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Levels of Heavy Metals in Soil Samples from an Active Automobile Workshop in Maiduguri City, Borno State-Nigeria

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Abstract: *The evaluation of heavy metals contamination of soils as a means of monitoring the status of the environment for the good of the ecosystem is crucial. The research investigated the concentration of some heavy metals in soil sample from active automobile workshop in Maiduguri, Borno state using Atomic Absorption Spectroscopy (AAS). The results obtained for these metals (Fe, Cr, Cd, Zn and Pb) from the sample location indicated that Fe was higher than all other metals. The results obtained in dry weight were Fe (1771.00 ±112.73 µg/g), Pb (117.30±7.13 µg/g), Cr (51.75±2.93 µg/g), Zn (30.54±0.61 µg/g) and Cd (0.277±0.02 µg/g). The soil pH in waters was 7.12 and in $CaCl_2$ was 6.39 and the moisture content was 5%. The concentration obtained was generally higher than the tolerable limit for safe environment as prescribed by Nigerian Federal Environmental Protection Agency (FEPA) and World Health Organization (WHO).*

Keywords: *Heavy metals, soil, automobile workshop, atomic absorption spectroscopy.*

Introduction

During the last decades of the twentieth century there was an awareness of the soil as an environmental component and recognition of the need to maintain or improve its capacity to allow it to perform its various functions (Arbike, 2016). Pollution in recent years has increased considerably as a result of increasing human activities such as burning of fossil fuels, industrial and automobile exhaust emissions which were identified as primary sources of atmospheric metallic burden (Begum *et al.,* 2009) and was well established that a variety of motor vehicles introduced a number of toxic metals into the environment (Williamson, 2003). Several studies have shown that metals such as Pb, Fe, Cd, Cr, Mn, Co amongst others are responsible for certain diseases that have lethal effects on man, animals and plant (Kanmony, 2009). According to WHO, 20 million children worldwide suffer from pollution which has become critical. The most common environmental pollutants in the world are heavy metals (Papafilippaki *et al.,* 2008). The knowledge of heavy metals accumulation in soils, the origin as well as possible interactions of these metals is a problem of concern (Qishlaqi and Moore, 2007).

As human activities began to undergo industrialization, the amount of waste thrown in the environment increased tremendously (Inuwa, 2004). Heavy metals can accumulate in the soils to toxic levels as a result of untreated waste waters and fertilizer (Lin *et al.,* 2004). The extent of soil pollution by heavy metals is very alarming because of their toxicity which lead to adverse effects on human and ecosystem health (Voet *et al.,* 2008). Chronic exposure to heavy metals

leads to serious kidney malfunction, anemia, hematological and brain damage (Sonayei *et al.,* 2009). Therefore, it is important to monitor some of the heavy metals pollutants in soil as such this research is aimed at evaluating the level of metallic element concentrations in soil which followed laid down procedures.

The paper reports a spectroscopic investigation of heavy metals in soil samples from a garage (i.e. automobile workshop, Maiduguri) where automobile repairs are prominent. The study examines the potential environmental risk of these activities in the area.

Material and Methods

Sample Collection:

The sampling was carried out in the month of May, 2020 and the sampling site was at automobile workshop in Maiduguri, Borno state. The sample was collected from the sample location using clean stainless steel material. The soil sample was collected at 15cm depth around the sample area; it was thoroughly mixed and transferred into clean and labeled polythene bag for onward analysis in the laboratory.

Sample Treatment:

The soil sample was oven dried at 105^{o}C to constant weight for 6 hours (Inuwa and Shuaibu, 2007). The oven dried material was crushed and sieved through 2.00mm mesh to obtain a representative sample.

Soil pH:

The soil pH was determined in 1:1 soil water suspension and 1:2 soil 0.01M calcium chloride suspensions as described in manual12. 20g of air dried soil sample was weighed into a 50cm^3 beaker and mixed with 200cm^3 of distilled water and 0.01M $CaCl_2$ separately. The mixture for each was stirred for 30minutes and allowed to stand for 1 hour. The pH reading was taken after inserting the electrode of the pH meter into the partly settled suspension and reported the result as soil pH in water and 0.01M $CaCl_2$. The pH meter was calibrated with 7.0 distilled water and pH buffer solution before used. The electrode was washed and wiped with dry clean filter paper after each reading (Inuwa and Shuaibu, 2007).

