Heavy Metal Contents in Soil and Plants at Dumpsites: A Case Study of Awotan and Ajakanga Dumpsite Ibadan, Oyo State, Nigeria

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Abstract
This study investigates the heavy metal contents in soils and plants at Awotan and Ajakanga dumpsites in Ibadan with a particular reference to physiochemical and heavy metal levels of the underlying soils, the relationship between the dumpsite soil metal content and the rate of bio-accumulation by plants. A systematic sampling of twelve (12) soils sample (four per site) of twenty meters (20m) interval and forty eight (48) dominant plants/ vegetable species were collected, uprooted from sample plot from Awotan and Ajakanga dumpsites and Idi-Ose farm land area which serve as control site of 20m. The soil samples were collected at each plot using clean stainless steel shovel at the depth of 0-30cm. The level of heavy metals (As, Cd, Co, Cu, Fe, Ni, Pb, and Zn) in soils, plants and vegetables from dumpsites and control site were determined using digestion and Atomic Absorption Spectrophotometer method (AAS). The transfer factor (Tf) revealed that plants grown on dumpsite soils by accumulated higher metal concentration than their counter part obtained from normal agricultural soil (control site). Generally, the result shows that there was an increase in the concentration of heavy metals in the two dumpsite soils than that of the soils at the control sites. The heavy metal (Fe and Zn) contents in the plants were higher at the two (2) dumpsites than control sites while the concentrations of Pb and Cd in the plants were higher at the dumpsite than control site. The level of heavy metals transfer for site A was in the order: Cu> Cd> As> Fe> Co> Pb> Zn> Ni while for site B was Cd > Cu > Fe > Co > As > Pb > Ni > Zn. Therefore, solid waste dumpsites contained high concentrations of heavy metals which are later absorbed and accumulated by the plants growing within such sites.
Keywords: Physiochemical, heavy metal level, Transfer factor and concentration.

1.0 Introduction

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 use of dumpsites as farm lands is a common practice in urban and sub-urban centers in Nigeria because of the fact that decayed and composted wastes enhance soil fertility (Ogunyemi, et al, 2003). Theses wastes often contain heavy metals in various forms and at different contamination levels. Human exposure to heavy metals occurs through three primary routes, i.e. inhalation, ingestion and skin absorption.

Pb is a particularly dangerous metal that has no biological role and negatively affects children in significant ways (Yilmax, 2005). The environmental problem with heavy metals is that they are unaffected during breakdown of organic waste and have toxic effects on living organisms when they exceed a certain concentration. The high concentration of heavy metals in soils is reflected by concentrations of metals in plants, water, animal, and human bodies.

Consequently, when pollutants from e-waste are washed into surrounding water bodies by rain or flood, there will be a change in the level of heavy metal concentration and nutrient concentration of the water bodies (Asuquo et al 2004).

Heavy metal pollution of the environment, even at low levels, and their resulting long-term cumulative health effects are among the leading health concerns all over the world. For example, bioaccumulation of Pb in human body interferes with the functioning of mitochondria, thereby impairing respiration, and also causes constipation, swelling of the brain, paralysis and eventual death (Chang, 1992). The situation is even more worrisome in the developing countries where research efforts towards monitoring the environment have not been given the desired attention by the stake holders.

Heavy metals concentration in the environment cannot be attributed to geological factors alone, but human activities do modify considerably the mineral composition of soils, crops and water. The recent population and industrial growth has led to increasing production of domestic, municipal and industrial wastes, which are indiscriminately dumped in landfill and water bodies without treatment.

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 soil as the sink when they are leached out from the dump sites. 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 bio-accumulated in the roots, stems, fruits, grains and leaves of plants (Fatoki, 2000).

Heavy metals are described as those metals with specific gravity higher or more than 5 g/cm. Most common heavy metals are copper, nickel, chromium, lead, cadmium mercury and iron. Some heavy metals, such as iron and nickel are essential to the survival or all forms of life if they are low in concentrations (Leah et al, 2004). However, heavy metals like lead, cadmium and mercury are toxic to living organisms even in low concentrations, and they cause anomalies in metabolic functions of the organism especially in greater quantities (Manahan, 2001). The disposal of domestic, commercial and industrial garbage in the world is a problem that continues to grow with human civilization (Abdus-Salam, 2009).

Toxicity sets in when the heavy metal content in the soil exceeds natural background level (Alloway and Ayres, 1997). This may cause ecological destruction and deterioration of environmental quality, influence yield, quality of crops as well as atmosphere, and health of animal through food chains within university Uyo where crops are cultivated on and around the waste dumpsites. Other activities that could contribute to excessive release of these metals into the environment include burning of fossil fuels, smelting, and discharges of industrial, agricultural, domestic wastes as well as deliberate application of pesticides (Solomon et al, 2014). The crops differ in their ability to uptake these metals. Soils are able to biodegrade almost all organic compounds found in waste, converting them into harmless substances. Since inorganic products such as heavy metals are non-biodegradable, thus they persist and accumulate in the soil. Heavy metals can accumulate and persist in soils at environmental hazardous levels to crops and human health (Alloway and Ayres, 1997).

Exposure to heavy metals may cause blood, bone disorders, kidney damage, decreased mental capacity and neurological damage (Asuquo et al, 2004, Awokunmi et al 2010).

Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver, and other vital organs. One specific threat resulting from inadequate wastes disposal is the contamination by heavy metals that have significant toxic potential for the environment (soil, water and air), human's beings and the exposed biodiversity (Tankari et al, 2013a). Population explosion and urbanization have increased the quantities and types of solid wastes produced (Ogbonna et al, 2007). Municipal solid waste usually contains paper, food waste, metal scraps, glass, ceramics, and ashes. Decomposition or oxidation process releases the heavy metal contained in these wastes to the soil of the waste dumpsite thereby contaminating the soil

(Ukpong et al, 2013). Investigation of heavy metals is very essential since slight changes in their concentration above the acceptable levels, whether due to natural or anthropogenic factors, can result in serious environmental and subsequent health problems (Yahaya et al, 2009). The concentrations of heavy metals in soil around waste dumps are influenced by types of wastes, topography, run-off and level of scavenging (Ideriah et al, 2007). Solid waste dumped along roadsides are usually left over a long time to decompose naturally by micro-organisms, eaten by animals, picked by scavengers or washed away by the floods into the larger creek and rivers thus affecting the surface water quality of contamination and are stored faster than they are excreted [Adepoju et al, 2012, Ogbonna et al, 2007, Zheng et al, 2007]. Indeed, many heavy metals are found to accumulate in fishes causing human contamination and related health issues. Heavy metals also affect agricultural products and their consumers (Asongwe et al, 2014).

Toxic heavy metals can also be taken directly by man and other animals through inhalation of dusty soil. Heavy metal pollutants such as copper (Nyangababo and Ichikuni, 1986) lead and zinc (Alloway and Davies, (1993) from additives used in gasoline and lubricating oils are also deposited on highway soils and vegetation.

Various studies have shown that dumpsite soils in south-eastern Nigeria and other parts of the country support plants growth and biodiversity and as such they have been extensively used for cultivating varieties of edible vegetables and plant based foodstuff (Cobb et al., 2000; Benson & Ebong, 2005). These practices pose serious health and environmental concern due to the anthropogenic contamination of these waste soils with intolerable level of chemical materials (Ellis & Salt, 2003; Jarup, 2003). Heavy metal content of soils is a critical measurement for assessing the risks of refuse dumpsites. However, only the chemical species/fractions of these heavy metals provide predictive insights on the bioavailability, mobility and fate of the heavy metal contaminants (Cataldo & Wildung, 1978; Kabata-Pendias, 2004). Thus, there is need to evaluate the chemical forms or species of these heavy metals since they control their bioavailability or mobility which ultimately control heavy metal soil-plant transfer (Kabata-Pendias, 2004; Gupta & Sinha, 2006; Iwegbue et al., 2007; Uba et al., 2008; Ikhouria et al., 2010).

Most dumpsite soils in Eastern Nigeria as in other parts of the country are extensively used for cultivating varieties of edible vegetables and plant-based foodstuff without proper routine assessment of the associated health and ecological risks (Obasi et al., 2012). This practice is scientifically unacceptable in this era and as such, there is need for proper assessment of dumpsite waste soils to ensure environmental sustainability. The aim of this research therefore is to provide biochemical data that will educate the general public on the possible ecological risks associated with the use of dumpsite soils for arable farming.

Municipal waste contains such heavy metal as As, Cd, 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 resources 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 through their roots or through foliar absorption. These absorbed metals get bio-acumulated in the roots, stems, fruits, grains and leaves of plant (Singh, 1999).

Ogunyemi, (2003) report hazardous concentrations of Pb and Cd in leafy vegetables grown in high density area in Ibadan, Nigeria and concluded that the contents are traceable to aerial deposition and foliar adsorption. Also study conducted by Kimani (2010) in Kenya on the Dandora waste dump site in Nairobi showed high levels of heavy metals, in particular Pb, Hg, Cd, Cu and Cr in the soil samples obtained on the site. A medical examination of the children and adolescents living and schooling near the dump site indicated a high incidence of diseases that are associated with high exposure levels to these metal pollutants. For example, about 50% of children examined who lived and schooled near the dump site had respiratory ailments and blood lead levels equal to or exceeding internationally accepted toxics levels (10ug/d1 of blood), while 30% had size and staining abnormalities of their red blood cells, confirming high exposure to heavy metal poisoning. These findings demonstrate the severe risks associated with municipal waste dumps.

Municipal refuse dumps are important feeding sites for pestiferous species especially birds, rats and stray animals; thereby contributing greatly to their sustenance and multiplication (Bellebaum, 2005).

Another problem arising from waste dumps is air pollution which sometimes results in temporary restrictions on movement of people and consequent slowing of economic activities in urban areas (Elaigwu et al, 2007). Perhaps of greater and longer term impact are the substances deposited on the soil that adversely impact the flora and fauna. Heavy metals such as arsenic, cadmium, lead, chromium, nickel, cobalt and mercury are of concern primarily because of their potential to harm soil organisms, plants, animals and human beings.

In addition to affecting plant and animal health metals contained in municipal solid wastes may be leached from the soil and enter surface water or groundwater (Woodbury, 2005).

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). 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).

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. Heavy metals are natural components of the Earth’s crust. They can neither be degraded nor destroyed. To a small extent they enter our bodies via food, drinking water and air (Helmenstine, 2014). Heavy metal content of soils is a critical measurement for assessing the risks of refuse dumpsites. Since these contaminants affect the environmental qualities in and around such open dumpsites, monitoring of soil qualities especially heavy metal content in dumpsite becomes necessary which can facilitate to recommend suitable remedial measures (Biswas et al., 2010).

Heavy metals can enter a water supply by industrial and consumer wastes, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers and groundwater (Lenntech, 2014).

Heavy metals are dangerous because they tend to bio-accumulate which means an increase in the concentration of a chemical in a biological organism over time, compared to the chemical’s concentration in the environment (Helmenstine, 2014).

Some metals, such as Mn, Cu, Zn, Mo and Ni, are essential or beneficial micronutrients for microorganisms, plants and animals. Their absence may cause deficiency diseases but at high concentrations all have strong toxic effects and pose an environmental threat. Some heavy metals such as Cd and Pb have been known to have no known biological importance. Heavy metals have received the attention of researchers all over the world, mainly due to their harmful effects on plants and other living organisms (Tahar and Keltoum, 2011).

