Original Research Article

DETERMINATION OF HEAVY METALS (LEAD, ZINC, NICKEL AND CADMIUM) IN SOIL AROUND AMASOMA COMMUNITY IN BAYELSA STATE, NIGERIA.

ABSTRACT

Aims: This study investigated the level of zinc, nickel, lead and cadmium in the soil extracted from the area where Scent Leaf (*Ocimum gratissimum*) and Pawpaw tree (*Carica papaya*) are grown in Amassoma community, Bayelsa State, Nigeria.

Study Design: Scent leaf (*Ocimum gratissimum*) and Pawpaw tree *(Carica papaya)* soils from where these plants are grown were randomly collected for heavy metal analysis from within Amassoma community in Southern Ijaw Local Government Area of Bayelsa State, Nigeria

Place and Duration of Study: This study was carried out in Biological Sciences, Faculty of Science, Niger Delta University, Wilberforce Island, Amassoma, Bayelsa State between March 2019 to September 2019

Methodology: Scent leaf (*Ocimum gratissimum*) and Pawpaw tree *(Carica papaya)* soils were digested and analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS, model S471096). The method used was wet-ashing method for the analysis.

Results: the concentrations of Lead (Pb), Nickel (Ni), Cadmium (Cd), and Zinc (Zn), in pawpaw soil and scent leaf soil. From the sample data analysis, the average lead (Pb) contents in pawpaw soil and scent leaf soil were 1.283 mg/kg and 1.44 mg/kg respectively. The average Cadmium (Cd) in pawpaw soil and scent leaf soil were 0.256 mg/kg and 0.256 mg/kg respectively. The average Nickel (Ni) compositions in pawpaw soil and scent leaf soil were 4.71 mg/kg and 5.09 mg/kg respectively. While the Average Zinc (Zn) in pawpaw soil and scent leaf soil is 2.280 mg/kg and 2.160 mg/kg respectively. The soil analyzed for heavy metals were below the threshold target values recommended by the WHO.

Conclusion: The Scent leaf (*Ocimum gratissimum*) and Pawpaw tree (*Carica papaya*) soils analyzed for heavy metals were below the permissible limit recommended by WHO for soil safety. The result from the present study revealed that there may not be soil contamination as a result of the selected heavy metals, however, It is recommended that caution should be taken in regulating the anthropogenic activities that may tend to elevate the level of heavy metals in the surrounding to prevent contamination of soil over time which could be detrimental to the health of the populace.

Keywords: *Carica papaya*, Heavy metals, *Ocimum gratissimum*, Pawpaw, Permissible limit, Scent leaf, Targeted values.

1. INTRODUCTION

Soil plays an essential part in human societies, including food production, as a natural component of the Earth. In recent decades, the soil compartment has absorbed a significant number of contaminants from a variety of sources, including heavy metals, as a result of rising industrialization and urbanization [1] (Wei and Yang, 2010). Soil is the most important environmental component because it acts as a natural buffer for heavy metals by controlling their transmission to the atmosphere, hydrosphere, and biosphere, as well as acting as a geochemical sink for contaminants [2] (Kabata-Pendias and Pendias, 2001). Contaminants in contaminated soils will spread to other parts of the environment, creating an indirect threat to human health [3,4] (Zhang *et al*., 2007; Cui *et al*., 2005). Because of their endurance and toxicity, heavy metals are among the most significant anthropogenic contaminants [5] (Adriano, 2001). Heavy metal pollution of soil is a major concern in many parts of the world [6,7] (Facchinelli *et al*., 2001; Solgi *et al*., 2012). Natural trace metal concentrations in soils are determined by the chemistry of the parent rocks from which they are derived. Human activity has the potential to significantly increase metal concentrations in soil, particularly in urban settings [8] (Guagliardi *et al*., 2013). Because of the sorption of metals on particles and their limited mobility, soils that have been poisoned often remain in this state for a long time [9,10] (Ferri *et al*., 2012; Peris *et al*., 2008). As a result, there is a risk of human cumulative exposure.

