

# ASSESSMENT OF THE IMPACT OF ABA-EKU DUMPSITE ON *TALINUM TRIANGULARE* IN IBADAN, NIGERIA

Nnaemeka Christopher Nwagbo

*Department of Chemistry*

*The Ambassadors College,*

Ota, Nigeria

nwagbochris001@gmail.com

**Abstract—** The pollution of the environment with heavy metals has become a global problem in recent times because of their non-biodegradable and toxic nature in view of determining the concentration of heavy metals in Aba-Eku dumpsite in Ibadan metropolis. Soil samples were analysed for physico-chemical parameters. Physico-chemical parameters of the soil samples were determined using standard analytical procedure while heavy metal concentrations were determined in soil, and vegetable using Atomic Absorption Spectrophotometer Technique. The result of the analysis showed that the total average pH of the soil was  $7.02 \pm 0.5$ , temperature (330C). Particle size ranging from sand ( $92.6 \pm 0.05$  %), Clay ( $7.31 \pm 0.07$  %), silt ( $0.05 \pm 0.05$  %), organic carbon ( $5.85 \pm 5.6$  %), and organic matter ( $10.1 \pm 9.6$  %). The metal analysis using Atomic Absorption Spectrophotometer showed that the soil was polluted with Lead (with an average concentration of  $303 \pm 36$  mg/kg) above the 300 mg/kg set limit by the World Health Organisation. Chromium, Nickel and Manganese were within the permissible limit of the World Health Organisation. The plant analysis showed that the vegetable (*Talinum triangulare*) contained  $3.75 \pm 1.0$  mg/kg of Lead (above the permissible limit of 0.3 mg/kg set by the World Health Organisation),  $0.89 \pm 0.7$  mg/kg of Chromium,  $6.88 \pm 2.3$  mg/kg of Nickel and  $72.0 \pm 11$  mg/kg of Manganese. This showed that the vegetable was highly contaminated with lead.

The results obtained showed that the studied Aba-Eku dumpsite was grossly polluted with heavy metals when compared with the results obtained for the control site.

**Keywords—** Dumpsite, Heavy metal, Soil, Atomic Absorption Spectrophotometer, *Talinum triangulare*

## I. INTRODUCTION

### A. Waste and Waste Management

Waste management has become an issue of growing global concern as urban populations continue to increase and

consumption patterns change. The health and environmental implications associated with garbage disposal are mounting in urgency, particularly in developing countries. However, the growth of the solid-waste market, increasing resource scarcity and the availability of new technologies are offering opportunities for turning waste into a resource. Urbanization has increased in speed and scale in recent decades, with more than half the world's population now living in urban centres [1]. By 2050, urban dwellers probably will account for 86 per cent of the population in developed countries and 64 per cent of the population in developing countries. Rapid urban population growth has resulted in a number of land-use and infrastructural challenges, including municipal solid-waste management. National and municipal governments often have insufficient capacity or funding to meet the growing demand for solid-waste management services [1]

The aim of this study is to assess the environmental impact of Aba-Eku dumpsite situated at Eku in Ona Ara Local Government Area of Oyo State, Nigeria, on the entire people living around the dumpsite, especially those directly or indirectly consuming the heavy metals polluted vegetables by assessing the dumpsite soil quality and the vegetables. The Objective of the study is to ascertain the degree of pollution in the soil and in the vegetable.

### B. The Scope of this work encompasses:

Determination of some physico-chemical parameters such as; pH, Temperature, Total Organic Carbon (TOC) and Particle Size Distribution (PSD) of the Top and Sub Soil samples.

Determination of heavy metals such as Lead (Pb), Chromium (Cr), Nickel (Ni) and Manganese (Mn) in Top and Sub soils samples. All Soil samples from the Aba-Eku dumpsite.

Determination of heavy metals such as Lead (Pb), Chromium (Cr), Nickel (Ni) and Manganese (Mn) in the edible *Talinum triangulare* plant samples obtained from the dumpsite.

## II LITERATURE REVIEW

A. *Management of Waste*

In recent years, most developing countries have started to improve on their municipal solid wastes management practices. The increasing amounts of wastes generated by rapid urbanization in these countries are usually not properly managed [2]. Improper management of waste has been reported by several researchers in different cities in developing countries [3]. Inadequate management of solid waste in most developing countries leads to problems that impairs human and animal health and ultimately result in economic, environmental and biological losses [3].