This study aimed at assessing the heavy metals contents in soil and plants in two dumpsites (Awotan dumpsites in Ido Local Government Area and Ajakanga dumpsite in Oluyole Local Government Area) and one control site at Idi-Ose in Akinyele Local Government. It is expected that results obtained from the study will widen our knowledge on the environmental risks associated with solid waste dumps in terms of heavy metal toxicity and the suitability of such site for plant cultivation.

2.0 Study Locations

Ibadan lies between longitude 7°2'E and 7°40'E and latitude. 3°35'N and 4°10'N, was founded in 1829. It was initially occupied by immigrants, who moved into the city in search of security from intertribal wars. It is now the largest indigenous city in tropical Africa and is the capital of Oyo state, one of the 36 states in Nigeria. It is 128 km northeast of Lagos and 345 km southwest of Abuja, the federal capital.

Ibadan consist of eleven Local Government Areas which are grouped together to what is called the Ibadan metropolitan area or Ibadan land with five (5) in the inner city and (6) in the outer areas as shown in (Fig 1). The administrative and commercial importance of Ibadan has resulted in land being a key investment asset and a status symbol for the population.

Since its founding the city has had rapid growth, both in area and in population. Developed land increased from only 100 ha in 1830 to 12.5 km2 in 1931, 30 km^2 in 1963, 112 km^2 in 1973, 136 km^2 in 1981, and 214 km^2 in 1988. Similarly, in 1856, the population was estimated at 60 000; by 1890, it had increased to about 200 000; in 1963, it was 625 000 and today, the overall population density of Ibadan metropolitan area as at 2006 figure by National Population Commission was 586 persons per km^2. The study area covers three Local Government Area of Ibadan namely; Ido LGA in which Awotan as one of the dumpsite site are located, Oluyole LGA in which Ajakanga as the second dumpsite are located and Akinyele LGA which the control site (farmland) is located.

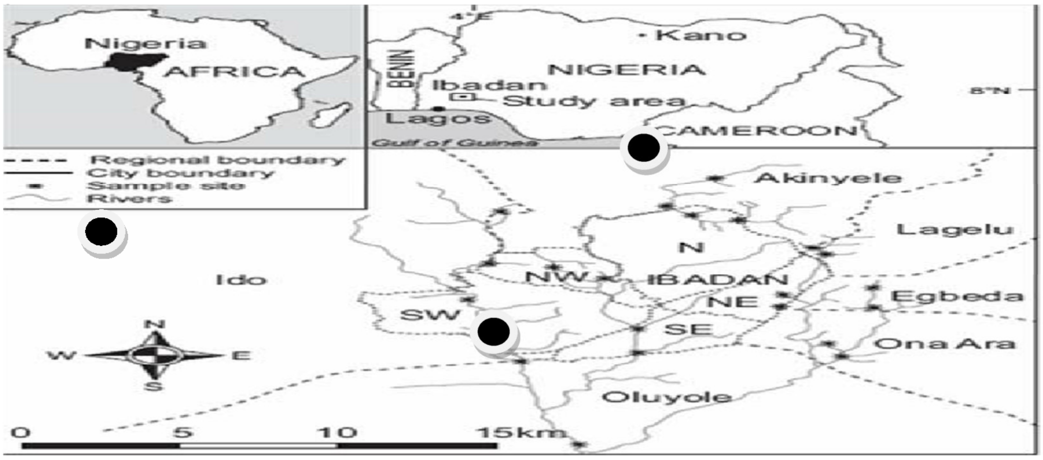

Figure 1: Map of Ibadan showing Local Government of the study Area

2.1 Site Description

This study was conducted at three locations of different Local government Areas which include Awotan and Ajakanga solid waste dumpsites and Idi-ose farmland which was used as control site in which the three Local Governments falls at the outer areas of Ibadan Metropolis. Awotan dumpsite is located at Apete along Akufo road which is situated at Ido Local Government Area. Ajakanga dumpsite is located at old ijebu road, Oluyole Local Government area and the control site (farm land) that was situated at Akinyele Local Government. Out of four dumpsites located in Oyo state, Awotan dumpsite is the second largest with 20.259 Hectares while Ajakanga dumpsites is the third largest with 10.034 hectares respectively. The Awotan dumpsite was designated as site 1 and is located at geographical coordinates of latitude 7.463069°N and longitude 3.849106°. The Ajakanga dumpsites was designated as site 2 and is located at geographical coordinates of latitude 7.3117°N and longitude 3.8414°E and the control site is at latitude 7.5011°N and longitude 3.9139°E.

Figure 2a: Awotan Landfill Site, Apete Ibadan A and B, Ido LG, Ibadan. (field Survey 2016)


Figure2b: Ajakanga landfill site A and B, Oluyole LG, Ibadan (field survey 2016)

3.0 Material/Methods

3.1 Equipment/Material Used

The following materials were used to carry out the work in the field:

- Measuring tape
- Polythene bag
- Marker and paper tape
- Shovel and hand trowel and knife
- Plastic bucket

The following instruments were used for laboratory analysis.

- Filter paper
- Distilled water
- Stove
- Stainless plate
- Stirrer
- Volumetric flask
- Dispenser
- Top loading balance
- Atomic absorption spectrophometer (AAS VGB 210 SYSTEM)

3.2 Sample Collection

Four sampling spots at a distance of 20m from each other were mapped out for soil sample collection within the sampling sites, using clean stainless steel shovel from 0-30cm depth. A soil sample to serve as control was also collected in a farm site. The collected dried soil samples were thoroughly mixed in clean plastic bucket to obtain a representative sample, crushed and sieved with 2mm mesh before stored in labeled polythene bags prior to analysis. Two arable plants and two forestry plants were randomly collected within the vicinity of the refuse dumpsite using a stainless steel trowel and knife. Total of twelve soil samples were collected and total of forty eight plants were also collected from the locations of the dumpsites and farmland. The plant samples collected are waterleaf (Talinium Triangulae), and Spinach leaf (Amarauthus cruentus) which are arable and Barbados Nut (Jatropha curcas) and Castorbean plant (Riciuns Communis) which are forestry plant (shrub or small tree). Plant leaves were rinsed with distilled water and dried to a constant weight in an oven at a temperature of 70^0C. The dried samples were pulverized using an agate pestle mortar and kept in polythene bags.