Environmental heavy metal contamination is a worldwide issue that has gotten a lot of attention [11] [Qingjie *et al*., 2008]. Rapid industrialisation, including dust emissions from cement manufacturing and heavy metal pollution of the environment [12,13] (Kumar and Singh, 1990; Oyedele *et al*., 1990), is one of the principal pathways of heavy metals introduction into the environment [14] (Qingjie *et al*., 2008). Heavy metals discharged into the environment are thought to end up in soils [15,16] (Banat *et al*., 2005; Sun *et al*., 2005). [17] (Pekey *et al*., 2004)

Heavy metals can be sensitive markers for monitoring environmental contamination. According to Nogaj *et al*. [18] (Nogaj *et al*., 2012), the amounts of various chemical elements in soil influence the intensity of biological processes as well as determining whether dietary intake of a certain food is safe for consumption. Heavy metals are potentially harmful to crops, animals, and humans when contaminated soils are utilized for agricultural production, according to Liang *et al*. [19] (Liang *et al*., 2011), because heavy metals are easily stored in important organs of crops cultivated on these contaminated soils. [19] (Liang *et al*., 2011) Humans and animals that ingest such crops are likewise at risk of poisoning. This has fueled research into the environmental challenges of heavy metal pollution in soil in recent decades [20] (Zhang *et al*., 2007), including the establishment of an ecological geochemical survey to aid in identifying levels of heavy metal pollution and potential harm.

2. MATERIALS AND METHODS

2.1 SAMPLE AREA

Amassoma community in Southern Ijaw LGA, Bayelsa State of Nigeria was selected for sampling. Sampling was done at random from three different locations within Amassoma metropolis. These locations were selected at random to centralize the sample stations within the community (Sample location) as shown in Figure 1. Geographically, sample area has land mass of 2,682km^2 and a population of 319413 at the 2006 census. The people are predominant farmers, fishermen, business men and civil servants.

