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Heavy Metal Concentration of Okra (*Abelmoschus Esculentus*) Grown on Dumpsite Soil in Benin City, Nigeria

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ABSTRACT

The study investigates the concentrations of heavy metals in Okra (*Abelmoschus esculentus*) planted in dumpsite soil obtained from the University of Benin and Ekosodin in Benin City. Soil samples were collected before and after planting and analyzed for pH, total nitrogen (N), total organic carbon (C), phosphorus (P), iron (Fe), zinc (Zn), manganese (Mn), and heavy metal concentrations (Cu, Pb, Cd, and Cr). The study reveals variations in soil acidity levels across different locations before and after planting. In Table 1, soil pH was moderately acidic in Farmland (5.61), neutral in Market (6.79) and Residential (6.76) areas, and slightly acidic in Faculties (6.14). In Table 2, after planting, the pH remained moderately acidic in Market (5.68) and Residential (5.80), while becoming strongly acidic in Farmland (5.42) and Faculties (5.36). Total N and P decreased in most dumpsites after planting, while total organic carbon increased. Fe, Zn, and Mn concentration varied between dumpsites and after planting stages. Particle size distribution remained predominantly sandy across dumpsites and planting stages. The study suggests that Okra plants cultivated in various dumpsite soils showed no toxic levels for the selected heavy metals, with concentrations generally falling within acceptable limits for vegetable consumption. The copper concentration highest uptake observed in Okra plants from Residential Land (36.0 mg/kg) and the lowest in Farmland (23.3 mg/kg). Lead (Pb) uptake varied across dumpsites: Market (0.15 mg/kg), Farmland (0.10 mg/kg), Residential Land (0.12 mg/kg), and Faculties (0.06 mg/kg). Cadmium (Cd) uptake was observed at Market dumpsites (0.05 mg/kg), Farmland (0.02 mg/kg), Residential Area (0.01 mg/kg), and Faculties (0.04 mg/kg). Heavy metal concentrations in the soil and Okra plants were generally below the permissible limits set by the Department of Petroleum Resources (DPR) for soil and World Health Organization (WHO) for vegetables intended for human consumption.

INTRODUCTION

Earth is very good at recycling waste, but when the amount of wastes generated is far more than the earth can cope with; it poses a big threat to lives, a phenomenon called pollution. Pollution occurs at different levels and affects all lives ranging from plants, animals to man (Skye, 2006). Nearly all human activities generate waste and the way, in which this is handled, stored, collected, and disposed of, can pose risks to the environment and to public health (Zhu *et al.*, 2008). The decay of these solid wastes releases substances that can affect the soil nutrients content, increase the concentration of heavy metals in the soil, altering the natural balance of nutrients available for plant growth and development thereby affecting species diversity and agricultural productions. Contamination of the environment by heavy metals with their potential effects on human health, agriculture and natural ecosystems has become a subject of worldwide concern. Hazards of heavy metal contamination have been reported (Chan *et al*, 1999). Wastes found in the dump sites come from municipal, domestic and industrial sources and may contain heavy metals (Babatunde *et al.*, 2013). The increase in population coupled with rural-urban drift has increased the quantity of wastes generated in the urban areas and the developing countries are faced with not only the challenge of collecting the wastes but how and where to dispose it without causing further environmental hazard (Oguche, 2013).

Heavy metal contamination of the environment arises at all stages of metal utilization from the mining of metallic ores to the disposal of domestic and industrial wastes. Human beings, animals, vegetation and soil are the ultimate receipt of heavy metals in the environment. However, lack of effective waste management in overpopulated cities can have substantial negative effects that include fetid water ways emitting stench from sewage, spreading diseases and harbouring vehicles that spew treaded exhaust into dust filled air. At a time when environmental quality and food production are of major concern, a better understanding of the behaviour of elements in the air-soil-plant system seems to be particularly important. The presence of lead for example has been reported in the bark of trees, in some fauna (Ogbonda 1992) and in man (Okokoyo and Rim- Rukeh, 2004). Heavy metal composition in different food types of various countries have been studied (Rashed, 2001). However, such data are not readily available for most foods of less-developed countries such as Nigeria (Onianwa *et al*, 1999). Okra which grows in wide range of soil is known for its nutrient supply and as a very common vegetable in tropical

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region most especially in the Southern part of Nigeria. It is widely cultivated and recognized as a fast-growing vegetable; however, this study focuses on the heavy metal content of Okro (*Abelmoschus esculentus*) grown on soil of dumpsite obtained in Benin City. The specific objective was to ascertain heavy metal concentration of okra raised on dumpsite soil.

