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HEAVY METAL CONCENTRATION OF COCOYAM AND PAWPAW CROPS GROWN AROUND ANAEKIE OBIAKOR ILLEGAL DUMPSITE, AWKA, ANAMBRA STATE, NIGERIA

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ABSTRACT: Heavy metal concentration of crops (cocoyam and pawpaw) grown around Aneakie Obiakor Illegal Dumpsite, Awka was studied. Plants samples were collected from the waste dumpsite and control site during wet season, and analysed for level of concentration of 10 heavy metals using Atomic Absorption Spectrophotometric method (AAS). The result was compared with the control site and WHO/FAO standard. It was observed that all the heavy metals present in the plants were within WHO/FAO safe limit with the exception of Pb, Hg, As and Cd. The study revealed that the presence of solid wastes on agricultural soil results in heavy metal accumulation in soil and bioaccumulation in plants. The work therefore, recommended regular monitoring of metals in plants for prevention of excessive buildup of the metals in the food chain.

KEYWORDS: Heavy Metals, Concentration, Dumpsite, Cocoyam, Pawpaw.

1 INTRODUCTION

Soil is a crucial component of the human environment; and land management is the key to soil quality. Various land uses like industrial activities resulting to the use of synthetic products like pesticides, paints, batteries, plastics, among others, can result in heavy metal contamination of the soil, (S. Donahue and Auburn, 2000). Many current studies have shown that heavy metals and metalloid from municipal wastes containing paper, food wastes, metals, glass, ceramics and ashes accumulate and persist with densities greater than $6g/cm^3$ in the soils at environmentally hazardous levels (Carlson, 1976 and Alloway 1996). Most waste dumpsites in many towns and villages in Nigeria attract people as fertile grounds for cultivating varieties of crops. The cultivated plants take up the metals either as mobile ions presents in the soil solution through the roots (Davies, 1983) or through foliar absorption (Chapel, 1986). The uptake of the metals by crops results in the bioaccumulation of these elements in the plant tissues. This is known to be influenced by the metal species, plant species and plant parts (Juste and Mench, 1992). Indeed, it has been reported that plant grown on soils possessing enhanced metal concentration due to pollution have increased heavy metal ion content (Alloway and Davies 1971; Grant and Dobbs, 1977).

Human activities, including industrialization, urbanization, commercial and household activities lead to generation of large amount of wastes in the environment. The waste production increases on daily basis (Ojiebe, 2005) and is compounded by population explosion, decreasing standards of living and low level environmental awareness (Beg, Mahmood and Naeem 1985). The people's attitude in littering the environment (Nwoke and Nwoke, 2006), the inadequate machinery of waste management skills of the staff in handling domestic waste leads to the accumulation of waste in the environment. In many cases, the refuse dumpsites are located wherever land is available without regard to safety, health hazard and aesthetic value of the environment (Ojiebe, 2005).

The presence of metals in the food chain, leads to the local populace being exposed to multiple hazardous pollution sources which are potential threats (Bridge, 2004) Prolonged human consumption of unsafe concentrations of heavy metals in foodstuffs may lead to the disruption of numerous biological and biochemical processes in the human body. According to Marshall et al., 2003 heavy metal accumulation results in toxic concentrations in the body, with some elements acting as carcinogens and others associated with developmental abnormalities in children. There is a growing global concern over the detection of metal in crops which affect food quality and safety. Food safety is a basic need for any population and supplying it is one of the World's most complex challenges especially in the face of an expanding population and environmental constraints (Arogunjo, 2007; Wong et al., 2002; Mashall et al., 2003). Plant crops are often grown in polluted and degraded environmental conditions. Hence, data on heavy metals in the soils and plant are important in determining the quality and health impact such soil and plant will have on the food chain. To this effect, this study assesses the heavy metal concentration grown around Anaekie Obiakor Dumpsite in Awka.