Heavy metals, which are natural components of the environment mainly in combined forms, are being added to the soil through direct or indirect consequences of anthropogenic activities such as disposal of urban and industrial wastes; mining and smelting of non-ferrous metals and metallurgical, addition of manures, sewage sludge, fertilizers and pesticides, spent engine oil, etc to soils [4]. Heavy metals are extremely persistent in the environment because of their non-biodegradable nature, long biological half-lives, thermal stability and potential to accumulate to toxic levels in both plants and animals [5]. Even at low concentrations, heavy metals have been reported to produce damaging effects on man and animals because there is no good mechanism for their elimination from the body [5].

B. *Environmental and Health Effects of Heavy Metals in Soil*

Mining manufacturing and the use of synthetic products (e.g. pesticides, paints, batteries, industrial waste and land application industrial or domestic sludge) can result in heavy metal contamination of urban and agricultural soils. Heavy metals also occur naturally, but rarely at toxic levels. Potentially contaminated soils may occur at old landfill sites (particularly those that accepted industrial waste), old orchards that used insecticides containing arsenic as an active ingredient, fields that had past applications of waste water or municipal sludge, areas in or around mining waste piles and tailings, industrial sites. Excess heavy metal accumulation in soils is toxic to humans and other animals. Chronic problems associated with long-term heavy metal exposures are as follows:

- **Lead:** Lead toxicity is associated with deficits in central nervous system functioning that can persist into young adulthood [6]. Lead toxicity has also been linked with reduced intelligence as well as juvenile delinquency and violent behaviour [7]. Similarly, toxic effects have been recorded in animals and also aquatic lives. In many cases, the effects of lead are due to its potency to act as anti-nutrient, hindering the utilization of magnesium, zinc and vitamin B1.

- **Chromium:** The relationship between Cr(III) and Cr(VI) strongly depends on pH and oxidative properties of the location, but in most cases, the Chromium (III) is the dominating specie. Major industrial sources of Chromium in the environment are non-ferrous metal plants, steel works, textile mills leather tanning, electroplating, motor vehicles, cement, fertilizers asbestos etc. Several in vitro studies indicate that high concentration of Chromium (III) in the cells can lead to DNA damage. Acute oral toxicity ranges between 1500 and 3300mg/kg (Ensley, 2001). Chromium (VI) can cause nose to bleed, ulcers, convulsion, kidney and liver damage, various cancer/death (ATSDR, 2007).
- **Nickel:** Higher concentrations of Nickel cause cancer of the lung, nose and bone. Dermatitis (Ni itch) is the most common effect of exposure to Nickel, which could be from coin or jewellery. Acute poisoning of Ni (II) causes headache, dizziness, nausea and vomiting, chest pain, tightness of the chest, dry cough and shortness of breath, rapid respiration, cyanosis and extreme weakness [8].
- **Manganese:** Manganese effects occur mainly in the respiratory tract and in the brain. Manganese can also cause Parkinson disease, lung embolism and bronchitis. When men are exposed to manganese for a longer period of time, they may become impotent. Also, excess manganese interferes with the absorption of dietary iron. Long-term exposure to excess levels may result in iron deficiency anaemia, increased manganese intake impairs the activity of copper metallo-enzymes. Manganese substances can cause lung, liver and vascular disturbances, decline in blood pressure, failure in development of animal foetuses and brain damage

C. *Properties Influencing Sorption of Heavy Metals in Soil*

Soil has the potential to immobilise introduced chemicals like heavy metal ions. The immobilisation of xenobiotics is mainly due to sorption properties which are determined by physicochemical properties of the soil such as amount of clay and organic fraction, pH, water content, temperature of the soil and properties of the particular metal ion [9]. The solid state of soils consists of mineral particles, organic matter and organic-mineral particles. They all play a very important role in giving the soil the ability to adsorb, exchange, oxidise, reduce, catalyse and precipitate chemicals and metal ions in particular. The inorganic colloidal fraction of soil is the most responsible for sorption by its mineral particles. It is comprised of clay minerals, oxides, sesquioxides and hydrous oxides of minerals.

#### D. Uptake of Heavy Metals by Plants

The high concentration of heavy metal in soils is reflected by higher concentrations of metals in plants, and consequently in animal and human bodies. Metal absorption and accumulation in plants depend on a few soil factors, such as; pH, clay content, organic matter content, cationic exchange capacity, nutrient balance, other trace elements concentration in soil, physical and mechanical characteristics of soil, etc. The metals availability for plants is controlled by their request for micronutrients and their capacity to absorb and eliminate toxic elements. This availability is different, depending on plant species and their adaptation to the environment conditions.