LITERATURE REVIEW

OKRA (*Abelmoschus esculentus*) (L) Moench Origin and Geographic Distribution

Okra Ablemoschus esculentus L. (Moench), a member of family Malvaceae, is widely cultivated vegetable of high nutritional values in human diet (Dikwahal *et al*., 2006; Jonathan *et al*., 2011). It is a good source of protein, carbohydrate, vitamin C and calcium (Kahlon *et al*., 2007; Arapitsas, 2008). The leaves, stems and fruits are also economically important in paper and pharmaceutical industries (Dilruba *et al*., 2009). The plant is cultivated in tropical, subtropical and warm temperate regions around the world (NRC, 2006). Okra can be grown on wide range of soils, but well drained fertile soils with adequate organic matter result to high yield (Akinyele *et al*., 2007). The crop is widely cultivated throughout the year in the tropics. Okra is a nutritious vegetable which plays important role to meet the demand of vegetable are scanty in the market (Ahmed *et al*., 1995).

Botany of Okra

Okra belongs to the family malvaceae and genus *Abelmoschus* (Schippers, 2000). It used to be classified within the genus *Hibiscus*, (Farooq *et al*., 2010) from which it has been separated. Schippers (2000) reported that the genus *Abelmoschus* has 5-toothed calyx (sepal) which splits longitudinally along a single suture at flowering. After flowering, the whole bloom consists of a calyx, petal, and staminal column, which are fused at the base, drops together, leaving the ovary and the epicalyx segment behind (Schippers, 2000). NRC, (2006) reported that *Abelmoschus* is now considered to consist of nine or ten species. Five species are in Africa, three are indigenous and two were introduced from Asia in the distant past. *A. ficulneus* L. is found in tropical lowland areas with a long dry season, such as parts of the Sahel (Mali, Chad, Sudan) and East Africa (Ethiopia, Somalia, Tanzania, Uganda, Madagascar), but more so in South and South-East Asia and in Australia (NRC, 2006). Schippers, (2000) reported that this specie can be strongly branched and short, such as in Sudan, or tall with few branches, reaching 2 m in height, such as plants found in the Selous Game Reserve in Southern Tanzania. It has pink flowers of about 2–4 cm with a distinctly dark centre. Its hairy fruit, often with a round rather than a pointed apex, are best recognized by its divided, pear-shaped leaves. It is a wild species and one of the two ancestors of the common okra (Schippers, 2000).

Varieties of Okra

Most plant populations consist of landraces or remnants of earlier introduced varieties such as Clemson spineless from the US (NRC, 2006). These can be seen in East and Southern Africa and remain the most popular cultivars in the forest zone of West Africa. They usually take about 10 weeks from sowing to produce the first fruit (early maturing) but are less mucilaginous than the West African okra or common okra (NRC, 2006). The Southern Asia cultivar Pusasawani has been introduced to East Africa where it has become very popular. Other varieties that have been introduced to Africa are Green emerald and Dwarf long green (NRC, 2006). NRC, (2006) also reported that only minimal research has been undertaken on truly African varieties. In Sudan, there are several varieties available from local seed houses which include a spiny one called Khartoumia. Other local varieties include Momtaza, Kerrari, Kassala, Medani, Sinnar and others which are named after the location where they are grown. The same applies to Kariba from Zambia. Rechiindia (early maturing dwarf variety) and Dererrerefu (late-maturing tall variety) are widespread (Schippers, 2000).

Soil and Environmental Requirements of Okra

According to Schippers (2000) and Remison (2005), a well-drained sandy loam with pH of 6.0–6.8 is ideal for growing okra. It does not grow well on clay soils, in swampy or areas or on acid soils. Okra is moderately tolerant to salinity, particularly A. esculentus, which originated in a semi-arid environment where salt is often encountered at the soil surface, and more so than *A. caillei* which is found in the humid forest belt (Schippers, 2000; Remison, 2005). The crop does not grow well when temperatures drop below 20°C, especially A. esculentus, which likes plenty of sunshine and does not do well in the shade. It can tolerate high temperatures, but heat coupled with low humidity slows down growth considerably (Schippers, 2000).