3.2.1 Sample Treatment

3.2.2 Soil PH

After the soil has been dried, the sample was then sieved with 2mm sieve, then soil sample of 10% was weighed to an analytical cup, and 20ml of distilled water was added 1:2 and stirred them for 5minutes with stirrer machine or shaker machine, the set of buffer (4.0,7.0,9.2) are used standardized to the Ph.

3.2.3 Texture (Sand, Silt, Clay)

Weight 50gm of 200ml sieve, and 15ml of calgon solution was added and stirred with mechanical stirrer and later transfer to 1 litter measuring cylinder and use hygrometer to measure for 1 minute and 2 hours later by taking temperature at interval to enable us to calculate the sand, silt and clay.

3.2.4 Soil

Two grammes (2.0g) of prepared soil sample was digested with 15.0ml nitric acid, 20.0 ml per chloric acid and 15.o ml hydrofluoric acid and placed on a hot plate for 3hrs. On cooling, the digest was filtered into a 100.0ml volumetric flask and made up to the mark with distilled water according to (Adekenya, 1998).

3.2.5 Plant

Similarly, dry plant samples were digested with 60% HC1O4, concentrated HNO3 and H2SO4 and placed on a hot plate until white fumes is formed and placed in a different volumetric flask. After cooling the solution was then sent to AAS to read the element. Blanks were prepared to check for background contamination by the reagents used.

3.2.6 Metal Analysis

The heavy metals of both the soil and plant samples were analyzed. The digested samples were analyzed for heavy metals (As, Cd, Co, Cu, Fe, Ni, Pb and Zn) using atomic absorption spectrophotometer (AAs VGB 210 System) according to the method of Allen *et al.* (1974). The instrument setting and operational conditions were done in accordance with the manufacturers' specifications. Plant samples were analyzed by first rinsing it with distilled water and oven-dried at 100°C for 48 h. The plant materials were ground to fine powder. One gram of the powder was digested as described above and analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS). Data generated were subjected to statistical analysis such as mean, standard error mean and Analysis of variance. Means were separated using Least Significance Difference (LSD) according to Ogbeibu (2005).

4.0 Results and Discussion

From table 4.1, it was observed that soil samples from control site has higher percentage of sand (78.80%), followed by soil samples from Ajakanga dumpsite (72.50%) and Awotan dumpsite (67.40%). Also the higher percentage values of silt and clay was observed in soil samples collected from Awotan and Ajakanga dumpsite respectively. It was also observed that soil samples collected from the farm land site (Control site) contained more sand particles than the soil samples from the dumpsites. Although the sand fraction was generally high in all the three soils and this could be attributed to the poorly sorted and nature of the various particles sizes of the soils that were not formed from the natural process of weathering of the underlying parent materials but rather from deposited wastes. However, this result is in agreement with findings of Nyles and Ray (1999) where they stated that soils separate with high sand and low clay content have high pollutant leaching potentials.

The mean pH values of the soils samples from three locations ranges from 5.7 to 7.4 (see table 4.1). However, the highest pH values were recorded from Awotan and Ajakanga dumpsite. This is an agreement with the study by Isrimah et al (2003) that most plants and soil micro-organisms thrive best in soil of pH 6.5-7.5.

Table 4.1: Mean values of physio-chemical properties of the dumpsite soil and control site (mg/kg)

Location	Sample	Soil			
		%sand	%silt	%clay	pH
Awotan	Site A Soil	**67.40**	**32.04**	**11.70**	**7.4**
Ajakanga	Site B Soil	**72.50**	**28.10**	**9.60**	**7.2**
Farmland	Control Soil	**78.80**	**20.06**	**8.70**	**5.7**

The result of heavy metal content in soils collected from the two dumpsites and control are presented in (table 4.2) as it is represented in the (chart 2). It was observed that the concentration levels of all the heavy metals determined in the soils are less than 1.0mg/kg.

The concentration of heavy metals in Awotan dumpsite soils are As(0.66mg/kg), Cd(0.48mg/kg) Co(0.58mg.kg), Cu(0.91mg/kg), Fe(0.63mg.kg), Ni(0.31mg/kg), Pb(0.49mg/kg) Zn(0.38mg/kg) and Ajankanga dumpsite soil are As(0.55mg/kg), Cd(0.84mg/kg), Co(0.63mg/kg), Cu(0.82mg/kg), Fe(0.64mg/kg), Ni(0.42mg/kg), Pb(0.53mg/kg), Zn(0.40mg/kg) and control farmland As(0.23mg/kg), Cd(0.32mg/kg), Co(0.33mg/kg), Cu(0.34mg/kg), Fe(0.27mg/kg), Ni(0.21mg/kg), Pb(0.10mg/kg), Zn(0.30mg/kg) (see table 4.2).

Generally, result, obtained showed that soils from the dumpsites recorded higher metal concentration than the control farmland and this is in agreement with results obtained from similar studies (Amusan et al 2005 and Ebong et al 2007) and this could be attributed to the availability of metal-containing wastes at the dumpsite which leached into the underlying soil.

Comparing the concentration of heavy metals in the studied soils with the background range values in soil given by Bowen (1979), the concentration level of As and Cu in soils are within the range while Cd, Co, Fe, Ni, Pband Zn are lower than the background range value (table 4.2).

