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Effects of ABSUTH Wastewater on Soil Physicochemical Properties in Aba, Abia State, Nigeria

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ABSTRACT---- ***The effects of Abia State University Teaching Hospital, Aba wastewater on soil physicochemical properties in Aba, Abia State, Nigeria was investigated using standard procedures. The level of pH of the wastewater from the hospital varied between 6.0±0.0 to 6.82±1.4 for the control water and wastewater samples from the collation point respectively. The pH values of the soil samples range from 7.0±0.0 to 10.5±0.3. Average temperature of wastewater samples investigated varied from 30.1±0.0^{0}C for laboratory wastewater samples, 28.60±3.4^{0}C for laundry wastewater samples, 30.20±0.1^{0}C for mortuary wastewater samples, 32.50±1.8^{0}C for collation point wastewater samples and 24.50±0.9^{0}C for the control water. The temperature range of the soil samples varied between 28.6±2.4to 30.7±1.1 for the control soil sample (unpolluted soil sample) and the soil samples from the point of discharge of the waste water. Dissolved oxygen (DO) values for all the sampling points varied between 1.90±0.9mg/l to 6.4±0.5mg/l for the laboratory waste water and collation point waste water samples. The concentrations of heavy metals in the waste water samples and soil samples as revealed in this study shows varying concentrations of the heavy metals. Physiochemical parameters of the wastewater and soil samples studied revealed that the hospital wastewater and the soil samples showed some parameters whose values are higher than the WHO standards. Others fall within the WHO acceptable limits. There is therefore, contamination of the soil environment as a result of the discharged hospital wastewater, which could probably be hazardous to human health.***

Keywords--- Wastewater, Soil, Contamination, Human health

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1. INTRODUCTION

Wastewater is defined as any water whose quality has been adversely abused by anthropogenic influence (Ekhaise and Omavwoya, 2008). This includes liquid waste discharged from domestic homes, industries, agricultural and commercial sectors (Ekhaise and Omavwoya, 2008). Health care waste consists of both organic and inorganic substances including pathogenic microorganisms. Hospital wastes possess serious health hazards to the health workers and the public.

Hospital wastewater is wastewater generated from all activities of the hospital as medical and non-medical activities from the operating, emergency and first aid, laboratory, diagnosis, radiology, kitchen to laundry activities (Prayitno*et al.*, 2013). Hospital wastewater contains harmful pollutant, such as: pathogenic microorganisms (bacteria, viruses, protozoa and helminths), residual drugs and laboratory chemicals (antibiotics, phenol, chloroform), chemical toxid (Pb), and biodegradable organic material (protein, fat, carbohydrate) (Radha, 2009).

There is more area of agricultural land in the world using untreated wastewater for irrigation due to lack of water (Mohsen and Mohsen, 2008). Surveys of wastewater use have shown that more than 85% of the applied heavy metals are likely to accumulate in the soil, mostly at the surface (Wyasu*et al.*, 2012). Food crops such as cocoyam, cassava and tomatoes constitute an important part of the human diet since they contain carbohydrates, protein as well as vitamins, minerals and trace elements. However, in recent years their consumption is increasing gradually particularly among the urban community. This is due to increased awareness on the exposure to other culture and acquiring proper education (Wyasu*et al.*, 2012).

Recently, pollution of general environment has increasingly gathered a global interest. In this respect contamination of agricultural soils with heavy metals has always been considered a critical challenge in set urban community (Faruk*et al.*, 2006). Heavy metals are generally present in agricultural soils at low levels and due to their accumulation behaviour and toxicity; they have a potential hazardous effect not only on crop plants but also a human health (Wyasu*et al.*, 2012).

Hospital wastewaters are major components of water, contributing to oxygen demand and nutrient loading of water bodies, promoting toxic algae blooms and leading to a destabilized aquatic ecosystem (Ekhaise and Omavwoya, 2008).

Abia State University Teaching Hospital, Aba is a referral health institution in Aba area as patients from Aba and its environs are regularly referred to this institution for proper medication. Waste water generated from this healthcare institution may represent a serious health hazard and little is known about the health hazard of hospital wastes in Aba metropolis. Children, adults and animals all have the potential to come into contact with these wastes, which may pose severe health risks to them.

