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Determination of Heavy Metal Concentration of Dumpsite in Enugu Central Metropolis

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ABSTRACT
Dumpsites exist throughout the developing countries, this presents a threat to human health. Most of these dumpsites are uncontrolled having grown over time from small dumpsites to large unmanaged waste sites. In this research work, the level of heavy metal concentration in soils of the dumpsites in Enugu central metropolis has been studied. The analysis of heavy metals indicates the presence of Pb (0.966 mg/kg), Cd (0.298 mg/kg), Mn (0.180 mg/kg), Ni (2.438 mg/kg), Zn (88.054 mg/kg), Cr (1.324 mg/kg), Cu (2.843 mg/kg), Co (0.052 mg/kg). Sample from the control site indicates mean concentration of Pb (1.300 mg/kg), Cd (0.145 mg/kg), Mn (0.191 mg/kg), Ni (0.9173) mg/kg, Zn (2.608 mg/kg), Cr (0.896 mg/kg), Cu (0.429 mg/kg), Co (0.049 mg/kg). The results also shows that the concentration of heavy metals in the soil increased at the dumpsite than the control sites for all the metals. However, the level of Zn and Ni had the highest value with mean concentrations of 8.054 mg/kg and 2.438 mg/kg respectively. Statistical analysis using SPSS 20.0 package was used. Result shows a significance difference between the sample and control sites at 95% confidence level with <1 standard deviation.
Keywords: *Heavy Metal Determination, Dumpsites, WHO permissible limit, Enugu.*

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INTRODUCTION

Proper waste disposal has been documented to be a major problem in the developing country like Nigeria[1]. Refuse are dumped recklessly along the drainage channels, on the streets, along the main road and on the streams. This has created serious environmental pollution and has constituted to the source of heavy metal pollution [1]. In some places, waste are carelessly dumped without considering the negative impact it would create in the environment. In some cases wastes are burnt after it has been dumped causing the loss of organic materials and other nutrients present in the soil. In addition, the implication of these contamination is that metals are deposited in the soil which could cause land pollution and health hazards to those living around the area. Soil waste has been described to be a useless, unwanted material that came from the activities of man which could not be disposed through sewer pipe [2]. Furthermore, the domestic commercial and industrial disposal of garbage in the environment has been noted to be a problem that increases with the civilization of human and its activity [3]. Recent studies have been carried out in relation to waste and its disposal [4], discharge of metals from automobile along the roadside [5]. A casual visit to Enugu central, Nigeria reveals reckless dumping of refuse and burning of refuse at the time of study. Therefore, we decided to investigate the heavy metal content of the soil in Enugu central and compared the gotten results with the World Health Organization (WHO) permissible limit. The aim of this study is the determination of heavy metal content of the soil in a dump site within the Enugu central of Enugu State , Nigeria and to compare the results gotten with WHO permissible limits [6].

MATERIAL AND METHODS

Apparatus and Equipment.

The following instruments were used for laboratory analysis. Soil auger, A 20 VGP system Atomic

Absorption Spectrophotometer. Other materials include matchet, marker and paper tape, shovel and hand trowel , Filter paper, 250ml volumetric flask, Beakers, Measuring cylinder, Top loading balance, Mesh sieve (2mm).

Location of Study

The location of study falls within latitude 60021N to 60591N and longitude 7021E to 70311E with an area extent of about 5,657.39$_{sq}$ km. (Fig 1). Enugu state is located in the southern part of Nigeria, and its capital is located in the city of Enugu, which is also one of the biggest commercial centers in the state.