The sequence of occurrence is Cu> Cd> As> Fe> Co> Pd> Zn> Ni in soil samples from site A and Cd > Cu > Fe > Co > As > Pb > Ni > Zn in soil sample from site B (see table 4.2).

Table 4.2: Mean values of Heavy metal level in the soil (Mg/Kg)

Location	Sample	Metals							
		As	Cd	Co	Cu	Fe	Ni	Pb	Zn
Awotan	Site A soil	0.66	0.48	0.58	0.91	0.63	0.31	0.49	0.38
Ajakanga	Site B Soil	0.55	0.84	0.63	0.82	0.64	0.42	0.53	0.40
Farmland	Control Soil	0.23	0.32	0.33	0.34	0.27	0.21	0.10	0.30
Range in Soil		0.5-50	10-100	2-110	0.5-65	10-300	2-200	2-200	100-700

Source: Authors *Bowen (1979)

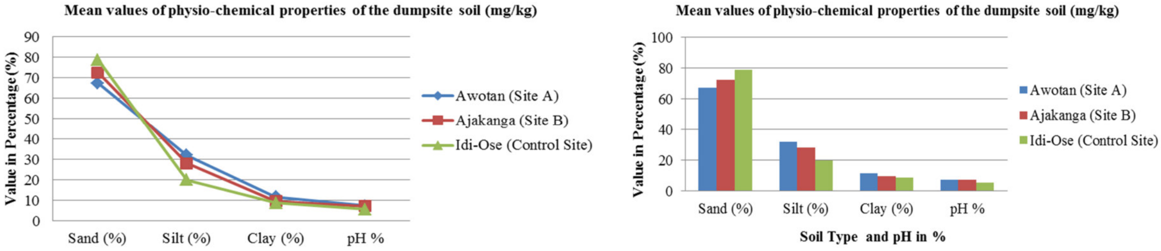

Chart 1: Mean values of physio-chemical properties of the dumpsite soil and control site (mg/kg)
Source: Authors

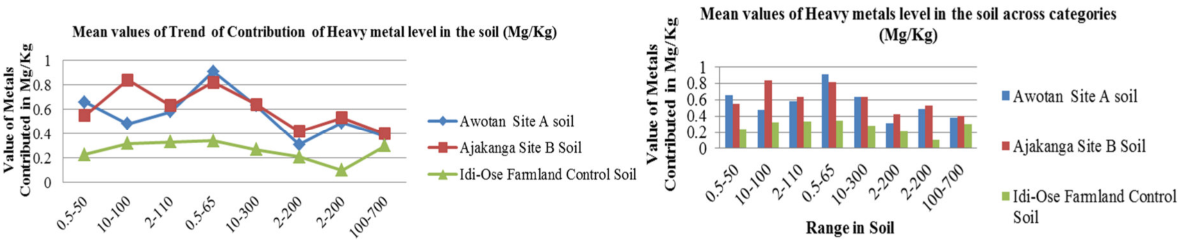

Chart 2: Trend of Contribution of Heavy Metals in the soil
Source: Authors

The mean concentration of heavy metals in plants from the dumpsites and control farm land are presented in (table 4.3). It was observed that plants grown in waste dumpsite soils recorded higher level of metals when compared with those from control farm land site and this is in agreement with the finding of (Udosen 1994, Amusan et al 2005, and Ebong et al 2008) when similar studies are undertaken. This could be attributed to the high metal contents of dumpsite soils which are eventually accumulated by the plants grown on them. This also indicates that the concentrations of metals in plants are dependent upon their concentrations in the habitual soil environment and this is in agreement with findings by (Udosen et al 1994). The levels of As and Co in water leaf, spinach from both sites A and B are above those of the control samples. However, the levels of Cd, Cu, Fe, Ni, Pb and Zn in water leaf, spinach studied were below the levels recommended by WHO/FAO and NAFDAC and EC/CODEX for metals in foods and vegetables and are also within the normal range of metals in plants (see table 4.3 & 4.4).

The concentration of metals in Ricinus communis from Awotan and Ajakanga dumpsites are all above those obtained from the control site (see table 4.3). In both Awotan and Ajakanga dumpsites the concentration levels of Cd, Cu, and Zn in Ricinus communis are not greater than 2.4, 2.5 and 100mg/kg in plants (see table 4.3). (Susaya, 2007).

The concentration of the metals in Ricinus communis from Awotan and Ajakanga dumpsites for As (arsenic) and Fe (iron) in Ricinus communis plants are below the toxic level that concentration of about 20mg/kg (see table 4.3). (Mcbride, 2003).

Table 4.3: Metal concentrations in plants (mg/kg)

Location	Sample	Metals							
		As	Cd	Co	Cu	Fe	Ni	Pb	Zn
Site A Soil	Waterleaf (Talinium triangulae)	0.26	0.22	0.33	0.30	0.32	0.01	0.02	0.04
	Barbadoss (Jatropha Curcas)	0.28	0.11	0.05	0.48	0.20	0.01	0.03	0.03
	Spinach (Amaranthus Cruentus)	0.36	0.21	0.32	0.28	0.24	0.02	0.07	0.03
	Castor plant (Ricinus communis)	0.17	0.12	0.28	0.36	0.23	0.03	0.02	0.04
Site B Soil	Waterleaf (Talinium Triangulae)	0.10	0.31	0.34	0.49	0.30	0.02	0.05	0.02
	Barbadoss (Jatropha Curcas)	0.02	0.14	0.07	0.24	0.34	0.01	0.23	0.05
	Spinach (Amaranthus Cruentus)	0.08	0.43	0.36	0.33	0.23	0.02	0.03	0.04
	Castor plant (Ricinus communis)	0.03	0.27	0.26	0.47	0.28	0.03	0.20	0.03
Control soil	Waterleaf (Talinium Triangulae)	0.05	0.03	0.09	0.06	0.07	0.01	ND	0.01
	Barbadoss (Jatropha Curcas)	ND	0.04	0.01	0.03	ND	ND	0.02	0.01
	Spinach (Amaranthus Cruentus)	0.03	0.02	0.05	0.07	0.02	0.02	ND	0.06
	Castor plant (Ricinus communis)	ND	ND	0.02	0.01	ND	0.04	0.01	ND

