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Some Chemical Properties and Heavy Metal Characteristics of Soil from Selected Dumpsites in Owo Metropolis

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ABSTRACT

This study was designed to assess some chemical properties and heavy metal concentration of soil at different dumpsites in Owo, Ondo state. Samples were collected from the major dumpsites and taken to the laboratory immediately for analysis. Digestion was done using Aqua-regia method while the heavy metal concentration was determined using AAS machine. The result shows that that soil from Fasawe dumpsite had the highest content of Arsenic (0.047mg/kg) compared to the other samples. Also, Cadmium was found in higher quantity in sample from the Old road (0.034mg/kg) compared to the others. It was further revealed that soil from Old road dumpsite had the highest (0.386mg/kg) Lead content compared to that other two samples. The phosphate content of the soil samples ranged between 0.176mg/kg and 9.475mg/kg while the sulphate content (19.560mg/kg) was higher in sample from old road. There is clear evidence from the study that there is no heavy metal pollution in the soil obtained from the dumpsites studied since the DPR limits for heavy metals in soil were not exceeded. The soil within this region in Owo can be used for agricultural purposes. However, extensive efforts are required for adequate awareness and legislation on the handling of wastes to hinder wastes related problems in the society.

Keywords: chemical, heavy metals, soil, dumpsites, Owo

INTRODUCTION

A soil is known to be rich for agriculture, depending on its nutrient content, amongst other physico-chemical factors such as soil pH (Cohen *et al.,* 2013). Soil acts as a reservoir for nutrients and water, providing the plants' needs throughout their growth (Li *et al.,* 2017). The soil may also provide an environment for the breakdown and immobilization of materials added to the surface such as fertilizers and pesticides and waste products such as sewage sludge, animal wastes and slurries, and composted refuse materials and then transferred to the underground water, food chain and ultimately human body, which in turn causes danger at various aspects of human health (Centeno *et al.,* 2015).

Hazardous waste has caused pollution, damage to health and even death to living systems. Exposure to multiple chemical combinations in inhabitants near waste dumpsites has led to series of diseases and health disorders (Chen *et al.,* 2019). It has been reported that heavy metals and anions in dumpsites leachates can cause chromosomal disorder and inhabitants in the vicinity of landfill sites are prone to mutagenic effects (Costa*.,* 2017; Duffus, 2012) and the level of contamination arising from percolation of leachates is determined by a number of factors that include the physico-chemical properties of the leachates and soil and the hydrological condition of the surrounding site.

Soil, particularly in urban and industrial areas, influences both the quality of life and the health of the people living in such an environment (Gabby, 2016). The general belief that wastes are sometimes hazardous to health cannot be overemphasized, and the most common heavy metal contaminants are Cd, As, Cr, Cu, Hg, Pb, Ni, and Zn. which Some of these metals are micronutrients necessary for plant growth, while others have no known biological functions and are very toxic to human health. There are various sources of heavy metals; some originates from anthropogenic activities like draining of sewerage, dumping of hospital wastes and recreational activities (Hartmann and Speit, 2014).

Many dumpsites have been rendered unsafe and hazardous to man and other living systems as a result of indiscriminate dumping of refuse (He *et al.,* 2015). Soil surface used as dumpsites where many unsafe and hazardous materials are dumped particularly in urban and industrial areas, most of the times influences both the quality of life and the health of the people living in such an environment (Patlolla *et al.,* 2018). Many studies had revealed that majorly, all dumpsites are mainly in heavy metals and in excess.

Most of the heavy metals found in the soil are essential for growth of organisms but are only required in low concentrations. Heavy metals occupy a special position in soil chemistry because they play very important physiological roles in nature. These trace elements have been proven to be dispensable for normal growth and reproduction of all higher plants (Velma *et al.,* 2019). Nevertheless, they exert toxic effects when their concentrations are increased, and at this stage, they could be referred to, as toxic metals. The main objective of this study is to assess physicochemical characteristics and Heavy metal concentration of soil at different Dumpsites in Owo, Ondo state.

Materials and Methods

Sample Collection

Three soil samples each were collected from three different location (A-C) namely; Sample A (Isuada dumpsite), Sample B (Fasawe dumpsite) and Sample C (Old road dumpsite).

Soil sampling extraction

Aqua-regia was used for the soil digestion as described by Wilson (2018). Aqua-regia is a mixture of nitric acid ($HNO3$) and hydrochloric (HCl) acid in the ratio of 1:3. One gram of soil sample previously air-dried, cleaned, gently crushed using an agate mortar and pestle and sieved through a standard sieve of 2mm mesh size was weighed and digested with aqua-regia. The mixture was heated slowly in a fume-hood at a temperature between 50-60ºC for 30 minutes. The resulting mixture was filtered into a cleaned plastic container using Watman filter paper and make up to 50mL with double-distilled water. The digested products were stored in a plastic vials prior to metals analysis.

Heavy metal analysis

The analysis of heavy metals was carried out with a Buck Model 211 VGP atomic absorption spectrophotometer, USA. In all cases, air-acetylene was the flame used and hollow cathode lamp of the individual metals was the resonance line source. The calibration plot method was adopted for the analysis. For each element, the instrument was auto zeroed using the blank (de-ionized water) after which the standard was aspirated into the flame starting from the lowest concentration. The corresponding absorbance values were obtained and the graph of absorbance against concentration was plotted by the instrument. The digested samples were then analyzed in duplicates with the average concentration of the metal present being displayed in part per million (ppm) by the instrument after extrapolation from the standard curve. For arsenic measurement, hydride generator was attached to AAS.