This study therefore investigated the influence of this hospital wastewater in the soil environment. The findings from this study will help to create awareness to the people of Aba metropolis about the health risks and environment hazards associated with hospital wastewater and therefore will expose the need for proper disposal of medical wastes.

2. MATERIALS AND METHODS

2.1 Study area

The study hospital was Abia State University Teaching Hospital, Aba in South-Eastern Nigeria. The hospital is a referral health institution in the area as patients from Aba and the environs are regularly referred to the hospital for proper medication. Aba lies in the tropical rainforest region of South-Eastern Nigeria. Aba is situated at 5.11° North latitude, 7.37° East longitude and 207 meters elevation above the sea level. Aba is a big town in Nigeria, having about 897,560 inhabitants and the main trading center in Abia State.

2.2 Source of Sample

The wastewater samples were collected at three consecutive times from four wastewater outlets from different units of Abia State University Teaching Hospital, Aba (laboratory wastewater, laundry wastewater, mortuary wastewater, the collation point where all the outlets meet) and the control which is the source of water for the Teaching Hospital. The five sampling points were designated A to E (A=laboratory wastewater sample, B=laundry wastewater, C=mortuary wastewater, D=collation point and E= control).

Wastewater from the collation point was discharged into a pit. Soil samples were then collected from different points in relation to distance from the discharge pit. These were the edge of the pit (P_1), 50m away from the wastewater pit (P_2), 100m away from the discharge pit (P_3) and from the site which has not been polluted by the wastewater in the hospital premise which served as the control soil sample (P_4) (500m away from the pit).

2.3 Sample Collection

The samples for the physicochemical analysis were collected in clean sterile containers devoid of chemical contamination at triplicates. Samples for dissolved oxygen (DO) and biochemical oxygen demand (BOD_5) were collected in 250ml amber coloured bottles with stoppers, one millimeter each of Winkler's solutions A and B were added to the samples on site to fix the oxygen in the case of DO and then transported to the laboratory for analysis. Soil samples were collected using Shiprek soil augar disinfected with cotton wool soaked in 70% ethanol at 0-15cm depth. Clean amber coloured glass bottles, rinsed thrice in distilled water solution, were used for the soil samples for physicochemical analysis.

2.4 Physicochemical Parameters

Determination of the pH of the samples

The waste water sample (30ml) was poured into a beaker and stirred using sterile glass rod for 2 minutes. The beaker and its contents were allowed to stand for 10 minutes. The digital pH meter was dipped into the water and the pH read after 2-3 minutes stabilization time, this was repeated three times and the average reading was taken. The reading was taken while the meter was still in the wastewater.

In the case of the soil, a 1:2.5 ratio mixture of soil and distilled water was made. The mixture was stirred vigorously for 3-5 minutes and then allowed to settle for 10-20 minutes. The pH of the soil was read three times and the average taken.

Determination of the temperature of the samples

The temperatures of the samples were determined in-situ using mercury-in-glass thermometer of the range 0^oC to 100^oC. The thermometer was inserted in the water sample for about 5-10minutes before the reading was taken while still in the water.

In the case of the soil, soil thermometer was inserted into the soil and the temperature read after 5 minutes stabilization time.

Determination of Dissolved Oxygen

This was done by Winkler's method. A 250-mL glass Biological Oxygen Demand (BOD) stoppered bottle was filled to the brim with the sample water. 2mL of manganese sulfate was added to the collection bottle immediately by inserting the calibrated pipette just below the surface of the liquid. The pipette was squeezed slowly so no bubbles were introduced via the pipette. 2mL of alkali-iodide-azide reagent was added in the same manner and the bottle was stoppered with care to be sure no air was introduced. The sample was mixed by inverting several times. 2 mL of concentrated sulfuric acid was added via a pipette held just above the surface of the sample. The bottle was carefully stoppered and inverted several times to dissolve the floc. At this point, the sample was "fixed" and was stored for up to 8 hours kept in a cool, dark place.

In a glass flask, 201mL of the sample was titrated with sodium thiosulfate to a pale straw color. 2 mL of starch solution was added after the titration resulting to the formation of a blue color.