ND = Not detectable

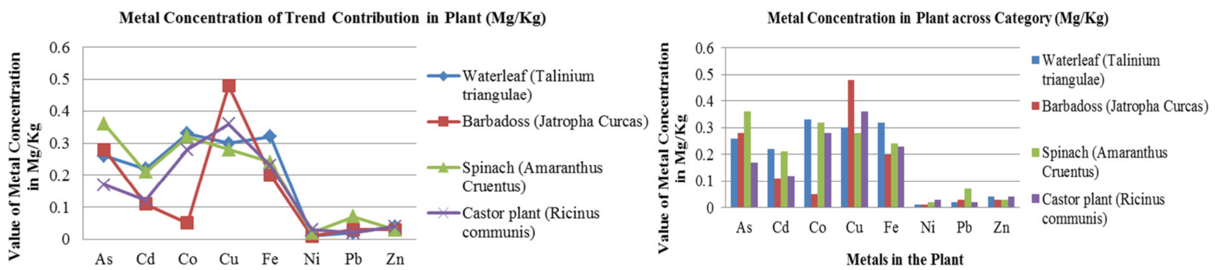

Chart 3a: Metal Concentration in Plant (Mg/Kg) at Awotan
Source: Authors

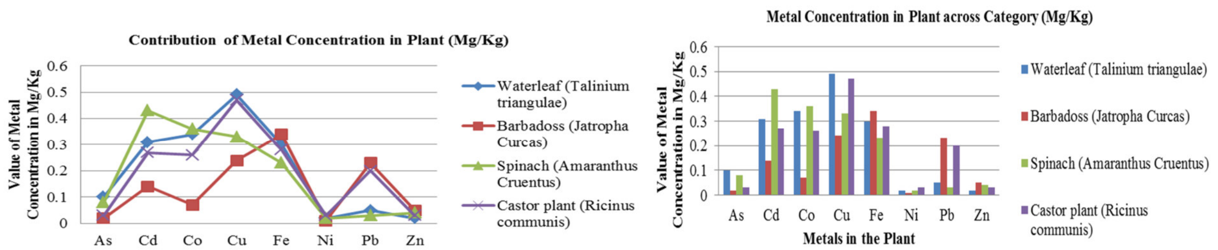

Chart 3b: Metal Concentration in Plant (Mg/Kg) at Ajakanga
Source: Authors

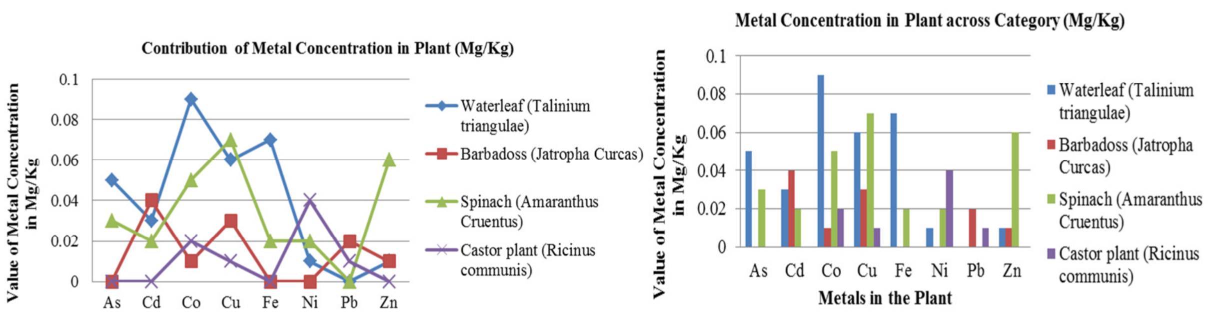

Chart 3c: Metal Concentration in Plant (Mg/Kg) at Idi-Ose (Control Site)
Source: Authors

Table 4.4: FAO/WHO guideline for metals in food and vegetables

Metals(mg/kg)	WHO/FAO	NAFDAC	EC/CODEX	Normal range in plant
Cd	1	-	0.2	<2.4
Cu	30	20	0.3	2.5
Pb	2	2	0.3	0.50-30
Zn	60	50	<5.0	20-100
Fe	48	-	-	400-500
Ni	-	-	-	0.02-50
Co	-	-	-	-
As	30	20	0.5	0.5-20

Source: FAO/ WHO

The transfer factor (tf) of heavy metals from the soil to plants, are presented in (table 4.5). The transfer factor can be defined as the ratio of the concentration of metals in plants to the total concentration in the soil. It was observed that the transfer factors for the same metal in the dumpsite were significantly different from those for control and according to the type of plants and vegetables. Cu, Co and As has high transfer factors which are 0.59, 0.56, and 0.54 respectively. The highest transfer factor value obtained for waterleaf were Co(0.55) and Fe(0.50); Barbadoss (Jatropher curcas) Cu (0.52) and As (0.42); spinach Co(0.55) and As (0.54); and Castor plant (Ricinus cummunis) Cu(0.56) and Fe (0.53). The study gave a generalized transfer coefficient in the soil-plant system as: As, Co, Fe. Cd, Pd,Cu and Zn (0.01-0.8) and (0.01-0.1) (see table 4.5). The transfer factors of all elements are within normal range in plant. Plants are known to take up and accumulate trace metals from contaminated soil (Abdul Kasheem, 1999); hence detection in plant leaves and crop samples was not surprising. Although the levels of these metal are within normal range for plants, however continual consumption could lead to accumulation and adverse health implication particularly for Pd, As, and Cd (Opabunmi, and Umar, 2010). Also the variation in values obtained for these heavy metals in the soil and crop plant samples as against those from control sites is an indication of their mobility from the dumpsites to the farmlands around particularly through leaching and run offs. This is in agreement with the report of Oluyemi et al, (2008).

