of the selected automobile mechanic workshops

Locations	**Samples No**	**Zn (mg/kg)**	**Cr (mg/kg)**	**Cu (mg/kg)**	**Pb (mg/kg)**	**Co (mg/kg)**	**Ni (mg/kg)**
Mech. Village	4	62.861	8.918	15.896	81.826	12.336	28.736
	5	63.121	8.981	15.413	82.367	12.481	28.911
	6	81.163	12.678	16.891	84.128	12.967	30.161
Empire wrkshp	7	78.248	11.967	18.226	82.967	12.891	28.982
Empire wrkshp	8	78.691	12.416	18.402	84.045	14.112	30.456
Johnson wrkshp	9	62.416	8.932	15.386	81.697	12.318	28.162
Johnson wrkshp	10	64.302	8.314	15.078	82.089	12.070	30.123
Mean		70.115	10.315	16.470	82.731	12.739	29.361

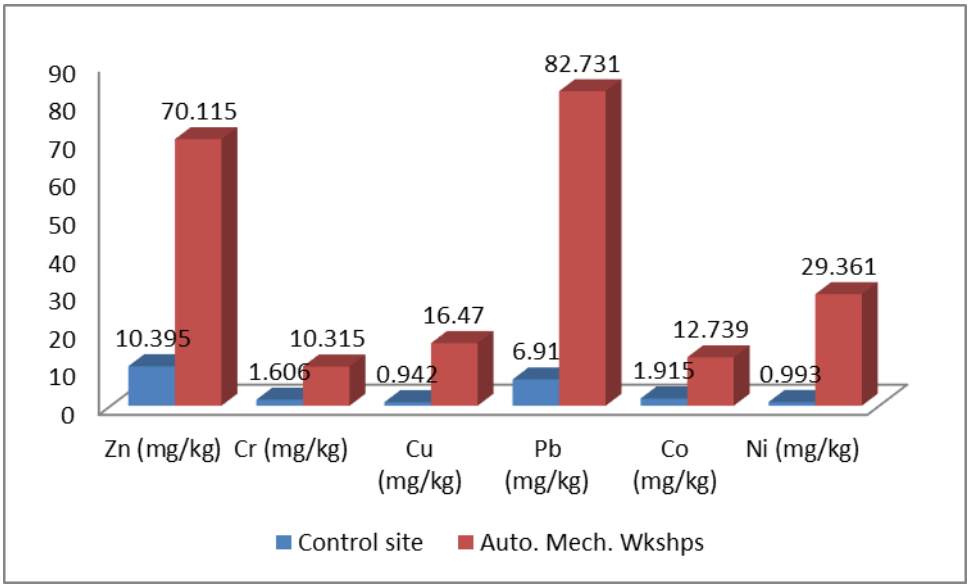

Figure 1: Mean values of the control site and Auto workshops

From Table 1&2, it is evident that the distributions of the heavy metals across the sampling site were found to be in high amount relative to values obtained at the control site. However, the result obtained showed that the heavy metals are more concentrated in the automobile mechanic workshop compared to that of the farmland (control site), and was also in agreement with the result obtained from a similar study by Olayiwola *et al*.,(2018) and could be attributed to the constant unregulated oil spillage at the mechanic workshop which leached to the underlying soil.

Table 3: FAO/WHO Guidelines for Heavy Metals in Soil (1996)

METALS	WHO/FAO (mg/kg)
Copper	36
Lead	85
Zinc	60
Nickel	35
Cobalt	-
Chromium	100

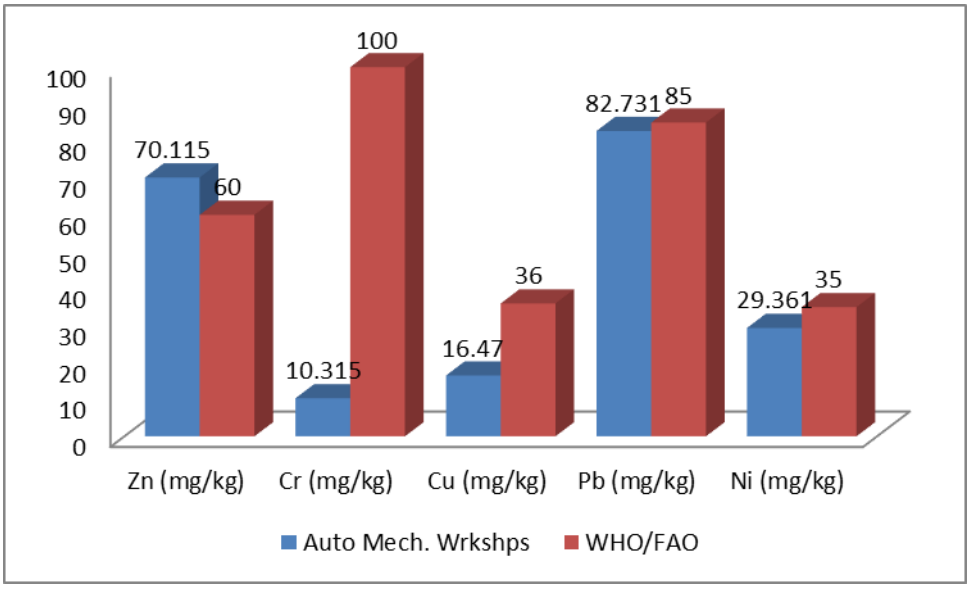

Figure 2: Chart showing Mean values of the Auto workshops with the WHO/FAO standards