#### E. Overview of the studied plants and its contamination

The predominant edible plant found on this dumpsite is *Talinum triangulare* commonly known as waterleaf. Vegetables serve as indispensable constituents of the human diet supplying the body with minerals, vitamins and certain hormone precursors, in addition to protein and [10]. The scientific name is *Talinum triangulare*, while the common name is waterleaf

*Talinum* is an erect perennial herb with swollen roots and succulent stems, 30-100 cm tall. The branches have two lateral basal buds. The leaves are spirally arranged to nearly opposite, often crowded at the top of the stem. The waterleaf is fast growing and once established, easily reseeds itself. *Talinum* flowers early year-round, and is mainly self-pollinating. The flowers are pink in colour and open in the morning. *Talinum* is adaptable throughout the country. It is best suited in a wet tropical environment with partial shade. The leaves and shoots are usually consumed as cooked (boiled or steamed) vegetable. They are rather soft and watery and should not be cooked for long time. Waterleaf's crude protein content compares favourably with that of cowpea, peanut, millet, and cashew nuts [11]. The crude protein content of waterleaf leaves and tender stems were found to be as high as 29.4% and 13.4%, respectively [12]. Waterleaf is usually propagated by seed; However, small seeds are difficult to collect because fruits readily dehisce. It can also be propagated vegetatively. Cuttings, 15-20 cm long, are taken from mature stems. Harvesting starts about 6-8 weeks after sowing either by uprooting or by cutting the young tops. This may be done 15-20 times a year at two weeks intervals. However, it is usually advisable to renew the planting after about six months. Yields have been estimated at 10 kg/m<sup>2</sup> per year.

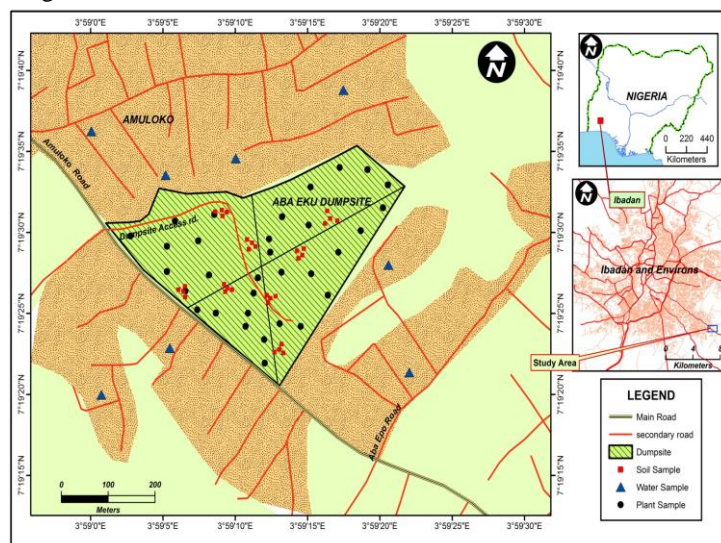
### III MATERIALS AND METHODS

#### A. Description of study area

Aba-Eku dumpsite, one of the largest dumpsites in the city of Ibadan, is situated at Eku in Ona Ara Local Government Area of Ibadan, Nigeria. It started operation in 2002. The dumpsite covers 10 acres of land and is densely surrounded by residential and commercial set ups. The landfill has since witnessed rehabilitation and constant restructuring as

regards to land filling. Virtually all the wastes from Ibadan metropolis are brought there.

The Aba-Eku dumpsite lies on the latitude 7° 19' 26" N and longitude 3° 59' 11" E.



**Fig. 3.1:** showing the map of Nigeria identifying Ibadan metropolitan city and map of Ibadan showing the study area (Aba-Eku dumpsite)

#### B. Soil Analysis

##### Sampling:

A plan of the number of samples and the composite sampling from the East, West and North to the main southern entrance to the half-fenced dumpsite designating the different fields by letters A1, A2, A3, A4 for Top Soils and B1, B2, B3, B4 for Sub Soil and was repeated in the same pattern, sampling soil 30m away from A1, A2, A3, A4. A map of the area was drawn on a sheet of paper, each area was separately traversed. With the aid of the soil auger, composite samples were ploughed at each sampling units-East, West, North to the Southern main entrance to the dumpsite, within 0-15cm depth and 15-30cm depth (i.e. top soil and subsoil respectively) and put in a clean bucket. The composite soil sample from the bucket was poured onto a piece of clean cloth and was thoroughly mixed. The soil was evenly spread and divided into quarters. Two opposite quarters were rejected and the rest of the soil mixed again. This process was repeated until the soil sample left was 0.5kg. The soil sample was collected and put in a clear cloth bag and was marked clearly for easy identification and the information sheet containing details of the bag was put in the bag and the mouth of the bag, tied carefully. This procedure was repeated at all the sampling units. Control samples of depth range 0-15cm and 15-30cm were collected from the Botanical Garden, University of Ibadan.