1.1 The Problem of the Study

Dumpsites accumulate heavy metals in soil which constitute hazard to the environment and human health, especially when crops produced in these dumpsites are consumed (Okoronkwo, Ano and Odoemenam 2005; Anikwe and Nwobodo, 2002; A. A. Amusan, 2005). Municipal waste contains such heavy metals as As, Cd, Co, Cu, Fe, Hg, Mn, Pb, Ni, and Zn which end up in the soil as the sink when they are leached out from the dumpsites. Soil is a vital resource for sustaining two human needs of quality food supply and quality environment. Plants grown on a land polluted with municipal, domestic or industrial wastes can absorb heavy metals inform of mobile ions present in the soil solution through their roots or through foliar absorption. These absorbed metals get bioaccumulated in the roots, stems, fruits, grains and leaves of plants (Fatoki, 2000). Data on heavy metals in the soils and plants are important in determining the quality and health impact such soil could have on the food chain (Akinola et al, 2011).

A casual visit to Anaekie Obiakor Dumpsite promptly reveals that there is no form of management at all. All sorts of wastes are carelessly dumped there. Apart from the obnoxious odour, the presence of rodents and disease-carrying vectors; one major problem easily noticed by anybody is the endless released of leachate from the dump, particularly during rainy season. There is no doubt that as soon as it rains, the leachates, with all its contents infiltrates and pollutes both the soil and ground water of the area.

In Anaekie Obiakor Dumpsite, there is yet to be established data on heavy metals like; lead arsenic, zinc, cadmium, mercury, silver, nickel, copper, iron and chromium. Farming activities such as crop production goes on in this area. Cassava, plantain, vegetables, corn, yam, cocoyam, potatoes and fruits such as pawpaw are grown in this farm land. Crops absorb whatever is present in the soil medium and therefore these hazardous metals are also absorbed and become bioaccumulated in the roots, stems, fruits, grains and leaves of the crops (Fatoki 2000), which may finally be transferred to man in the food chain. Also, when wind blows, it carries the dust particles emitted from the dumpsite to the leaves of foods crops planted around the area. Plants around Anaekie Obiakor dumpsite are observed to have a blanket deposit of fine particles on the leaves surface after rainfall.

Heavy metal pollution may constitute hazard to the health of the inhabitants of Anaekie Obiakor community who grow and consume crops grown around the dumpsite. Heavy metals become toxic in human when they are not metabolized by the body and accumulate in the soft tissues causing health problems (Usman, Nda-Umar, Gobi, Abdullahi, Jonathan, 2012). Therefore, there is a great need to assess the heavy metal content of the plant of the dumpsite in order to ascertain the risk effect of ingesting crops grown around the area.

1.2 Aims and Objectives

The aim of this work is to assess the concentration of heavy metals in the crops planted around Aniekie Obiakor Dumpsite, Awka.

To achieve the above aim, the following objectives will be required:

- To determine the heavy metals concentration of some plants around the dumpsite.
- To suggest possible ways of managing or reclaiming contaminated soil.

1.3 Research Hypotheses

The paper tested the following hypotheses:

Ho: There is no significant difference in the heavy metal concentration of pawpaw plant in the dumpsite (polluted) and that of the control site.

Ho: There is no significant difference in the heavy metal concentration of the cocoyam plant in the dumpsite (polluted) and that of the control site.

1.4 AREA OF THE STUDY

The dumpsite studied is situated at Anaekie Obiakor Lane. Anaekie Obiakor Lane is located in Awka, the capital of Anambra State, Nigeria. Awka has an estimated population of 301,657 according to the 2006 Nigerian census. The city is located between latitude 6^{o} 13'N and 6^{o} 15'N and longitudes 7^{o} 04'E and 7^{o} 06'E. Awka is located in Awka South Local Government Area of Anambra state. Awka lies about 300meters above sea level in the valley on the plains of the Mamu River. It lies within the derived Guinea Savannah Zone of Nigeria (Egbokhare, Francis, Oyetade, Oluwole, 2002).