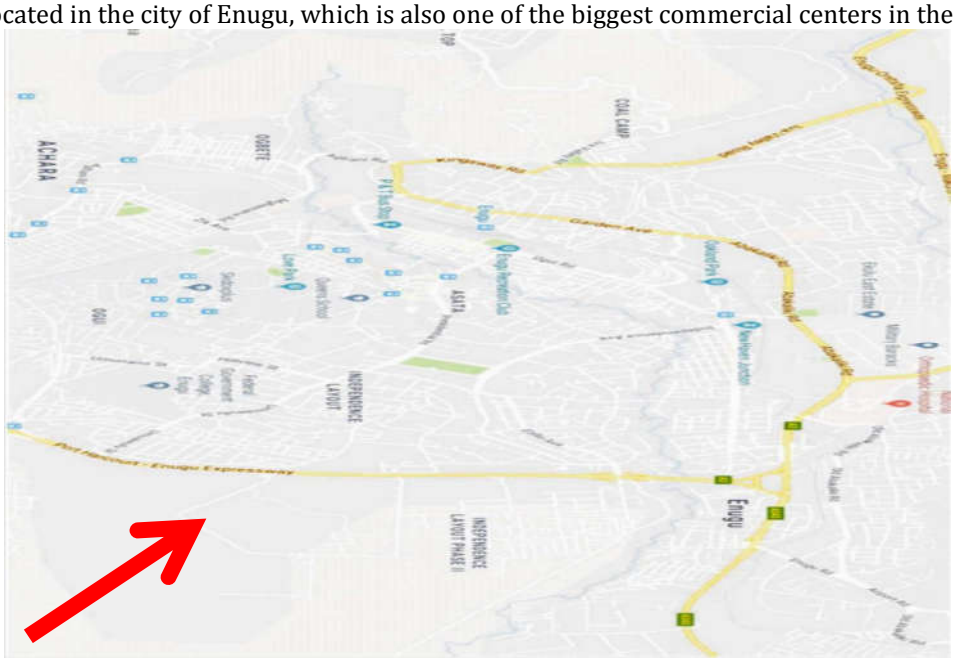

Fig 1 : Location of the study area

Collection of Samples

Sample collection was conducted around March 2019, from the Enugu central dumpsite in Enugu State, Nigeria. Three soil samples were collected from the dumpsite, the soil samples were collected at a depth of between 0-15cm. Three other soil samples were collected from three other locations away from the dump site, at a depth of between 0-15cm using a soil auger. Plate 1, 2, and 3 shows the collection points of the dumpsite.

Digestion of Samples

A modified wet digestion method as described by American standard was employed [7]. The heavy metal content of the soil samples were carried out AAS.

Preparation of samples

The wet soil samples were air dried by spreading on sheets of papers under room temperature and allowed to dry for 48h. After drying the samples were sieved using a 2mm mesh sieve and the coarse particles were discarded. The powdered form were then stored for digestion and subsequent analysis. The digestion experiment was carried out by weighing 2g of the soil sample into a Teflon crucible and 10ml, of agua-ragia which made up of 3mols of HCl and 1mol of HNO_3. It was placed in an oven at 2000 for 2 hours. The digest was filtered with ash less whatman No 1 before making up to 250ml mark. The various metals were analyzed at different wavelength of absorption using an Atomic Absorption Spectrophotometer (AAS).

Plate 1: Dumpsite A

Plate 2: Dumpsite B

Plate 3: Dumpsite C

RESULTS AND DISCUSSION

The levels of heavy metals in soil samples were collected around march, 2019 from Enugu central dumpsites are presented in (table 4.1)

TABLE 4.1: HEAVY METAL CONCENTRATION IN ENUGU CENTRAL DUMPSITES

Sample site	Pb (mg/kg)	Cd (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Co (mg/kg)
A	1.575	0.075	0.466	5.173	9.920	1.227	5.591	0.055
B	0.334	0.070	0.037	0.984	8.206	1.841	1.994	0.047
C	0.990	0.751	0.038	1.158	6.036	0.905	0.943	0.055
mean	0.966	0.298	0.180	2.438	8.054	1.324	2.843	0.052

Lead (Pd)

Table 4.1 indicate the presence of lead up to a mean average concentration of 0. 966 Mg/kg , which is below WHO permissible limit [6]. The presence of lead in the sample site is attributed to the fact that the dumpsite is sited near the main road [8]. This can be attributed to the availability of lead containing waste at the dumpsite which are eventually leached into the underlying soils. It is pertinent to note that exposure to amount of above 0.01 is detrimental to health as it may result in possible neurological damage to foetus, abortion and other complication in children under three years old [9].