##### Sample pre-treatment and preservation:

The samples which were moist were air-dried on wooden trays for one month. Larger stones, debris and sticks were manually removed with the hand and the soil samples were effectively ground with the agate mortar and pestle. Thereafter the samples were screened through a 2mm sieve to obtain a homogenous particle size of 2mm. The particle

sizes greater than 2mm were re-introduced into the mortar and ground until almost all the sample were screened through the 2mm sieve.

#### 1) Analysis of soil for physico-chemical parameters

##### pH

The Soil pH was measured in deionised water using 1:1 (w/v) soil/solution ratio. 10g of the air dried and sieved soil sample was weigh into a 250mL beaker and 10mL of distilled water was added to it. The mixture was allowed to stand for 30 minutes while stirring occasionally with a glass rod before noting the pH. The pH meter was first turned on and allowed to warm up for 30 minutes. The electrode was taken out from the storage solution, rinsed with distilled water and the electrode was dabbed with Kim wipe. The electrode was then submersed into the pH 7 buffer and the temperature at this point noted to be 25°C, then, the calibration button was pressed and waited until the pH icon stopped flashing and the calibration button was again pressed. The electrode was again rinsed with distilled water and wiped with Kim wipe. The electrode was submersed into the pH 4 buffer, again, waited until the pH icon stopped flashing and the measure button was then pressed. The electrode was again rinsed with distilled water and again dabbed with dry Kim wipe. The electrode was then submersed at 25°C into the sample and the measure button was again pressed to measure the pH of the sample. The pH was recorded when the pH icon on the pH meter stopped flashing.

##### Determination of particle size distribution

50g of air-dried sample was weighed using weighing balance (mettler P163N) into 500ml beaker. 50ml of 5% Calgon along with 100ml of distilled water was added to the sample and it was allowed to soak for about 10minutes. The suspension was then mixed with a stirring rod for 15minutes and transferred quantitatively into a 1 L volumetric flask (sedimentation cylinder) placed on the bench. The cylinder was filled to the 1 L mark with distilled water and the set up was inverted up and down vigorously to disperse all of the soil particles and make them suspend. The time was noted. Then very gently, the hydrometer was inserted into the suspension and the reading at 40 seconds taken (H1). The hydrometer was then removed from the cylinder and the set up left for two hours. After two hours has elapsed, very gradually the hydrometer was again inserted into the suspension and the hydrometer reading taken (H2).

##### Calculations:

$$\% \text{Sand} = 100 \{ H1 + 0.2 (T1 - 68) - 2.0 \} 2$$

$$\% \text{Clay} = \{ H2 + 0.2(T2 - 68) - 2.0 \} 2$$

$$\% \text{Silt} = 100 - (\% \text{Sand} + \% \text{Clay})$$

Where; H1 = Hydrometer reading at 40 seconds; T1= Temperature at 40 seconds; H2 = Hydrometer reading at 3 hours; T2= temperature at 3 hours; Temperature Correction = 0.2 (T-68);

Where T is in Degree Fahrenheit

##### Determination of Total Organic Carbon

0.1002g of air-dried representative soil sample pulverized to pass through 0.5mm mesh sieve was weighed in duplicate into a 250mL conical flask. 10mL of 6M  $K_2Cr_2O_7$  solution was accurately added and the flask swirled gently to disperse the soil in the solution. 20mL of concentrated  $H_2SO_4$  was added using a 100 mL measuring cylinder and the stream directed into the suspension. The flask was immediately swirled until soil and reagents mixed properly. The flask was allowed to stand on a sheet of asbestos for 30 minutes. 100 mL of distilled water was then added. 5 drops of the ferroin indicator was added and the resulting solution was titrated against 0.5 M Ferrous Ammonium Sulphate. As the end approached, the solution turned from green to dark green, at which point, the titrant was added drop-wisely until the colour changed sharply form blue to red (maroon colour) in reflected light against a white background and the volume of the Ferrous Ammonium Sulphate used was recorded. The blanks (without soil) were also carried out using the same procedure to ensure reliable results.