Awka is the tropical zone of Nigeria and experiences two distinct seasons; the rainy season (April - October) and dry season (November - March). The rainy season is characterized by heavy down pours accompanied by thunder storms, heavy flooding, soil leaching, extensive sheet outwash, ground infiltration and percolation (Egboka and Okpoko, 1984).

On the other hand, the dry season begins when the dry continental North – Eastern wind blows from the Mediterranean Sea across the Sahara Desert down to Southern Nigeria. It is characterized by extensive aridity and a lot of particulates generation. Again, there is marked lowering of water table and intense leaf fall (Egboka et al, 1984). The dry season is characterized by high temperatures and low humidity, while wet months have lower temperatures and lower relative humidity. The area lies within the zone characterized by relative warm temperatures. Although the temperatures vary slightly, depending on the period of the year, the dry season has high temperatures and lower humidity. The temperature is generally between 27^{o} C - 30 ^{o} C between June and December but rises to 32 ^{o} C - 34^{o} C between January and April with the last few months of the dry season marked by intense heat.

Awka is sited in a fertile tropical valley but most of the original Rain Forest has been lost due to clearing for farming and human settlement. The people of Awka are well known for blacksmithing, farming and trading. Many economic activities go on in Awka, establishment carrying out government duties and private sectors including companies like Juhel, which manufacture drugs within the town and export it to other countries.