Nutritional/Medicinal Value of Okra

The nutritive value of okra/100 g edible portion includes energy, 35Kcal; moisture, 89.6 g; carbohydrate, 6.4 g; protein, 1.9 g; fat, 1.2 g; mineral, 0.7 g; phosphorus, 56.0 mg; sodium, 6.9 mg; sulphur, 30.0 mg; calcium, 66.0 mg; iron, 0.35g; potassium, 103 mg; copper, 0.19 mg; riboflavin, 0.01 mg; thiamine 0.07 mg; niacin 0.06 mg; vitamin C 13.1 mg; oxalic acid, 8.0 mg (Goppalan *et al*, 2007). It medicinal value has also been reported in curing ulcers and relief from hemorrhoids (Kumar *et al*., 2010). Unspecified parts of the plant were reported in 1898 to possess diuretic properties (Kumar *et al*., 2010) this is referenced in numerous sources associated with herbal and traditional medicine. Okra has found medical application as a plasma replacement or blood volume expander (Lengsfeld *et al*., 2004). It is also good source of iodine which is useful in the treatment of simple goiter and source of other medically useful compound (Lui *et al*., 2005). It is very useful genitor-urinary disorders, spermatorrhoea and chronic dysentery (Lui *et al*., 2005). Tests conducted in China suggest that an alcohol extract of okra leaves can eliminate oxygen free radicals, alleviate renal tubular interstitial diseases, reduce protein urea, and improve renal function (Kumar, 2009).

Dumpsite

Dumpsite is an old traditional method of waste disposal similar to landfill method of waste management. Dumpsites are often established in disused quarries, mining or excavated pits away from residential areas (Abduls-Salam, 2009). Designated government agency, corporate bodies and some individuals collect wastes routinely into these dumpsites (Abduls-Salam, 2009). Wastes found in the dump sites come from municipal, domestic and industrial sources and may contain heavy metals (Babatunde *et al.*, 2013).The management of these wastes generated has become a serious problem because; little efforts have been made in order to improve on the wastes collection and disposal facilities. This is not without their consequence such as deteriorating soil quality (Obute *et al.*, 2010). In Benin City and in Nigeria in general, modern landfill facilities are not found in these municipal dumpsites, hence the sorting-out of solid wastes into degradable, non-degradable and recyclable precious materials cannot be achieved. Poor management of dumpsites could create a number of adverse environmental impacts, including wind-blow litter, attraction of mice and pollutants such as leachate, which can pollute underground soil bed, and / or aquifer (Abduls-Salam, 2009). Landfill gas mostly composed of methane and carbon (IV) oxide is produced through biodegradation of such waste (Abduls-Salam, 2009). Leachate from dumpsites is of particular interest when it contains potentially toxic heavy metals. These metals are known to bio accumulate in soil and have long persistence time through interaction with soil component and consequently enter food chain through plants or animals (Dosumu, 2003).

Household and industrial garbage may contain toxic materials such as lead, cadmium, mercury, manganese from batteries, insect sprays, nail, polish, cleaners, plastics polyethylene or PVC (polyvinyl chloride) made bottles and other assorted products (Abduls-Salam, 2009). Soil microorganisms can degrade organic contaminants, while metals need immobilization or physical removal because metals at higher concentrations are toxic and can cause oxidative stress by formation of free radicals (Henry, 2000) and thus may render the land unsuitable for plant growth and destroy the biodiversity. When waste is dumped on land, soil microorganisms including fungi and bacteria, readily colonize the waste carrying out the degradation and transformation of degradable (organic) materials in the waste (Stainer *et al.*, 1989). Microorganisms in waste dump use the waste constituents as nutrients, thus detoxifying the materials as their digestive processes' breakdown complex organic molecules into simpler fewer toxic molecules (Gimmler *et al.*, 2002). However, municipal solid wastes are known to contain large amount of persistent organic pollutants (Minh *et al.*, 2006). The concentrations and transformations of heavy metals in solid municipal wastes lead to accumulation in the food web (Gimmler *et al.*, 2002).