##### Calculation:

$$\% \text{ Organic Carbon} = \frac{(\text{Blank titre} - \text{Sample titre}) \times 0.003 \times 100 \times f}{\text{Mass of air dried sample}}$$

Correction factor, f = 1.33

##### Determination of Soil Organic Matter:

Soil Matter (SOM) is the organic matter component of soil, including living biomass of microorganisms, fresh and partially decomposed residues, and humus. The percentage (%) organic matter of the soil samples was determined by calculation. Thus,

$$\% \text{ Organic Matter} = \% \text{ Organic Carbon} \times 1.729$$

##### 2) Analysis of soil for heavy metals

1.0g of the crushed, sieved soil sample was weighed using weighing balance (mettler P163N) into a centrifuge tube. 10ml of the 1:1  $HNO_3$  was added to the sample. The centrifuge tube was covered but not too tightly to minimize evaporation and then heated on shaker water bath at 100°C for 2hours. (to achieve efficient extraction). The vessel was allowed to cool to room temperature. The digest was filtered using Whatman filter paper into a 50ml volumetric flask. The filter paper was washed while still inside the funnel with distilled water. The volume was then made up to mark with distilled water. This procedure was repeated for all the samples according to labeling. The filtered samples were emptied into a plastic vial with cap and labeled properly and were taken for analysis. Blank determination was treated similarly as above but with the exception of the sample. The Buck Scientific (model 200A) Atomic Absorption Spectrophotometer (AAS) was employed for the measurement of the absorbance of the heavy metals. The instrument was operated according to the manufacturer instruction.

$$\text{Metal conc. (mg/kg)} = \frac{(\text{Sample concentration mg/L} - \text{Blank concentration mg/L}) \times 50\text{mL}}{\text{Mass of Sample}}$$

### C. Plant Analysis

#### Sample Collection:

1. The dumpsite was divided into four parts with each part randomly sampled and pooled together and representative sample was collected from each part. The shoots were removed with the aid of a sharp stainless-steel cutter for whole shoot and leave analysis.
2. The plant samples were washed severally with water and latter with 0.2 percent detergent solution to remove the waxy / greasy coating on the leaf surface.
3. The plant samples were then washed with 0.1HCl followed by thorough washing with plenty of water and finally washed with distilled water.
4. The plants samples were then air-dried on a perfectly clean surface at room temperature for 3 days in a dust-free atmosphere.
5. The samples were then put in the oven and dried at 70°C for 48 hours.
6. The plant samples were then ground in an electric stainless-steel mill and then finally sieved with 0.5mm sieve too obtain a homogenous.
7. The sample was again put back in the oven and dried again to obtain a constant weight and was then stored in a well-stopper plastic bottle for analysis.

#### 1) Spectrophotometric determination of heavy metals in plant

1.0g of oven dried, ground sieved (0.5mm) plant material was weighed into an acid-washed porcelain crucible. The crucible was placed in a muffle furnace and the temperature raised slowly over 2 hours to 500°C. The crucible was left in the furnace for at least 4 hours. The crucible was removed from the furnace and cool. 2.5 mL 5 M HNO<sub>3</sub> was added to dissolve the ash. The mixture was filtered and transferred to a 50 mL volumetric flask and the flask made up to the mark with distilled water. The concentration of the heavy metal (Pb, Ni, Cr and Mn) in the digest was determined using Buck Scientific (model 200A) Flame Atomic Absorption Spectrophotometer. Blank was also prepared by repeating the procedure but without plant samples.

Metal concentration (mg/kg dry matter) was then calculated as follows:

$$\text{Metal conc. (mg/kg)} = \frac{(\text{Sample concentration mg/L} - \text{Blank concentration mg/L}) \times 50\text{mL}}{\text{Mass of Sample (g)}}$$

#### Preparation of Standards

The metal standards were prepared from the stock solution of 100 ppm. Varying concentrations were prepared from the stock solution depending on the metal to be determined and their absorbances were read at appropriate wavelengths to obtain the calibration curves. For Lead (Pb), Chromium (Cr), Nickel (Ni), and Manganese (Mn), series of working standards; 1, 2, 3, 4, 8 and 10 ppm were prepared by taking aliquots of 1, 2, 3, 4 and 10ml respectively of the stock solution and made up to 100ml.