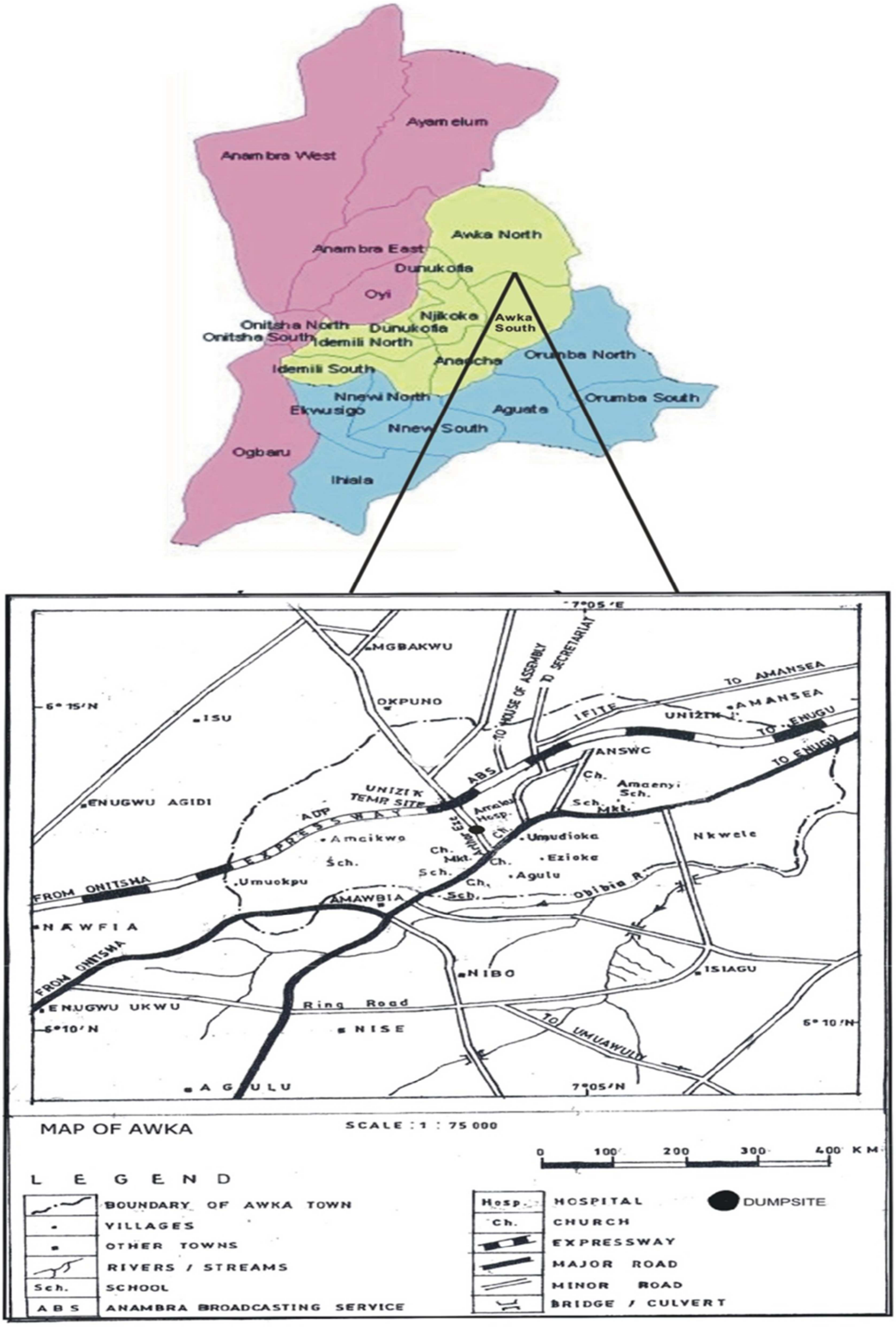

Fig. 1. Map of Anambra State Showing Awka; Map of Awka showing the dumpsite (dot on the map)

1.5 THE CONCEPTUAL FRAMEWORK OF THE STUDY

The conceptual framework of the work is hydrogeopollution cycle (Egboka, Nwankwor, Orajaka, Ejiofor, 1989). Hydrogeopollution cycle involves two processes; hydrologic and geologic cycles. In the both processes pollutants and contaminants may be produced and cyclically dispersed from one point of hydrologic cycle to another. Pollutants and contaminants may be generated through natural or anthropogenic processes and circulated into the environment (atmosphere, pedosphere, lithosphere, biosphere and hydrosphere) through the activities of air, water, chemical, physical and microbiological processes. These complex and cycle processes may be continuous with respect to distance and time and may be localized or regional in areal spread. Thus, pollution at one source or area may threaten nearby or distant places unless it spread is checked or controlled.

Pollutants from dumpsites can reach soil, plant and man through a combination of the actions involving the hydrologic and the geologic cycle. The geologic cycle involves movement of rock, sediment and soil. Geologic characteristics of rock can play a role in contaminants spread or retention. The hydrologic cycle involves water evaporation, precipitation, ground water flow, water run-off and aquifers. The sources of pollution and contamination can be either point sources or distributive sources. Through a complex interplay of both hydrologic and geologic cycles, a combination termed; hydrogeopollution cycle (Fig 1.1). Contaminant and pollutant spread can be enhanced from either point sources or distributive sources.

In view of the above, this work is meant to examine the distribution of heavy metals around the study area. This study is prompted by the fact that agricultural activities and human habitation is very close to the dumpsite. Moreover, heavy metal is dangerous to human health and the environment