Use of Dumpsite as Farmland

The use of dumpsites as farmland is a common practice in urban and sub-urban centers in Nigeria because decayed and composted wastes enhance soil fertility (Ogunyemi *et al.*, 2003). These wastes often contain heavy metals in various forms and at different contamination levels. Some heavy metals like As, Cd, Hg and Pb are particularly hazardous to plants, animals, and humans (Alloway and Ayres, 1997). Municipal waste contains such heavy metals as As, Cd, Co, Cu, Fe, Hg, Mn, Pb, Ni, and Zn which end up in 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 a land polluted with municipal, domestic, or industrial wastes can absorb heavy metals inform of mobile ions present in the soil through their roots or through foliar absorption. These absorbed metals get bioacumulated in the roots, stems, fruits, grains and leaves of plants (Fatoki, 2000). Heavy metals like iron, tin, copper, manganese, and vanadium occur naturally in the environment and could serve as plant nutrients depending on their concentrations. Mercury, lead, cadmium, silver, chromium, and many others that are indirectly distributed because of human activities could be very toxic even at low concentrations. These metals are non-biodegradable and can undergo global ecological circles (Adekola *et al.*, 2008).

Heavy Metals

Heavy metals are chemical elements grouped under the generic name of micro-elements that exhibit metal properties with relatively high atomic weight, density and with a specific gravity of 5.0g/cm^3 or greater (Ademoroti, 1996). Heavy metals occur naturally in the ecosystem with large variations in concentrations. In modern times, anthropogenic sources of heavy metals, i.e., pollution from the activities of humans, have introduced some of these heavy metals into the ecosystem (Oluyemi *et al.*, 2008). The presence of heavy metals in the environment is of great ecological significance due to their toxicity at certain concentrations, translocation through food chains and non-biodegradability which is responsible for their accumulation in the biosphere (Awofolu, 2005). The presence of very high contents of heavy metals in the soil causes "heavy metal soil pollution". This indicates that the content of these elements in the soil are higher than the maximum concentration that has a beneficial or harmless effect on vegetation in some areas. The negative effect of heavy metals depends on the concentration as well as on series of physical and chemical soil specific characteristics, such as texture, organic matter content, pH, redox potentials, and hydraulic conductivity etc. (Lacatusu, 2001). Concern has been expressed regarding the accumulation of toxic heavy metal such as Cadmium (Cd), Zinc (Zn), Copper (Cu) and lead (Pb) and their potential effect on human health, agriculture and natural ecosystems (Adefemi and Awokunmi, 2009). The accumulation of the toxic heavy metal in a particular domestic dumpsite is because of indiscriminate dumping of domestic waste, such as decayed food item, rotten eggs, animal slain and bones, useless tin, cans in which heavy metals are found to be mostly trapped.

Heavy Metal on Soil Due to Wastewater from Dumpsite

Streck and Richter (1997) reported that movement of heavy metals in soils from dumpsite with wastewater is very slow and more than 90% of Cd, Ni, and Pb accumulated in the 10–15 cm soil depth. Wastewaters often contain significant concentrations of organic and inorganic nutrients for example nitrogen, phosphate, (Alshammary and Qian, 2008) micronutrients and heavy metals (Mojiri and Amirossadat, 2011). Waste waters carry appreciable amounts of toxic heavy metals which vary from city to city. Important sources of heavy metals in wastewater are urban and industrial effluents. Heavy metals are extremely persistent in the environment; they are non-biodegradable and non-thermodegradable and thus readily accumulate to toxic levels. Long-term flow of waste waters from dumpsite on lands often results in the build-up of the elevated levels of heavy metals in soils (Tabari *et al*., 2008). Metal absorption and accumulation in a plant depends on many soil factors, such as- pH, EC, clay content, organic matter content and physical and mechanical characteristics of soil. Plant takes heavy metals from soil through different reactions such as: absorption, ionic exchange, redox reactions, etc. (Zabalawy *et al*., 2015).