Table 4.5: Transfer factor (tf) of heavy metals from soil to plants

Location/Site	Sample	Metals							
		As	Cd	Co	Cu	Fe	Ni	Pb	Zn
Awotan Soil									
	Waterleaf (Talinium Triangulae)	0.40	0.46	0.56	0.32	0.50	0.03	0.05	0.11
	Barbadoss (Jatropha Curcas)	0.42	0.22	0.09	0.52	0.31	0.03	0.06	0.08
	Spinach (Amaranthus Cruentus)	0.54	0.43	0.55	0.31	0.37	0.08	0.14	0.08
	Castor plant (Ricinus communis)	0.26	0.25	0.48	0.40	0.36	0.09	0.05	0.11
Ajakanga									
	Waterleaf (Talinium Triangulae)	0.18	0.36	0.54	0.59	0.47	0.05	0.09	0.05
	Barbadoss (Jatropha Curcas)	0.04	0.17	0.11	0.29	0.53	0.02	0.43	0.13
	Spinach (Amaranthus Cruentus)	0.14	0.51	0.57	0.39	0.36	0.05	0.06	0.10
	Castor plant (Ricinus communis)	0.05	0.32	0.41	0.56	0.53	0.07	0.38	0.08
Farmland (Control soil)									
	Waterleaf (Talinium Triangulae)	0.04	0.19	0.09	0.24	0.11	ND	0.30	0.13
	Barbadoss (Jatropha Curcas)	ND	0.13	0.03	0.09	ND	ND	0.20	0.03
	Spinach (Amaranthus Cruentus)	0.13	0.06	0.15	0.20	0.02	0.07	ND	0.20
	Castor plant (Ricinus communis)	ND	ND	0.02	0.01	ND	0.04	0.01	ND

ND = Not detectable

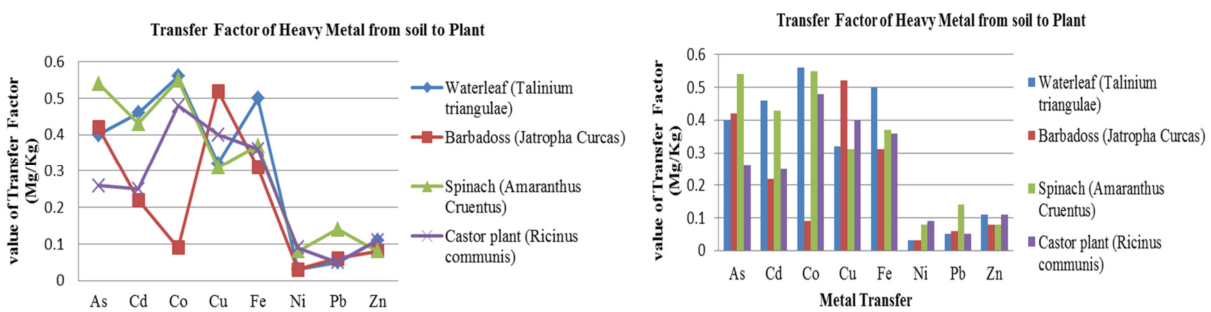

Chart 4a: Contribution and categories of Transfer Factor of Heavy Metals from Soil to Plant at Awotan
Source: Authors

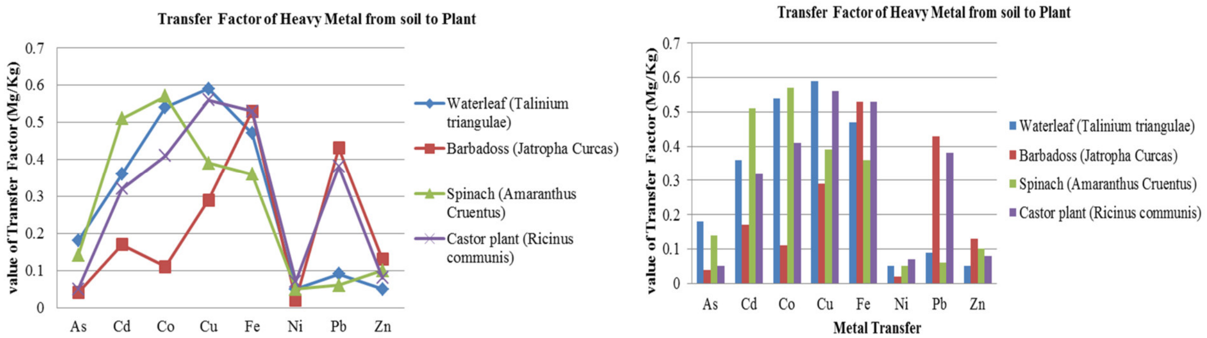

Chart 4b: Contribution and categories of Transfer Factor of Heavy Metals from Soil to Plant at Ajakanga
Source: Authors