The mean average concentration of cadmium (Cd) from the sample site is seen in(table 4.1) to be 0.298mg/kg as against the o.145mg/kg seen from the control site in table 4

TABLE 4.2 HEAVY METAL CONCENTRATION IN CONTROL SITE

Sample site	Pb (mg/kg)	Cd (mg/kg)	Mn (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Co (mg/kg)
D	1.220	0.023	0.024	1.123	2.485	0.875	0.384	0.011
E	0.650	0.046	0.472	0.968	2.574	1.231	0.365	ND
F	2.032	0.367	0.078	0.661	2.762	0.583	0.538	0.037
mean	1.300	0.145	0.191	0.9173	2.608	0.896	0.429	0.049

ND = NO DATA

Nickel (Ni)

The average mean concentration of Nickel from table 4.1 is seen to be 2.438 mg/kg as against the control which has an average mean concentration of 0.9173mg/kg(Table 4.2) . This concentration is below the target permissible limit (Table 4.3). The presence of Nickel is attributed to the fact of the absence of industries in the studied area.

TABLE 4.3: PERMISSIBLE LIMITS FOR METALS IN SOIL (MG/KG) [11]

Metals	Parameters
Cadmium	0.01-0.7
Chromium	1-1000
Copper	2-100
Lead	2 -200
Manganese	20 - 3,000
Nickel	5-500

Copper (Cu)

Copper (Cu) is released form mineral rocks known as weathering. The range of copper (Cu) in soil is 2-250 ppm, an approximate mean value of 30ppm [8]. When copper (Cu) content is less than 4ppm in mineral soil, the soil is said to be deficient. However the presence of copper (Cu) was seen to be 2.843(mg/kg) from the sample site which is below the limit set by WHO [6] (Table 4.4). This is similar to a reported work [8].

Zinc (Zn)

The mean concentration of zinc(Zn) was found to be 8.054mg/kg (Table 4. 1) from the sample site which varied from the control site with a mean concentration of 2.108 mg/kg (Table 4.2). This is in contrast to a reported work [12]. However the value of the zinc concentration was below the WHO permissible limit [6] The presence of zinc in the sample site is attributed to the occurrence of dry cells present in the dump site as reported by [13].

Cobalt (Co)

Cobalt (Co) was found in small concentration in both sites as presented in(Table 4. 1 and 4.2). This implies that waste carrying cobalt are not present in much quantity. The low concentration could be accorded to the absence of industries and smelting activities in Enugu central municipal area.