MATERIAL AND METHODS

Study Area

This study will be carried out at the Screen House of the Department of Soil Science and Land Management, University of Benin, Benin City in Edo State, Nigeria. The area lies from 6° 23' 53" - 6° 24' 40" N and 5° 37' 24" - 5° 37' 34" E. It is the segment of the coastal plain sand commonly referred to as acid sand of Nigeria. The soil type in this area is Ultisol (Rhodic paleudult). This region is within the rain forest zone of Nigeria. It has an annual average temperature of about 27°C and an annual rainfall of about 2000 mm. The study area experiences two major seasons namely the rainy season which lasts between March to October and the dry season lasts from November to February (Ogeh and Ogwurike, 2006).

Sample Collection and Planting

Twelve (12) dumpsites were carefully selected in University of Benin, Benin City, Edo State. The dumpsites were: three (3) each from marketplaces, Residential places, learning centers and farmland. Soils sample from the market and residential places were collected from Ekosodin dumpsites in Benin City. From Farmland: The Faculty of Agriculture Experimental Farm, Forestry and Wildlife and Fisheries dumpsites were selected. Learning centers: The Faculty of Agriculture, Faculty of Law and Faculty of Art Dumpsites were used. Collected soil samples were filled into plastic buckets and placed in the screen house of the Department of Soil Science and Land Management, University of Benin, Benin City. Seeds of *Abelmoschus esculentus* were planted at a depth of 2cm and 3 seed per bucket. Soil samples were taken from the buckets before and after planting, soil samples from the same Land use were bucked to make a composite sample.

Soil Laboratory Analysis

The analysis of the soil physical and chemical properties was carried out at the Faculty of Agriculture main laboratory. Standard laboratory procedures were used in the analysis of the selected physiochemical characteristics selected in this study. The particle size distribution was determined by the hydrometer method (Boyoucos, 1951) as modified by Gee and Bauder (1986). The pH of the air-dried soil was determined using a glass electrode pH meter at ratio 1:1 and (20g soil to 20ml distilled water) and in 1N KCl solution at a ratio of 1:2 soil to water suspension according to Mclean, (1982) method. Calcium and magnesium were determined volumetrically by the EDTA titration procedure, and Potassium was determined from the filtrate by flame photometry described by Black (1965). Organic carbon was determined by the chromic acid wet oxidation procedure of Walkley and Black as described by (Black 1965). The available phosphorus in the soil samples was determined using Bray and Kurtz (1945) solution. The total nitrogen in the filtrate was determined by the alkaline phenate procedure of Fiore and O' Brien (1962).

Analysis for Micro-nutrients and Heavy Metals

1g of the prepared soil samples were weighed into a 100ml of conical flasks. 15ml of concentrated Nitric (HNO_3) acid was added and heated for 30 minutes. 5 ml of Perchloric ($HClO_4$) acid was added to the solution and heated further till samples become clear. The samples were cooled and 30ml of distilled water was added. These mixtures were filtered using Whatman No 45 filter Paper into 100ml volumetric flasks and were made up to 100ml mark. These samples were stored in 100ml plastic reagent bottle for instrumental analysis. These samples where read at recommended wavelength for different elements in an Atomic Absorption Spectrophotometer (AAS). Heavy metal content in plant were determined with the use of mass spectrometry (MS) usually coupled to liquid (LC) or gas chromatography (GC).

Statistical Analysis

Data obtained were subjected to analysis of variance using GENSTAT Version 8 (2012), while Duncan's Multiple Range Test was used to separate means, at 5% level of significance.