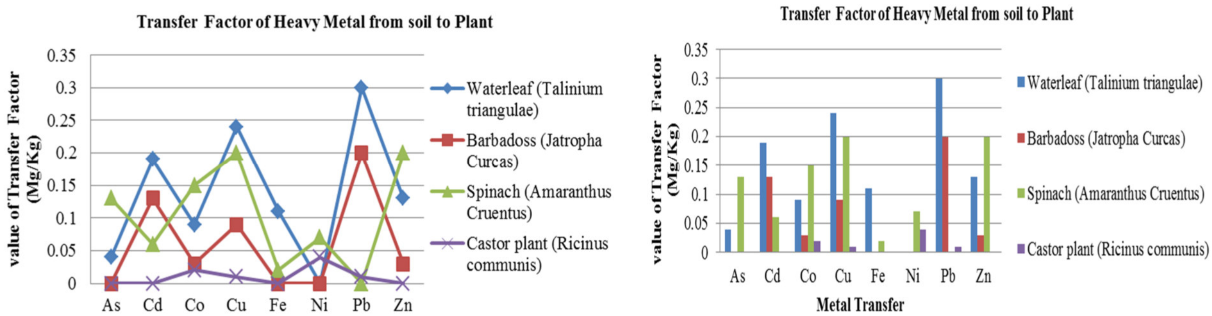

Chart 4c: Contribution and categories of Transfer Factor of Heavy Metals from Soil to Plant at Control/S.
Source: Authors

4.1 Heavy Metal in Soil

The levels of iron (Fe) obtained in this study are below the normal range of 10-1700mg/kg while Cu is within the range of 0.5-6.5 given by the Bowen (1979). Leads (Pd) are found within the range 2-200mg/kg reported by (Kabata-Pendias 1984) and within range given by Bowen (1979) (see table 4.2).

Nickels were found to be below the critical permissible concentration of 50mg/kg given by (MAFF (1992, and EC (1986) and within the range by Bowen (1979). Though these heavy metal concentrations falls below the critical permissible concentration level, their persistence in these soils of the dumpsite may lead to increase uptake by plants. (Klock et al, 1984), also reported that plants can accumulate relatively large amounts of these elements by foliar absorption. Copper level was within the normal range in soil (0.5-65mg/kg) as given by (Bowen 1979). Zinc was also found to be above the normal range in soil (10-30mg/kg) observed by (Logan 2000), the range (10-300) stated by Bowen (1979) (see table 4.2).

4.2 Heavy Metals Content in Plants

The concentration of heavy metals in plants may be attributed to the waste dumpsite of the study area. Similar work by Ademoronti (1995) showed that vegetable accumulate considerable amount of heavy metal in roots and leaves. Anikwe and Nwobodo, (2002) and Amusan et al (1999) reported that high concentrations of heavy metals in vegetables grown in waste dumpsite soils. The level of concentrations of these metals in soil and plant harvested from the waste dumpsite raises environmental concern.

Consequently, people depending on these as their source of food are indirectly ingesting heavy metals. Animals in grazing pasture may also ingest considerable amounts directly as soil and materials coatings the leaves and are thus exposed to these even without direct plant uptake. Therefore, there is high risk on the environment and health association the use of both active and abandoned municipal waste dumpsite for food crop production. Alloway and Davies (1971) and Grant and Dobbs (1977) reported that plant grown on soils possessing enhance metals concentration have increased heavy metal ion content. The uptake of metals ions has been shown to be influenced by the metal species and plant parts (Juste and Mench, 1992).

5.0 Conclusion

The indiscriminate dumping of these solid wastes in the environment has caused great harm to our ecosystem through the release of pollutants such as heavy metals which in a high concentration in the soil can be harmful to humans if ingested directly or indirectly and plants which depend on the nutrient from the soil for their growth and development. Pollution of heavy metals of soil and plants is a concern environmental issue especially when it involved chemical composition of metals. The levels of concentration of heavy metals were noticed to be affected by seasonal changes, sampling distance, depth of soil and plant part. For this study, the result also revealed that plants grown on dumpsites soils can accumulate more of the toxic metals than plants grown on the normal agricultural soils. Consequently, plants grown on Awotan wastes dumpsites have higher metal contents than counterparts at Ajakanga dumpsites. Consumption of the vegetables with high levels of heavy metals may cause health disorders. Frequent observation of the quality of soil, and plants will be of good idea to know the changes in chemistry of the environment and perhaps introduce remedial measures.

The concentration of heavy metals determined in soil samples are in order of Cu>As>Fe>Co>Pb>Cd>Zn>Ni from Awotan dumpsite, and Ajakanga dumpsite are in order of Cd>Cu>Fe>Co>As>Pb>Ni>Zn while that of Idi-Ose (control site) are in order of Cu>Co>Cd>Zn>Fe>As>Ni>Pb respectively (see table 4.2). It was found that copper have the highest concentration level while Nickel had the lower concentration level in plants grown on dumpsites. Although these metals was found in soils and plants around the dumpsites, it is worthy of note that they were below WHO permissible levels. Lead was found to be above the WHO standard maximum permissible of 0.01mg/kg and below the tolerable levels recommended by EC, (1986). However when these are high in concentration in plants, they may be dangerous to human health. The continuous usage of the dumpsites for growing plants/ crops could lead to bioaccumulation of these metals and may have adverse effect on human health.

Recommendation for further Research

It is therefore recommended that efforts should be intensified to discourage the practice of cultivating on dumpsites soils. Hence the use of dumpsite soils as a source of manure for plants and vegetables which is a common practice in Nigeria should be noted as devastating tradition and should be discouraged. Also proper education and legislations on handling of wastes in the society should be intensified to forestall waste related problems along the food chain. Moreover, the wastes dumpsites should be upgraded to a modern waste deposition (sanitary landfill). Waste sorting into biodegradable and non-biodegradable ones before deposition should be encouraged. Education and legislation on management of dumpsite should be intensified to forestall other causes of contamination problems.

Also proper remediation work should be done on such site found to contain high level of heavy metals before it can use for the cultivation of edible food crop in order to avoid heavy metal poisoning through bio-magnification. The habit of using dumpsite soil for agricultural purpose and consumption of dumpsite plant 'vegetable' should be avoided by the farmers and the resident around the dumpsite.

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