Moisture Content Determination:

The soil sample was dried at a temperature of 105^{o}C for 24hours and dried to constant weight. The sample was removed and cooled in a desiccator and weighed again. The weight lost was obtained by subtracting the weight of dry sample from original weight of the sample using the following equation (IITA, 2019);

$$\text{Moisture content (\%)} = \frac{\text{Loss in weight on drying (g)}}{\text{Initial weight of sample}} \times 100$$

Sample Digestion:

1g of the oven dried sample ground sample was weighed using a top loading balance and placed in a 250ml beaker which has been previously washed with nitric acid and distilled water. The sample was reacted with sample was reacted with 5ml of HNO_3, 15ml of concentrated H_2SO_4 and 0.3ml of $HClO_4$ using dropping pipette. The mixture was digested in a fume cupboard, heating continued until a dense white fume appeared which was then ingested for 15minutes, set aside to cool and diluted with distilled water. The mixture was filtered through acid washed Whattman No.44 filter paper into a 50ml volumetric flask and diluted to mark volume (Walinga *et al.,* 2016). The sample solution was then aspirated into the Atomic Absorption Spectroscopic machine at intervals.

Results and Discussion

The results of pH, moisture content determination and average concentration of heavy metals in soil sample collected at automobile workshop are presented in tables-1, 2 and 3 respectively;

Table-1
pH of Soil sample

Source	pH in Soil	pH in 0.01M $CaCl_2$
automobile workshop, Maiduguri	7.12	6.39

Table-2
Moisture content of Soil sample

Source	Moisture (%)
automobile workshop, Maiduguri	5.00

Table-3
Heavy metal distribution in automobile workshop, Maiduguri (µg/g dry weight)

S/N	Element	Mean±SD
1	Zn	30.54±0.61
2	Pb	117.3±7.13
3	Cr	51.75±2.93
4	Fe	1771±112.73
5	Cu	0.277±0.02

Values are expressed as mean ± standard deviation of replicate determinations.

The pH of the soil is an important parameter that directly influences mineral mobility. The soil pH of the sampling site in water is 7.12 indicating neutrality (table-1). The soil pH in $CaCl_2$ is 6.39 indicating moderately acidic soil. In general, the acidic nature of the soil may be attributed to the industrial pollution of acidic gases, effect of bush burning and harmattan dust (Sahrawal *et al.,* 2002). The higher pH of automobile workshop, Maiduguri can also be attributed to the deposition of calcium compounds in the soil of the sample site. Brady and Weil (2009) reported that, the neutral to alkaline pH observed in semi-arid soil such as that of the sample site was due to low rainfall, alkaline compounds are not leach away, thus making the soil of the region too

alkaline. The moisture content of the sampling site was 5.0% (table-2) which might depend on the nature of the soil.

The results of the study revealed that Fe, Pb, and Cr present in the soil sample are in higher concentrations than Zn and Cd, that are in trace amount and were in the following order of abundance Fe > Pb> Cr> Zn> Cd (Table 3). Fe is present in concentration higher than other metals investigated because of geographical origin of the soil (Usman, 2000). Pb was high due to wide use of lead products in storage batteries and its anthropogenic sources being the combustion of leaded gasoline (Abubakar and Ayodele, 2002). The higher Fe, Pb and Cr concentrations showed that there is heavy metals pollution at the sampling site where anthropogenic activities such as battery charging, welding are heavier while the lower concentration of Zn and Cd showed that anthropogenic activities are lower and could be as a result of variety of iron salt (Jankiewicz *et al.,* 2002).

In general, the results obtained showed that, the heavy metals concentration in the soil sample can be attributed to leaching of the top soil and unproductive nature of the garage at the time of sampling. The distribution patterns of the metals in the soil sample were similar to those reported by many researchers (Abdulrahman *et al.,* 2005). The concentrations of Fe, Pb and Cr have exceeded the permissible limit prescribed by World Health Organization (WHO, 2011) and Federal Environmental Protection Agency (FEPA, 2008). This means that the inhabitants of this area are vulnerable to heavy metal toxicity (Zaharaddeen *et al.,* 2014).

Conclusion

The concentrations level of heavy metals determined in the present study are generally higher than the tolerable limits prescribed by WHO and FEPA, implying that the inhabitants around the sampling site are liable to heavy metal pollution.

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