RESULTS AND DISCUSSION

Soil Physical and Chemical Properties of Dumpsites Soils

The physical and chemical properties of the soil in University of Benin, and Ekosodin, Benin City are shown in Table 1 (before planting) and Table 2 (after planting). The table 1 pH of the soils was moderately acidic for Farmland with a pH of (5.61) while for Market and Residential where neutral with pH of (6.79), (6.76) and Faculties (6.14) was slightly acidic respectively. For Table 2 the pH of the soil were moderately acidic for Market and Residential with value of (5.68) and (5.80) respectively while that of Farmland and Faculties were strongly acidic with pH range of (5.42) and (5.36) according to the rating of Chude *et al.*, (2011). The total nitrogen (N) in the soil decreased at the various dumpsites; however the highest total nitrogen value (1.13 g/kg) which is considered moderately low and lowest value (0.83g/kg) very low were obtained at the Faculties and Market dumpsites respectively; while that of Table 2 recorded very low in total N for all dumpsite and according to the rating of Chude *et al.*, (2011). The total Organic carbon (C) in the soils in Table 1 increased at various dumpsites. The faculties dumpsites 22.5 g/kg (very high) have the highest Carbon (C) whereas Market dumpsite had the lowest (16.0 g/kg) and all the other dumpsite values considered (High) according to the rating of Chude *et al.*, (2011). In Table 2 they all recorded (High) according to the rating of Chude *et al.*, (2011) with this range values of (14.6), (14.8), (15.9) and (18.6) in the decreasing order below. The Total Organic Carbon (C) increased in the following order: Faculties > Residential > Farmland > Market Area Table 1 Phosphorus content of 13.6 mg/kg, 14.6 mg/kg, 14.0 mg/kg and 12.2 mg/kg were recorded on Market, Farmland, Residential and Faculties respectively while that of Table 2 contains 9.54 mg/kg in Market, 10.8 mg/kg in Farmland, 12.1 mg/kg in Residential area and 8.70 mg/kg in Faculties which they are considered (Moderate) according to Chude *et al.*, 2011. The reduction in P content of farmland may be due to the nutrient uptake (Yeshanch, 2015). The Iron (Fe) content in Table 1 was highest at the Residential land with iron content (102.5mg/kg) and the Farmland had the lowest iron (53.8mg/kg) in these dumpsites. While that of Table 2, the highest was at the Residential land with iron content (89.4mg/kg) and the Farm land had the lowest iron (45.8mg/kg); the reduction of these elements in Table 2 is due to plant uptake and according to Samaranayke *et al.*, (2012) the reduction of iron in Farm land may be primarily due to the low solubility of the oxidized ferric form in aerobic environments. Table 1 shows that, the highest Zinc (Zn) value (30.0 mg/kg) was obtained at Residential land while the lowest value (25.3mg/kg) was obtained at the Farmland. While that of Table 2, the highest zinc value (25.3 mg/kg) was obtained at Residential land while the lowest value (20.1 mg/kg) was obtained at the Farmland and the variations occurs in Table 1 and 2 because Table 2 shows the report of after planting effect. The lowest value of Zinc obtained from Farmland in Table 2 agrees with the report of Brady and Weil (2002) indicated that the solubility, availability, and plant uptake of micronutrient cations (Zn) are more under acidic conditions (pH of 5.00 to 6.60) which the pH of Farmland falls between in Table 2. Table 1 and 2 falls below the target value set aside by department of petroleum resources (DPR) in 2002 in Nigeria. Table 1 show that Farmland had the least Manganese (Mn) content (18.4 mg/kg); closely followed by Faculties (20.3 mg/kg) respectively. While the highest values (21.6 mg/kg) were recorded on Residential land. While that of Table 2, follows same pattern in variations but the major difference between Table 1 and 2 is that; nutrient reduction occurs most in Table 2 due to plant uptake of these nutrient.

Dumpsite effect on Particle Size Distribution on Soils

The result of the soil separates under each dumpsite are presented in Table 1 and Table 2. For Table 1 the results showed that the texture of all the dumpsites were predominantly sandy having a sand fraction ranging from 886-852 g/kg; a silt fraction ranging from 80-50 g/kg and a clay fraction ranging from 68-54 g/kg. The similarity in the textural class could be attributed to the fact that soil texture is not readily influenced by soil management (Oyedele *et al.*, 2009). For that of Table 2, the results showed that the texture of all the dumpsites after planting were predominantly sandy, i.e there was a major increase in sand content of the soil having a sand fraction ranging from 889-878 g/kg; a silt fraction ranging from 69-48 g/kg and a clay fraction ranging from 63-52 g/kg. The reduction in silt and clay could be due to planting effect because, humus is present in Silt and CEC is high in Clay which shows the presence of organic matter.