This was done continually and slowly until the sample turned clear. As this experiment reached the endpoint, the concentration of dissolved oxygen in the sample was equivalent to the number of milliliters of titrant used. Each mL of sodium thiosulfate added to the 201ml of the sample to get a pale straw colour and to get a clear solution after the addition of 2ml of starch solution equals 1 mg/L dissolved oxygen

Determination of Biological Oxygen Demand (BOD_5)

The BOD was determined from two separate dissolved oxygen measurements made using Winkler's method. The initial dissolved oxygen reading was taken at the sampling site using the procedures outlined above. Using a light-free sample bottle, the water sample was collected at the same site. The sample was transported back to the lab and incubated at 20°C for a total of five days. After five days, the incubated sample was tested for dissolved oxygen. The oxygen reading at the end of the five days was subtracted from the initial reading. The resulting value gave the BOD level.

Determination of heavy metals

The aim of this exercise was to determine the presence of heavy metals in the water samples. The heavy metals whose concentrations were analyzed include: Iron (Fe), Chromium (Cr), Nickel (Ni), Cadmium (Cd) and Potassium (K). The concentrations of these metals were determined using the Atomic Absorption Spectrophotometer (AAS) method as described in (2011) methods. Each lamp has a hollowed lamp for its determination. The water samples were sprayed through a nebulizer into an air-acetylene flame resonance line in element generated in a hollow lamp. This was passed simultaneously through the flame. The absorbance of radiant energy by the element of interest is related to tits concentration in the water samples.

2.5 Statistical Analysis

The results obtained in this study were subjected to standard statistical analysis by the use of correlation analysis, standard deviation and ANOVA. This was used to determine the significance of the results.

3. RESULTS

Table 1: Physicochemical analysis of ABSUTH waste water samples

PARAMETERS	SAMPLES A	B	C	D	E
pH	6.13±0.2*	6.57±0.6*	6.8±1.4*	6.82±1.4*	6.0±0.0*
Temperature(°C)	30.1±0.0	28.60±3.4	30.20±0.1	32.50±1.8	24.50±0.9
DO(mg/l)	1.90±0.9	1.80±0.7	2.0±0.1	6.4±0.5	4.0±0.0
BOD (mg/l)	40.2±0.3	12.50±1.8	40.50±0.5	39.6±1.4	5.0±0.0
Sulphate (mg/l)	75.7±1.2	20.7±1.1	20.9±1.0	30.5±0.5	17.4±0.7
Nitrate (mg/l)	30.0±1.2	30.5±0.5	30.1±0.2	29.2±1.3	17.4±0.7
Phosphate (mg/l)	31.0±0.0	29.8±0.3	28.0±3.5	24.5±0.9	3.2±0.8

Values are means of three triplicates and are expressed as mean ± standard deviation.

At p>0.05, there is significant difference except values with asterisk (*)

Keys:

A= LABORATORY WASTE WATER SAMPLE
B= LAUNDRY WASTE WATER SAMPLE
C= MORTUARY WASTE WATER SAMPLE
D= COLLATION POINT
E= CONTROL

Table 2: Physicochemical analysis of the soil samples

	SAMPLES			
PARAMETERS	P_1	P_2	P_3	P_4
pH	10.5±0.3*	7.0±0.0	7.4±0.5	7.2±0.4
Temperature(^oC)	30.7±1.1	29.0±0.0	28.7±1.5	28.6±2.4
Sulphate (mg/kg)	29.0±0.0	30.0±1.5	33.6±0.4	46.1±1.0*
Nitrate (mg/kg)	24.3±0.3	26.2±0.8	27.8±1.3	48.4±1.1*
Phosphate (mg/kg)	1.0±0.1	0.8±0.1	1.1±0.1	2.3±1.1*

Values are means of three replicates and are expressed as mean ± standard deviation.