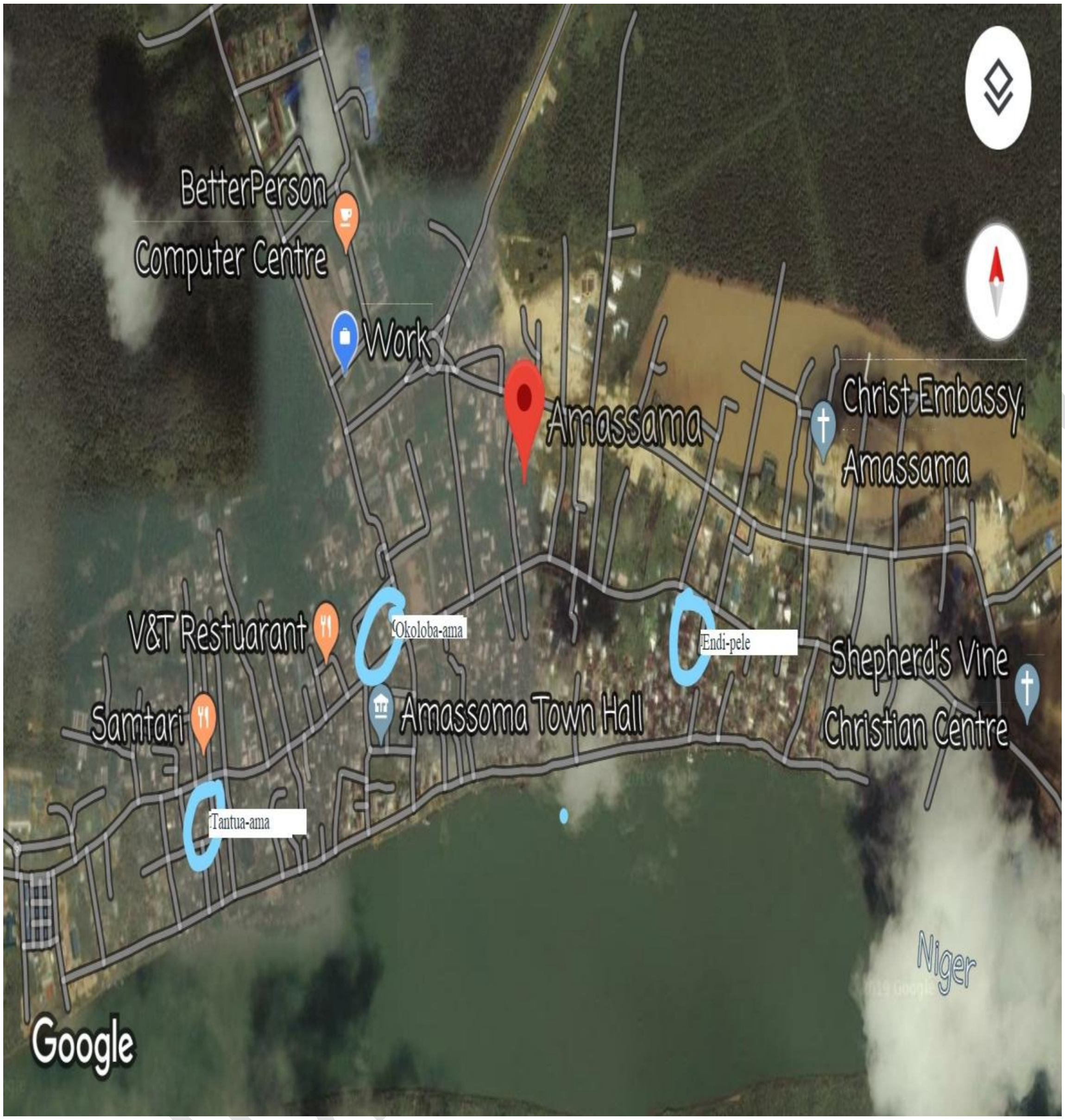

Figure 1: Study Area Map (Amassoma Community), Showing sampling sites

2.2 SOIL SAMPLE COLLECTION AND PREPARATION

Samples of soil were taken from the rhizosphere of the tested species, from the depth of 0-30 cm. The soil samples were air-dried and crushed into dust in order to provide for proper analysis [21] (Wilke *et al*., 2016).

2.3 SAMPLE ANALYSIS

Beakers and flasks, Solar thermo elemental atomic absorption spectrophotometer (Flame AAS), Burner, Hollow cathode lamps, Graphical display and recorder, Pipette (micro liter with disposal tips), Pressure reducing valves, Glassware, Volumetric flask of suitable precision and accuracy.

Air, Acetylene, Metal free water, Stock metal solution, Potassium chloride solution, Aluminium nitrate solution, Hydrogen tetraoxosulphate (vi) acid (H_2SO_4), Trioxonitrate (v) acid (HNO_3), Perchloric acid ($HCLO_4$).

A total volume of 100ml of H_2SO_4, HNO_3, and HCIO in the ratio of 40%: 40%: 20% was mixed together. A portion (1g) of the sample was weighed into a conical flask; 2ml of the mixed acid was taken to each of the sample in the conical flask. It was digested in a fume cupboard with hot plate until white fumes appeared. After that, it cooled and was filtered into 100ml volumetric flask and made up to mark with distilled water [22] (Luevano and Damodaran, 2014)

This technique operates on Beer-Lambert's law which states that Absorbance is directly proportional to concentration. Hence, absorption spectrometry is used to evaluate the concentrations of analyte in a sample; it requires standards with known analyte concentrations. The light source is a lamp with a cathode of the same element being determined since each element has a characteristic wavelength that is readily absorbed. An AAS consists of an atomizer burner to convert the element in the solution to free atoms in an acetylene flame, a monochromatic to disperse and isolate emitted and a photomultiplier to detect and amplify the light transitory through the monochromatic into its component wavelength. The photomultiplier then receives only the isolated resonance wavelength and absorption of its light by the sample. After proper lamp for the test element has been inserted, the intensity of the light is measured by passing through the unrestricted flame. Then the sample is introduced into the flame and the concentration of the elements in the sample is determined by the increase in light intensity.

2.5 STATISTICAL ANALYSIS

The samples of this study were analysed using the Statistical Programme for Social Sciences (SPSS). A t test was used to determine the significant difference between the means of the various sample, using $P < 0.05$ level of significance.