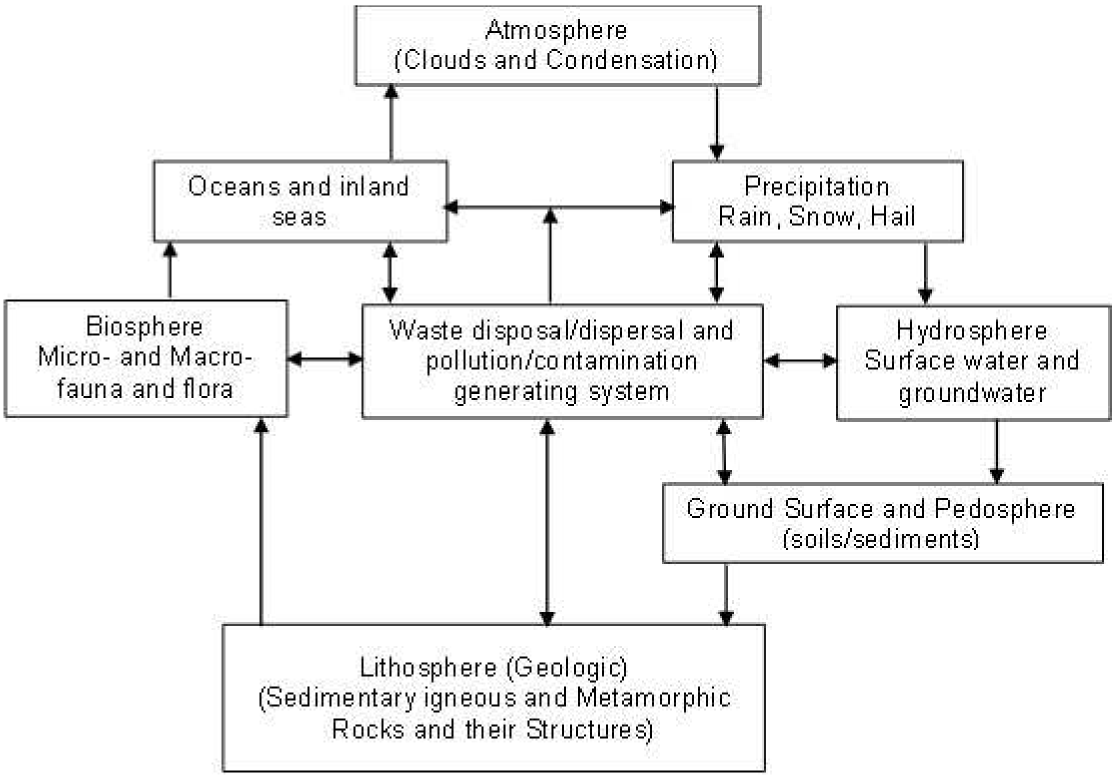

Fig. 2. The Hydropollution Cycle

2 RESEARCH METHODOLOGY

Experimental design was used to derive information used for the study. Laboratory analyses of the plant samples collected from Anaekie Obiakor dumpsite and Anaekie Obiakor lane (control sites) were carried out. This methodology was chosen because the data needed for the study include heavy metals concentration of the plant samples.

Two plant samples; pawpaw and cocoyam were collected from the farm which shared the boundary with the dumpsite and two samples from the control site (Anaekie Obiakor Lane, 2km away from the dumpsite). The heavy metals studied are: Cd, Hg, As, Pb, Cr, Fe, Ag, Zn, Ni and Cu (table 1.1). The roots of the plant samples were collected and stored in polythene bags which had already been labelled and carried to the laboratory for analyses.

The samples obtained from ashing was dissolved with $50cm^3$ of concentration hydrochloric acid (HCl) and made up to $100cm^3$ with distilled water. This was filtered into plastic sample bottle using filter paper. The heavy metal content of the plant root was determined using the atomic absorption spectrophotometers (AAS) Unican 969 Instrument. The trace metals in the samples were determined with aliquots of the digest. The quantity of each trace metal in each sample was calculated by proportion methods using the standard curve method. The absorbance and concentration were read from a calibration curve drawn by computer software attached to AAS.

Table 1. Concentrations of Heavy Metals (Mg/kg) (mg/l) in Plant Root from Anaekie Obiakor Dumpsite and Control Site.