Table 1: Physical and Chemical Properties of Soils on Dumpsites before Planting

Before Planting	Market	Farmland	Residential	Faculties
pH	6.79	5.61	6.76	6.14
T.O.C (g/kg)	16.0	17.0	18.8	22.5
Total N (g/kg)	0.83	0.85	0.94	1.13
Av.P (mg/kg)	13.6	14.6	14.0	12.2
Fe (mg/kg)	92.4	53.8	102.5	95.3
Zn (mg/kg)	28.6	25.3	30.0	27.2
Mn (mg/kg)	20.8	18.4	21.6	20.3

Sand (g/kg)	859	886	852	868
Silt (g/kg)	75	50	80	78
Clay (g/kg)	66	64	68	54

Where N/D: Not Detected

Table 2: Physical and Chemical Properties of Soils on Dumpsites after Planting

After Planting	Market	Farmland	Residential	Faculties
pH	5.68	5.42	5.80	5.36
T.O.C (g/kg)	14.6	14.8	15.9	18.6
Total N (g/kg)	0.83	0.80	0.85	0.90
Av.P (mg/kg)	9.54	10.8	12.1	8.70
Fe (mg/kg)	88.2	45.8	89.4	72.6
Zn (mg/kg)	23.4	20.1	25.3	22.5
Mn (mg/kg)	18.9	15.2	19.5	17.2
Sand (g/kg)	878	889	880	879
Silt (g/kg)	64	48	66	65
Clay (g/kg)	58	63	54	52

Where N/D: Not Detected

Heavy Metal Concentration

Copper (Cu) content in Table 3; the highest value (35.2mg/kg) was obtained at Residential land while the lowest value (30.9mg/kg) was obtained at the Farmland before planting. While that of after planting had highest value (30.2mg/kg) was obtained at Residential land while the lowest value (24.6mg/kg) was obtained at the Farmland and the difference is due to plant uptake. They both falls below the target value set aside by department of petroleum resources (DPR 2002) in Nigeria. Lead content in Table 3 before planting was highest in dumpsite soils of Market (1.66 mg/kg) and lowest at Farmland (0.67 mg/kg) and this also have the same highest and lowest value after planting but the difference is observed due to plant uptake of the nutrient in the soil in after planting. The highest value in market dumpsites agrees with the finding of Akhilesh *et al.*, 2009, who stated that; most serious source of lead contamination in soil is through direct disposal of different kind of waste in soil. Both results fall below the target value set aside by Department of Petroleum Resources (DPR 2002). The concentration of Cadmium recorded in dumpsite soils were as follows; Residential land (0.45 mg/kg) which is closely followed by Market (0.44 mg/kg) and lowest at Farmland (0.12 mg/kg) before planting. While in after planting, there was a variation in dumpsite with Market having the highest value (0.26 mg/kg) and lowest value in Farmland (0.10 mg/kg); the difference in after planting is clear due to plant uptake of the nutrient in the soil. Both results also fall below the target range value set aside by DPR (2002). The highest value of Cd in market dumpsites after planting may be due to the concentration of biosolids (sewage sludge), the disposal of industrial wastes or the deposition of atmospheric contaminants in open dumpsites which increases the total concentration of Cd in soils (Weggler, 2004).

Table 3: Heavy Metal Concentration in Soil Before and After Planting

Locations	Cu (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Cr (mg/kg)
Before planting				
Market	34.5	1.66	0.44	0.05
Farmland	30.9	0.67	0.12	0.09
Residential	35.2	1.15	0.45	0.11
Faculties	33.7	1.00	0.14	0.14
After Planting				
Market	28.8	1.05	0.26	0.03
Farmland	24.6	0.51	0.10	0.04
Residential	30.2	0.83	0.22	0.09
Faculties	26.3	0.80	0.20	0.10

Note: The maximum allowable limit (M.A.L) for heavy metals concentration (mg/kg) use in Nigeria soils as set by the Department of Petroleum Resources (DPR) in 1991 for some heavy metals includes:

Table 4: Heavy metal target value & intervention value		
Metals	**Target value (mg/kg)**	**Intervention value (mg/kg)**
Cadmium	0.8	17
Chromium	100	380
Copper	36	190
Lead	85	530
Zinc	140	720

Table 3 shows the highest Chromium value (0.14 mg/kg) was obtained at Faculties land while the lowest value (0.05 mg/kg) was obtained at the Market before planting. While that of after planting had the highest Chromium value (0.10 mg/kg) at Faculties land while the lowest value (0.03 mg/kg) was obtained at the Market. The variations occur in because of before and after planting reading. According to (Raymond and Felix, 2011), Chromium mobility depends on sorption characteristics of the soil, including clay content, iron oxide content, and the amount of organic matter present which depict the T.O.C of Faculties dumpsites having the highest value. The results actually fall below the target value set aside by Department of Petroleum Resources 2002.