3. RESULT AND DISCUSSION

The distribution of metal in the soil in the Amasoma community suggests that there are various sites with low Zn, Ni, Pb, and Cd concentrations that are not contaminated currently. The low levels of Zn, Ni, Pb, and Cd were contrary to those found by Bi *et al*. [23] (Bi *et al*., 2006) and Wu *et al*. [24] (Wu *et al*., 2010).

The present study determined the concentrations of Lead (Pb), Nickel (Ni), Cadmium (Cd), and Zinc (Zn), in pawpaw soil and scent leaf soil. From the sample data analysis, the average lead (Pb) contents in pawpaw soil and scent leaf soil were 1.283 mg/kg and 1.44 mg/kg respectively. The average Cadmium (Cd) in pawpaw soil and scent leaf soil were 0.256 mg/kg and 0.256 mg/kg respectively. The average Nickel (Ni) compositions in pawpaw soil and scent leaf soil were 4.71 mg/kg and 5.09 mg/kg respectively. While the Average Zinc (Zn) in pawpaw soil and scent leaf soil is 2.280 mg/kg and 2.160 mg/kg respectively. This is in consonance with the research of Olatunde and Onisoya, 2017 [25], which ascertained that the heavy metals concentrations in pawpaw soil and scent leaf occurred in a decreasing order pattern of Pb > Cu > Hg > Cd > Zn.

This study evaluated the extent to which soil is contaminated by these heavy metals, comparing their levels with prescribed benchmark values of WHO for soil heavy metals. The average Lead (Pb) contents in pawpaw soil and scent leaf soil were 1.283 mg/kg and 1.437 mg/kg, respectively. When compared with targeted limit of 85 mg/kg recommended by the WHO, papaw soil and scent leaf soil are below the permissible limits. The average Cadmium (Cd) contents in pawpaw soil and scent leaf soil were 0.256 and 0.256, respectively. When compared with targeted limit of 0.8 mg/kg recommended by the WHO, papaw soil and scent leaf soil are below the permissible limits. The average Nickel (Ni) contents in pawpaw soil and scent leaf soil were 4.706 mg/kg and 5.087 mg/kg, respectively. When compared with targeted limit of 35 mg/kg recommended by the WHO, papaw soil and scent leaf soil are below the permissible limits. The Average Zinc (Zn) contents in pawpaw soil and scent leaf soil were 2.28 mg/kg and 2.16 mg/kg respectively. When compared with targeted limit of 50 mg/kg recommended by the WHO, papaw fruit, papaw soil and scent leaf soil are below the permissible limits.

Table 1 shows the mean concentration, standard deviation and the difference of the concentration mean and the recommended permissible limit by WHO of Lead (Pb) in pawpaw soil, and scent leaf soil in mg/kg. The table shows that the average concentration of Pb in pawpaw soil and scent leaf soil were 1.28mg/kg, 1.44mg/kg respectively, with observed standard deviations of 0.17, 0.26 respectively. The table also compared the average value of Pb in pawpaw soil and scent leaf soil with 41 the targeted value of Pb recommended by WHO. The table shows that the mean difference for pawpaw soil and scent leaf soil were -83.72 and -83.56 respectively when compared with the allowable limit of 85 mg/kg recommended by WHO. The pawpaw soil sample shows that P= 0.000 at P< 0.05. This shows that the mean of the sample was significantly different.

Table 1: Descriptive Statistics on the Concentration of Lead in the Soil Samples with the Permissible Limit Recommended by WHO.