3.2 Discussion of Results

Zinc (Zn): Despite the importance of trace elements like Zn and the significant role it plays in the metabolism and physiological wellbeing of various organisms, a higher level of its concentration can be very hazardous to the very existence of such organisms (Ogunkolu et al., 2019). It is vital in the process of protein synthesis and its concentration in the surface water is known to be fairly low as a result of its restrained mobility from its natural source i.e. the point where the rock weathering took place. The concentration of Zinc in the soil samples from the automobile mechanic workshops ranged from 62.416 to 81.163 mg/kg with a mean value of 70.115 mg/kg (Table 2). The mean value of the concentration of zinc from the automobile mechanic workshops was found to be higher than both the mean value of 10.395 mg/kg (Table 1) from the control site and the permissible limit of 60 mg/kg set by WHO/FAO (Table 3).

Copper: Copper particles are released into the atmosphere by windblown dust, volcanic eruption, anthropogenic sources, primary copper smelters and ore processing facilities. Copper accumulated in the liver and brain, contamination of drinking water with a high level of copper may lead to chronic anaemia. Also, copper toxicity is a fundamental cause of Wilson's diseases. The concentration of copper in the soil samples from the automobile mechanic workshops ranged from 15.078 mg/kg to 18.402 mg/kg with a mean value of 16.47 mg/kg (Table 2). Although the computed mean value of the concentration of copper obtained from the automobile mechanic workshops was higher than that of the control (0.942 mg/kg), it is well below the WHO/FAO permissible limit of 36 mg/kg (Table 3).

Lead: The menace of soil contamination by lead is epidemic. Over the years, it piles up and stored up in various significant parts of the body such as bones, aorta, kidney, liver and spleen. Lead can gain access into the human body via different pathways; these include ingestion (food (65%) and water (20%)) and inhalation (air (15%)). The high concentration of lead shows that the environment is polluted due to high activities such as fuel combustion and vehicle emission (Nwachukwu, et al., 2010). Lead has toxic properties and it is found in large amount in many electronic devices (Nwachukwu, et al., 2010). It is a major constituent of lead-acid battery used extensively in car batteries and tires which can end up in soil through the activities carried out in the workshop and through erosion. The concentrations of Lead in the soil of the automobile mechanic workshops ranged from 81.697 to 84.045 mg/kg (Table 2) with a mean value of 82.731 mg/kg. The computed mean value of the concentration of the metal from the soil of the automobile mechanic workshops was found to be lower than the WHO/FAO permissible value of 85 mg/kg (Table 3), but higher than the mean concentration value (6.91 mg/kg) of the soils from the control site.

Nickel: It has been discovered and known that Nickel is an important trace element for the wellbeing of organisms particularly human and animal (Okoro and Orimolade, 2017). Nevertheless, a higher concentration of nickel can be toxic to organisms. The mean concentrations in all soil samples from the automobile mechanic workshops ranged from 28.162 to 30.456 mg/kg with the mean value of 29.361 mg/kg (Table 2) which is lower than both the mean value obtained from the soil samples from the control site and the WHO/FAO permissible limit of 35 mg/kg (Table 3).

Chromium: The mean concentration of chromium in all soil samples which were significantly below the WHO/FAO permissible limit of 100 mg/kg (Table 3). The concentrations measured from the automobile mechanic workshop ranged between 8.314 and 12.678 mg/kg with a mean value of 10.315 mg/kg (Table 2) which is much higher than the mean value of 1.606 mg/kg (Tabel 1) obtained from the control site. Although chromium has been known to an important trace element needed in only a very small amount, recent discoveries have surfaced to prove otherwise but a pharmacologically active element (Vincent, J. B., 2017).

Cobalt: Being an essential trace element which is needed by the organism in small amount as considered, it serves as part of vitamin B–12 and it is needed for making red blood cells in the body. However, high consumption of Cobalt has a high range of negative effect on organisms such as heart failure, loss of vision, loss of hearing and lots more. The measured concentration from the soil samples from the automobile mechanic workshops ranged from 12.070 – 14.112 mg/kg with a mean value of 12.739 mg/kg (Table 2) which is much higher than the mean value of 1.915 mg/kg (Table 1) obtained for the control.

Nevertheless, the reasons for the high concentration of heavy metals in soil samples obtained from the mechanic village site could be due to activities in the sites which give rise to different forms of waste products (oil and its by-products: used and unused) indiscriminately discarded in the bushes nearby and surrounding areas.

4. Conclusion

Conclusively, heavy metals concentration in the soil from the mechanic workshops are relatively higher than that of the control sites but lower than the WHO/FAO standard except for Zinc which is higher than the WHO/FAO standard. It is also observed that the Lead concentration in the soils around mechanic workshops has reached the permissible threshold and if urgent action is not taken to control the waste disposal, the concentration of Lead may go higher than the safety limit. The setting up of mechanic workshops in almost every free space in the society where used oils are disposed of without a safe waste disposal system being put in place could be hazardous the environmental health and safety.

Based on the findings of this study, there is a need for strict regulations by concerned environmental and health authorities on waste disposal management system. Therefore, the government/health agency should set standards or surveillance on activities done at the mechanic workshops to adopt a good waste management system to reduce the level of heavy metals accumulation and concentration in the soil.

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