At P>0.05, there is significant difference except values with asterisk (*)

Keys:
$P_{1=}$ POINT OF DISCHARGE OF THE WASTE WATER
$P_{2=}$ 100M AWAY
$P_{3=}$ 200M AWAY
P_4= CONTROL (UNPOLLUTED SOIL SAMPLE)

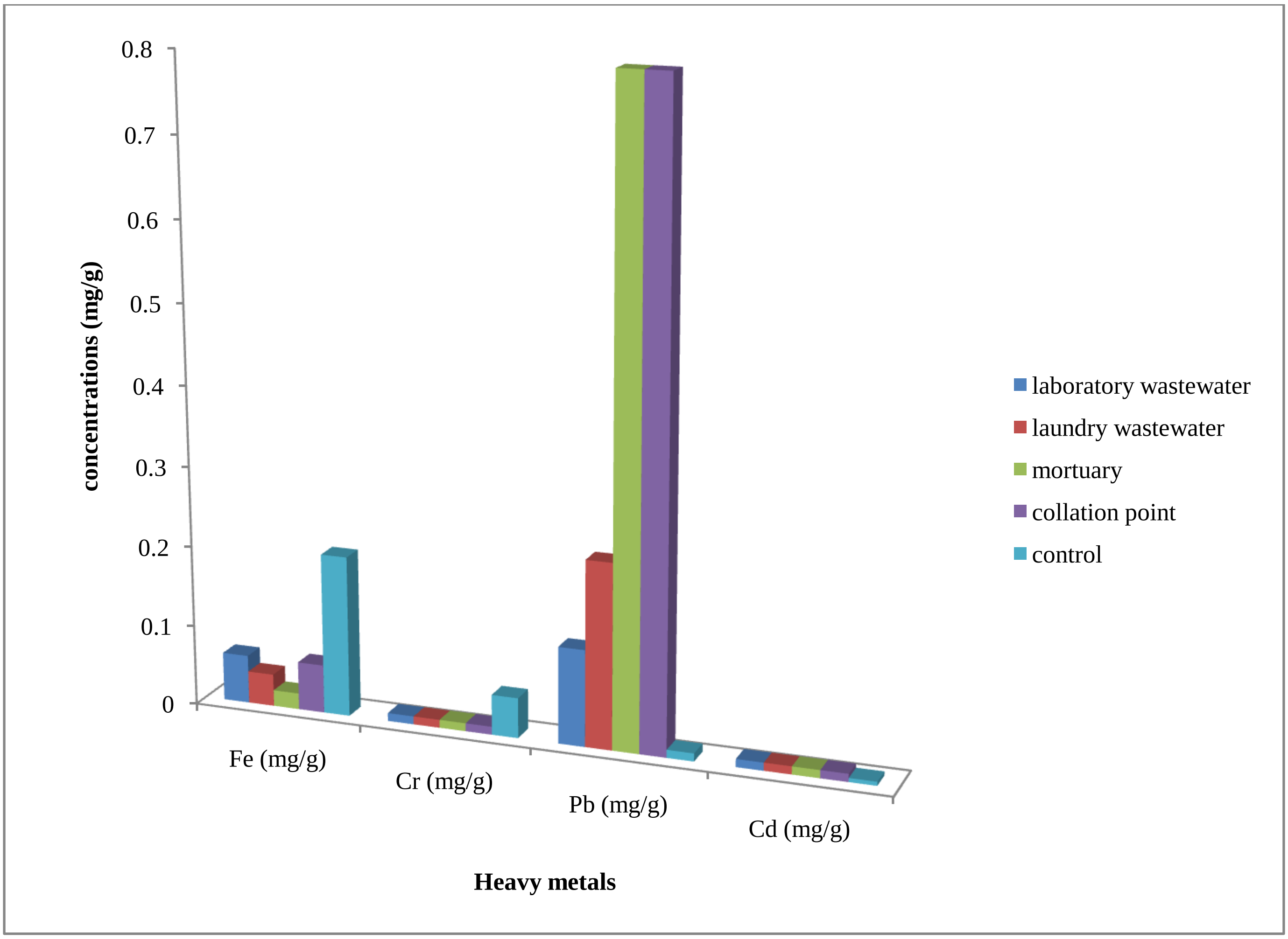

Figure 1: Heavy metals concentrations of ABSUTH wastewater samples

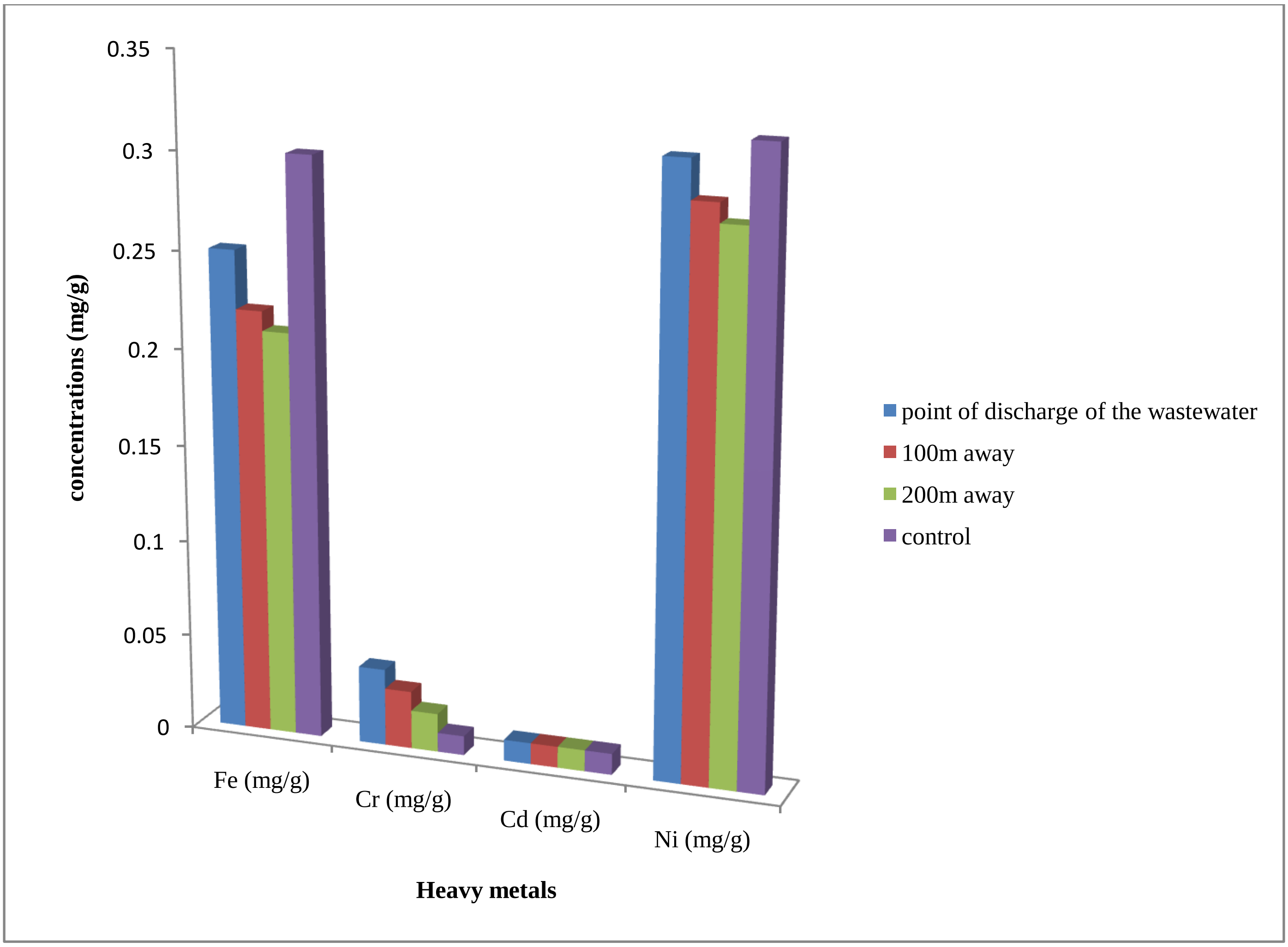

Figure 2: Heavy metals concentrations in the soil samples

4. DISCUSSION AND CONCLUSION

This research was conducted to investigate the various effect of hospital waste water generated from Abia State University Teaching Hospital, Aba on the physiochemical parameters on the receiving environment (soil). There was significant increase in most of the physiochemical parameters studies with slight fluctuation. The hospital wastewater was observed to play a significant role in the influence on the qualities of the parameters studies.