Treatment	**WHO permissible limit = 2**					
	T	**df**	**Sig. (2-tailed)**	**Mean**	**Mean Difference**	**Std. Deviation**
Pawpaw Soil	-842.330	2	0.000	1.2833	-83.71667	0.17214
Scent Leaf Soil	-404.181	2	0.000	1.4367	-83.56333	0.35810

Table 2 shows the mean concentration, standard deviation and the difference of the concentration mean and the recommended permissible limit by WHO of cadmium (Cd) in pawpaw soil, and scent leaf soil in mg/kg. The table shows that the mean average of Cd in pawpaw soil and scent leaf soil were 0.26mg/kg and 0.26mg/kg respectively, with observed standard deviations of 0.029, 0.006 respectively. The table also compared the average value of Cd in pawpaw soil and scent leaf soil with the targeted value of Cd recommended by WHO. The table shows that the mean 42 difference for pawpaw soil and scent leaf soil are -0.62 and -0.56 respectively when compared with the allowable limit of 0.8 mg/kg recommended by WHO. The pawpaw soil sample shows that P= 0.001 at P< 0.05. This shows that the mean of the sample is significantly different.

Table 2: Descriptive Statistics on the Concentration of Cadmium in the Soil Samples with the Permissible Limit Recommended by WHO

Treatment	Targeted Value = 0.8					
	T	df	Sig. (2-tailed)	Mean	Mean Difference	Std. Deviation
Pawpaw Soil	-32.600	2	0.001	0.2567	-0.54333	0.02887
Scent Leaf Soil	-163.000	2	0.000	0.2567	-0.54333	0.00577

Table 3 shows the mean concentration, standard deviation and the difference of the concentration mean and the recommended permissible limit by WHO of Nickel (Ni) in pawpaw soil, and scent leaf soil in mg/kg. The table shows that the average Ni in pawpaw soil and scent leaf soil was 4.71mg/kg and 5.09mg/kg respectively, with observed standard deviations of 3.76, 3.88 respectively. The table above compared the average value of Ni in pawpaw soil and scent leaf soil with the targeted value of Ni recommended by WHO. The table shows that the mean difference for pawpaw soil and scent leaf soil were -30.29 and -29.91 respectively when compared with the allowable limit of 35 mg/kg recommended by WHO. The pawpaw soil 43 sample shows that P = 0.005 at $P < 0.05$. This shows that the mean of the sample was significantly different.

Table 3: Descriptive Statistics on the Concentration of Nickel in the Soil Samples with the Permissible Limit Recommended by WHO

Treatment	Targeted Value = 35					
	T	**df**	**Sig. (2-tailed)**	**Mean**	**Mean Difference**	**Std. Deviation**
Pawpaw Soil	-13.968	2	0.005	4.7067	-30.29333	0.17214
Scent Leaf Soil	-163.000	2	0.006	5.0867	-29.91333	3.88181

Table 4 shows the mean concentration, standard deviation and the difference of the concentration mean and the recommended permissible limit by WHO of Zinc (Zn) in pawpaw soil, and scent leaf soil in mg/kg. The table shows that the average observed amount of Zn in pawpaw soil and scent leaf soil were 2.28mg/kg and 2.16mg/kg respectively, having standard deviations of 0.97 and 1.08 respectively. The table also compared the average value of Zn in pawpaw soil and scent leaf soil with the targeted value of Zn recommended by WHO. The table shows that the mean difference for pawpaw soil and scent leaf soil were -47.72 and -47.84 respectively when compared with the allowable limit of 50 mg/kg recommended by WHO. The pawpaw soil sample shows that $P = 0.000$ at $P < 0.05$. These 44 shows that the mean of the sample was significantly different.

Table 4: Descriptive Statistics on the Concentration of Zinc in the Soil Samples with the Permissible Limit Recommended by WHO

Treatment	Targeted Value = 35					
	T	**df**	**Sig. (2-tailed)**	**Mean**	**Mean Difference**	**Std. Deviation**
Pawpaw Soil	-84.886	2	0.000	2.2800	-47.72000	0.97370
Scent Leaf Soil	-76.978	2	0.000	2.1600	-47.84000	1.07643

4. CONCLUSION

This study showed the presence of the selected heavy metals in the soil samples. The papaw soil and scent leaf soil are below the lead (Pb), Nickel (Ni), cadmium (Cd), and Zinc (Zn) permissible limits which indicate that the soils around the Amasoma community in Bayelsa State may not be contaminated presently but appropriate measures should be put in place to ensure that there will be no gradual accumulation of these heavy metals which may result to soil contamination over time thereby resulting to serious environmental concern.

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