Heavy Metals Concentration in Okra Plants

Table 5, Copper concentration in Okra plant varies and the highest uptake is in Residential Land with value of (36.0 mg/kg) while the lowest is at Farmland with value of (23.3 mg/kg). The normal range of Cu in plant is given to be (0.4-45.8 mg/kg) according to the rating of Singh and Steinnes (1994). This shows that there is no toxicity effect on Okra plant cultivated in the various dumpsite soils. However, according to WHO (1996) permissible limits of 10 mg/kg in Vegetables, Copper content in okra vegetable is considered high. Lead (Pb) uptake in Okra at the various dumpsites studied were given to be Market (0.15 mg/kg), Farmland (0.10 mg/kg), Residential land (0.12 mg/kg) and Faculties (0.06 mg/kg) and of which Market dumpsites uptake recorded the highest value among others. According to the rating of Singh and Steinnes (1994) the normal plant uptake range of Pb is given to be (3 mg/kg) and the toxicity range is soil of plant (100-400 mg/kg). These values show that Pb uptake by Okra plant cultivated on the various dumpsites below the normal plant range and agrees with WHO (1996) permissible limits of 0.30 mg/kg for vegetables. Heavy metal uptake of Cadmium at Market dumpsites is (0.05 mg/kg), Farmland value is (0.02 mg/kg), Residential Area value is (0.01 mg/kg) while that of Faculties is (0.04 mg/kg); and according to Kabata and Pendias, (1984) the normal plant range of this element is stated to be (0.2-0.8 mg/kg) while the Toxicity range in plant is (5-30 mg/kg). This shows that Cd has no toxicity effect on Okra plant cultivated on the various dumpsites and the uptake is below the normal range in the plants and agrees with WHO (1996) permissible limit of 0.1 for vegetables. According to Ross (1994), the normal plant range uptake of Chromium is given to be (0.006-18 mg/kg) and the uptake of Cr in Farmland and Residential land is given to be (0.01 mg/kg) respectively, while that of Market and Faculties is not detected.

Table 5: Heavy Metal Concentration of Okra Plants

Heavy Metals	**Market**	**Farmland**	**Residential**	**Faculties**
Cu (mg/kg)	35.8	23.3	36.0	30.4
Pb (mg/kg)	0.15	0.10	0.12	0.06
Cd (mg/kg)	0.05	0.02	0.01	0.04
Cr (mg/kg)	ND	0.01	0.01	ND

Where N/D: Not Detected

The heavy metal uptake by Okra plant cultivated in Farmland and Residential land falls between the normal ranges, showing that there is no toxicity effect, and this result agrees with the permissible limits 10 mg/kg of WHO (1996) for vegetables.

CONCLUSION

The study reveals that dumpsites significantly influence on soil properties, particularly pH, nutrient contents, and heavy metal concentrations. Planting also impacts these properties, with changes in nitrogen, carbon, and phosphorus levels.
Heavy metals in soil raises concerns, but the concentrations generally remain below toxic levels. The particle size distribution remains consistent across dumpsites and planting stages, indicating limited soil management influence. Okra plants show variable heavy metal uptake, although concentrations largely adhere to permissible limits for safe consumption.

RECOMMENDATION

Based on the findings, sustainable soil management practices should be implemented to counter dumpsites' adverse effects. Strategies such as organic matter addition and pH adjustment could be considered to restore soil fertility and structure in farmland soil. Continued monitoring of soil properties and heavy metal concentrations is crucial, especially in areas affected by dumpsites. Remediation techniques such as phytoremediation to reduce heavy metal concentrations in soil are encouraged. Conducting further research to understand the long-term effects of dumpsite soil on plant growth, human health, and the environment is highly suggested.

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