The physicochemical parameters studied showed some degree of variation among the sampling points. The level of pH of the wastewater from the hospital varied between 6.0±0.0 to 6.82±1.4 for the control water and wastewater samples from the collation point respectively. The pH values of the soil samples range from 7.0±0.0 to 10.5±0.3. The highest pH value (10.5±0.3) was observed in the waste water samples from the point of discharge of waste water which is higher than WHO and Federal Environmental Protection Agency limits for the discharge and application of waste water in the environment. The pH values recorded for all the sampling points were within the WHO pH tolerance limit between 6.00-9.00 for wastewater to be discharged into the environment. Temperature is basically important for its effect on other properties of wastewater. Average temperature of wastewater samples investigated varied from 30.1±0.0^{0}C for laboratory wastewater samples, 28.60±3.4^{0}C for laundry wastewater samples, 30.20±0.1^{0}C for mortuary wastewater samples, 32.50±1.8^{0}C for collation point wastewater samples and 24.50±0.9^{0}C for the control water. The temperature range of the soil samples varied between 28.6±2.4to 30.7±1.1 for the control soil sample (unpolluted soil sample) and the soil samples from the point of discharge of the waste water. These results indicate that some reactions could be speeded up by the discharge of this wastewater into the environment. It will also reduce solubility of oxygen and amplified dour due to anaerobic reaction (less oxygen).

Dissolved oxygen (DO) values for all the sampling points varied between 1.90±0.9mg/l to 6.4±0.5mg/l for the laboratory waste water and collation point waste water samples. The DO is a measure of the degree of pollution by organic matter, the destruction of organic substance as well as the self purification capacity of the water body. The standard for sustaining aquatic life is stipulated at 5mg/l. A concentration below this value adversely affects aquatic biological life, while concentration below 2mg/l may lead to death for most biological lives (Wyasu*et al.*, 2012). The DO levels from the laboratory waste water samples and laundry waste water samples were below 2mg/l, while DO from the collation point waste water samples is greater than 5mg/l, which implies aquatic biological life will be adversely affected if this waste water samples are discharged into environment. The high concentration of dissolved oxygen in this point as compared to other sampling points, could be due to increased waste disposal and other human activities that may enhance their growth and proliferation leading to consumption of available oxygen.

An indication of organic oxygen demand content of wastewater can be obtained by measuring the amount of oxygen required for its stabilized either as BOD and COD. Biological oxygen demand (BOD) is the measure of the oxygen required by microorganisms whilst breaking down organic matter, while chemical oxygen demand (COD) is the measure of amount of oxygen required by both potassium dichromate and sulphuric acid to break down both organic and inorganic matters. BOD concentration of the hospital wastewater obtained ranged between 5.0±0.0 to 40.50±0.3mg/l for the control water sample and mortuary waste water sample.

The concentrations of heavy metals in the waste water samples and soil samples as revealed in this study shows varying concentrations of the heavy metals. Heavy metals have been variously defined as those metals with higher atomic number and weight; large group of elements with an atomic density of greater than 6 g cm-^{3}, which are both biologically and industrially important; any metallic chemical element that has a relatively high density and is toxic or poisonous at low concentration (Holdings, 2004). They are trace metals that are at least five times denser than water, and as such, they are stable elements (meaning they cannot be metabolized by the body) and bio-accumulative (passed up the food chain to humans). Heavy metals are natural components of the environment, being present in rocks, soil, plants and animals. They occur in different forms: as minerals in rock, sand and soil; bound in organic or inorganic molecules or attached to particles in the air (Ezejiofor*et al.,* 2013). The results of this study generally revealed that the mean concentrations for most of the metals including such toxic ones as lead, , chromium, cadmium, iron were all found to be quite high relative to those of the control sites where (except nickel).

Conclusively, it was observed that hospital wastes have negative influence on the physiochemical parameters on the environment. The high densities of the physiochemical parameterssuggests that the activities of hospital wastes in the environment is a major health and environmental threat, which therefore call for a proper regulatory system on disposal of hospital waste in the world, especially in the developing countries like Nigeria.

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