Heavy Metals	**Dumpsite**		**Control site**		**Safe Limit of Heavy Metals**
					WHO/FAO 2001/1999
	Pawpaw	**Cocoyam**	**Pawpaw**	**Cocoyam**	**Plant**
As	0.20	0.10	0.03	0.02	**0.03**
Cd	0.76	0.81	0.22	0.30	**0.20**
Zn	0.20	0.20	ND	ND	**9.40**
Pb	0.55	0.51	0.21	0.10	**0.30**
Cr	0.34	0.25	0.12	0.02	**1.30**
Hg	0.96	0.79	0.51	0.30	**0.05**
Cu	0.10	ND	ND	ND	**73.0**
Ni	0.12	0.20	0.01	0.01	**2.00**
Fe	0.56	0.71	0.31	0.41	**425**
Ag	ND	ND	ND	ND	**-**
TOTAL	**3.79**	**3.57**	**1.41**	**1.16**	**-**

ND: Not Detected

Source: Author's Laboratory Analysis and Computation (2012); WHO/FAO (2001, 1999)

3 DISCUSSION OF RESULTS

Table 1.1 shows the distributions of heavy metals in the plant roots of Anaekie Obiakor dumpsite as well as the control site. The result revealed that the dumpsite has higher concentration of heavy metals than the control. In comparison with the WHO/FAO Standard, all the heavy metals studied are within Safe Limit exception of Cd, Hg, Pb, and As (Table 1.1). Silver (Ag) was not detected in any of the plant sample. The detection of higher concentrations of heavy metals in the plants of the dumpsite could be attributed to the fact that the area regularly receives very high quantities of domestic waste.

The safe limit of cadmium in plant is 0.20mg/kg (Table 1). High concentration of cadmium exerts detrimental effects on human health and causes severe diseases such as tubular growth, kidney damage, cancer, diarrhea and incurable vomiting. The concentration of lead if exceeding the maximum permissible limits (0.30 mg/kg) in human, affect nervous system, bones, liver, pancreases, teeth and gum & causes blood diseases. Mercury is more toxic than Cd and Pb. The concentration of mercury exceeding the maximum permissible limit (0.05mg/kg) in food and food stuff cause serious health problems such as loss of vision, hearing and mental retardation and finally death occurs. Arsenic is extremely toxic. The concentration of arsenic exceeding the maximum permissible limit (0.03mg/kg) in foodstuff causes short term (nausea, vomiting, diarrhea, weakness, loss of appetite, cough and headache) and long term (cardiovascular diseases, diabetes and vascular diseases) health effects.

In view of the above, the human population of the study area which ingest crops especially cocoyam and pawpaw grown around the area are exposed to high risk of Cd, Pb, As and Hg poisoning and the associated health effect since their levels in plant were found above WHO/FAO Safe Limit.

3.1 Discussions on Statistical Analyses

Hypothesis One:

From the calculations made, tested at 5% significant, the calculated value, 0.55 is greater than the tabulated, which is 0.05. This shows that there is no significant difference between the heavy metal concentration of the pawpaw from the dumpsite and that of the control.

The implication of this is that though pawpaw plant from the dumpsite had higher percentage of heavy metal concentration than that of the control, the difference is not statistical significant. This is due to the short duration of time the pawpaw plant stayed in the soil before being used for the experiment.

Hypothesis Two:

Again, the result of the analysis of hypothesis two showed that the there is a significant difference between the heavy metal concentration of the cocoyam from the dumpsite and that of the control site.

This implies that the cocoyam plant from the dumpsite has higher concentration of heavy metals studied when compared with the control.

4 Conclusion and Recommendations

The plants of Anaekie Obiakor Dumpsite contain higher concentration of heavy metals when compared with the control. The observed concentrations of heavy metals in the studied plants were below the FAO/WHO limit guideline for food exception of Pb, Cd, As and Hg.

The paper makes the following recommendations:

- There should be regular monitoring of metals in plants for prevention of excessive buildup of the metals in the food chain
- The present dumpsite should be treated accordingly to minimize the impact of persistent heavy metals in the area to be used for further economical use of the land.

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