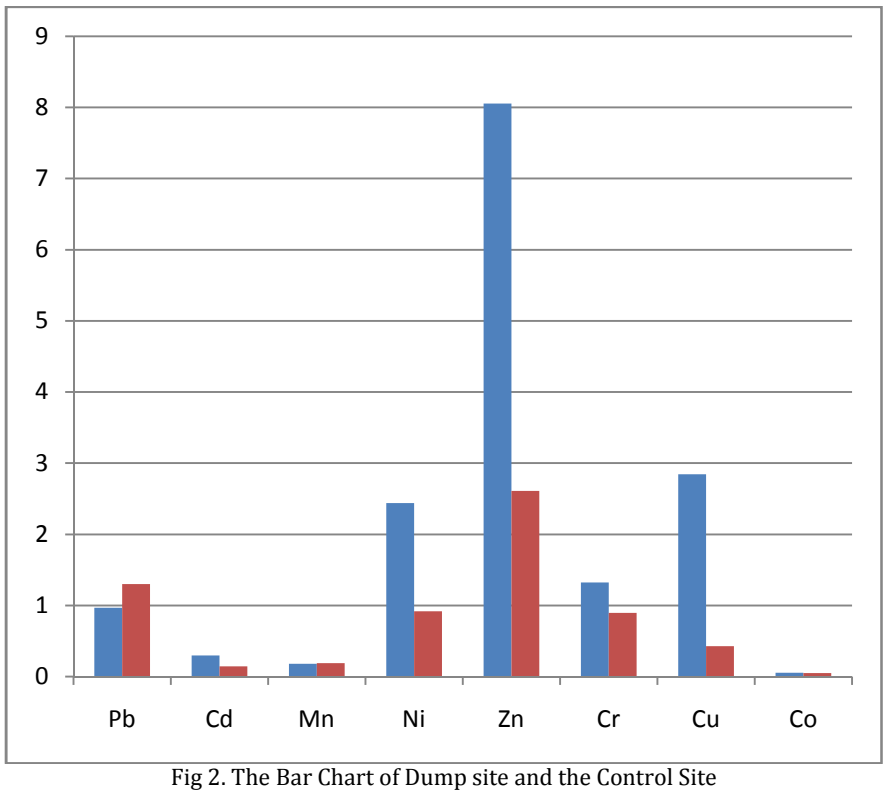

Fig 2. The Bar Chart of Dump site and the Control Site

The results showed that the concentration of heavy metals in the soil increased at the dumpsite than the control site. For all the metals, the level of Zn, Ni and Cu at dumpsite were higher than the levels at the control site. The accumulation of copper could cause liver, brain and Wilson's disease as reported by [14].

Table 4.4 : WHO permissible limit for heavy metals in soil (mg/kg) [6]

Metals	Parameters
Lead (Pd)	85
Cadmium (Cd)	0.8
Manganese (Mn)	ND
Nickel (Ni)	35
Zinc (Zn)	50
Chromium (Cr)	100
Copper	36

ND = No Data

Statistical Analysis

Test of significance result

H_0: The null hypothesis could be accepted if $p < 0.05$ meaning that there is no significant difference between the mean concentration levels of metal deposits in the dump and control site.

H_A: The (H_A) hypothesis could be accepted if $p > 0.05$ meaning that there is significant difference in the mean concentration levels of metals in the dumpsites and control sites

TABLE 4.5: STATISTICAL ANALYSIS OF THE METALLIC CONCENTRATION BETWEEN THE DUMPSITE AND CONTROL SITE.

Concentration of Metal Deposits	N	Mean	SD	df	t	p	Decision
Dumpsites	8	2.02	2.65	14	1.06	0.31	Reject Ho
Control Sites	8	0.98	0.83	8.35			

Table 4.5 represents the statistical analysis of the dumpsite and control site. Result shows that P value is equal to 0.31 which means that it is greater than 0.05. This shows that there is significant difference between the mean values of the dumpsite and control site hence the (Ho) null hypothesis is rejected. However, H_A is accepted on the claim that there is significant difference in the mean concentration of heavy metals present in the dumpsite and control site.

TABLE 4.6 : GROUP STATISTICS OF THE DUMPSITE AND CONTROL SITE

	Site	N	Mean	Std. Deviation	Std. Error Mean
mean concentration	dump site	8	2.0194	2.64792	0.93618
	control site	8	0.9800	0.82614	0.29208

Table 4.6 is the group statistics between the dumpsite and control site. Result reveals a mean standard error of < 1 which shows the accuracy of the work.

CONCLUSION

From the studies, the dumpsite in Enugu central metropolis contained most of these heavy metals up to a permissible limit. However, the levels of Zn,Ni, Cu at dumpsite had higher values than the control site although they fall within the WHO permissible limit. It was also observed that the dumpsite had higher concentration of these metals than others from the control site, this could be attributed to the presence of waste carrying higher amounts of these heavy metals to the soil.

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