Determination of pH

Ten (10) gram of each of the soil sample were weighed into 50 ml beakers and 25 ml distilled water were added to form 1:2.5soil/water mixtures. The mixture were stirred for 30 minutes and allowed to stand for about 5 minutes. Two point calibrations were done with buffer solution having pH of 7 and 4 (buffer 7 and buffer 4). Finally, the pH meter electrodes were immersed into the soil/water mixture and the pH were measured on the upper part of the suspension.

Statistical Analysis

All data obtained were determined in triplicate and they were subjected to Statistical Analysis of Variance (ANOVA) at 5% significant level using SPSS version 16.00 and the means were separated using the Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Table 1 below shows the physicochemical properties of dumpsite soil samples from Isuada, Fasawe and Old road. The result from the table revealed that soil from Fasawe dumpsite had the highest content of Arsenic (0.047mg/kg) compared to the other samples. The table also revealed that the Cadmium content in the soil from the dumpsite at the Old road was higher (0.034mg/kg) compared to that of the other two soil samples. The copper content of the soil samples ranged from 0.276mg/kg to 0.512mg/kg. The soil from the dumpsite at Old road show the highest Cobalt content (0.034mg/kg) compared to the other two samples. It was further revealed that soil from Old road dumpsite had the highest (0.386mg/kg) lead content compared to other samples. The phosphate content of the soil samples ranged between 0.176mg/kg and 9.475mg/kg while the sulphate content ranged from 1.597 mg/kg to 19.560mg/kg in the soil samples.

Table 1: Physicochemical properties and heavy metal characteristics of soil from selected dumpsites in Owo

Parameters (mg/kg)	ISU	FAS	OLD	WHO	FAO
Ph	6.220 ± 0.028	5.070 ± 0.033	6.0208 ± 0.032	6-7	6-7
Arsenic	0.026 ±0.001	0.047 ± 0.02	0.012 ± 0.001	4.5	4.5
Cadmium	0.016 ±0.001	0.024 ± 0.002	0.034 ± 0.003	0.76	0.2
Copper	0.306 ± 0.003	0.514 ± 0.001	0.276 ± 0.001	0.1	0.2
Cobalt	0.010 ± 0.001	0.014 ± 0.002	0.034 ± 0.001	0.1-50	0.1-50
Lead	0.171 ± 0.003	0.240 ± 0.004	0.386 ± 0.001	0.3	-------
Phosphate	0.176 ± 0.001	9.475 ± 0.008	0.386 ± 0.001	-----	-------
Sulphate	1.597 ± 0.033	7.477 ± 0.033	19.560 ± 0.033	-----	-------

Keys: ISU = Isuada Dumpsite, FAS = Fasawe Dumpsite, OLD = Old road Dumpsite

All the physicochemical properties observed in this study were related to previous studies. The result from the pH value of the soil samples ranged from 5.070 to 6.220 which was in range with the FAO (2010) classified standard for soil nutrients of about 6.00 to 7.00. The values of acidic pH in this study was in agreement with the 4.49 to 6.25 reported by Velma *et al*. (2019) on the physicochemical properties of soil polluted with spent engine oil and lower than the reported value from WHO (2018). According to Velma *et al.* (2019), the availability of nutrients to plants is altered by soil pH and acidic soil reduces most of the nutrients presence in the soil.

The arsenic content of the soil ranged between 0.012 to 0.026mg/kg. This result correlates with the one obtained from the findings of Hartmann and Speit (2014) from soil pollution by slag from an automobile battery manufacturing plant in Nigeria and this was very high due to the nature of the activities of the facility. Anthropogenic input of arsenic comes from solid wastes, where approximately 30% of it originates from plastics packaging materials (GESAMP, 2017).

The Cadium values recorded for all the soil samples was lower compared to the 0.2mg/kg maximium permissible value of WHO (2018). Accumulation of cadmium in the soil is found to cause reduction in shoot growth and likewise cause inhibition of root growth (Wang *et al.*, 2017). The concentration of copper in the soil samples was noticed to be more high in soil samples from Fasawe dumpsite (0.514mg/kg). This is against the FAO, (2010) classified standard for soil nutrients of about 0.2mg/kg and WHO, (2018) of about 0.1mg/kg.

The concentration of Pb in the soil sample was higher compared to the standard estimated value by WHO, (2018) of 0.3mg/kg. The increment of Pb can cause inhibition of enzyme activity which could affect CO_2 fixation in the soil.

The phosphate content of soil samples ranged from 0.176 to 9.475mg/kg. And that of sulphate ranged from 1.597mg/kg to 19.560. the concentration of both phosphate and sulphate as observed from the study shown a high level of acidity. Phosphate (PO43¯) and sulphate (SO42¯) are acidic and when taken in high concentrations can alter the acid-base load of the body and obviously manifest as net acid load if the diet source does not provide basic cations (K, Ca, Mg) that could balance it (Zhitkovich *et al.*, 2011. This tends to produce low grade chronic metabolic acidosis and hence hypercalcuria, calcium is released from the bone and osteoclastic activity sets in.

CONCLUSION

There is clear evidence from the study that there is no heavy metal pollution in Isuada dumpsite, fasawe dumpsite and Old road dumpsite, since the DPR limits for heavy metals in soil were not exceeded. The soil within this region in Owo can be used for agricultural purposes. However, extensive efforts are required for adequate awareness and legislation on the handling of wastes to hinder wastes related problems in the society.

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