## IV RESULTS AND DISCUSSION

### A. Soil pH

The values of soil pH obtained in this study ranged from 7.40-7.53 with an average of 7.47±0.1 This value is not only higher than the normal pH range for ordinary soil given by Banjoko and Solubo<sup>[13]</sup> but also higher than the control value (6.84) for the pH of the top soil and 6.61-6.75 with an average of 6.68±0.1 for the top soil 30m away from the initial sampling points. Also, for the sub soil, the pH ranged from 7.13-7.40 with an average of 7.30±0.1 and 6.55-6.70 with an average of 6.61±0.1 for sub soil 30m away from the initial sampling points. The relatively high pH observed in the soil from the dumpsite is as a result of leaching from the dumpsites into the surrounding soils.

### B. Mechanical Property of Soil (Partical Size Distribution)

The results of the mechanical property analysis obtained, on the average, consisted 92.6±0.00 % of sand, 7.36±0.00 % of clay, 0.01±0.00 % of silt. And also 92.6±0.05 % of sand, 7.26±0.00 % of clay and 0.09±0.07 % of silt for that of 30m away from the initial sampling points. The mean values of Aba-Eku dumpsite soil consisted 92.6±0.05 % of Sand, 7.31±0.07 % of Clay and 0.05±0.05 % of Silt. This showed that the soil sample collected at the dumpsite was highly sandy.

Similarly, the control samples gave an average of 92.6±0.00 % of sand, 7.33±0.00 % of clay and 0.006±0.00 % of silt. High content of sand in soil may lead to an increase in the mobility of heavy metals while clay and silt decrease heavy metal mobility, which is due to their chemical interaction. Thus, the high percentage of the sand content and low clay content indicate that the soil have high pollution leaching potentials.

### C. Organic Carbon and Organic Matter

The average level of Organic Carbon was 5.85±5.6% while the average value of Organic matter was 10.1±9.6% for the dumpsite soil while for the control site, the average level of Organic Carbon and Organic matter were 1.60±0.9% and 2.76±1.9% respectively. According to Udousoro *et al.*,<sup>[14]</sup> a good forest top soil should contain between 3-4% organic carbon. On this basis, the soil samples are rich in organic matter. The high organic matter content may be attributed to high percentage of food waste, garden yards and other organic based wastes including decaying municipal wastes.

It also gives an indication that the Aba-Eku dumpsite is a very good source of organic matter.

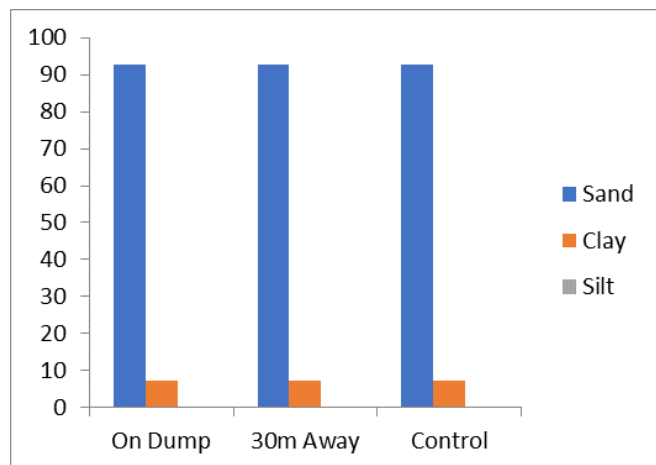


Figure 4.1: Particle Size Distribution (PSD %) of soils from dump, 30m away and control.

*D. Heavy metals in the Aba-Eku dumpsite Soil*

The top and sub soils analyses for heavy metals show that the pollution of the soil with respect to the concentration of lead in the soil was significant as the mean value of lead in the soil was above the permissible limits which was established at 300 mg/kg. The mean concentration of lead in the soil was  $277 \pm 210$  mg/kg. Also, the analysis of the soil samples collected 30m away from original sampling point showed that the mean concentration of lead in the soil was  $328 \pm 49$  mg/kg which still showed a wide range of pollution. This invariably showed that the soil was polluted with lead. Therefore, the mean concentration of Lead in Aba-Eku dumpsite soil was  $303 \pm 36$  mg/kg. The mean concentration of Chromium, Nickel and Manganese were  $34.4 \pm 7.5$  mg/kg,  $57.1 \pm 1.6$  mg/kg and  $1230 \pm 700$  mg/kg respectively. This showed that Chromium with  $34.4 \pm 7.5$  mg/kg was still within the permissible limit while Nickel was more than the permissible for the France threshold limit and manganese ( $1230 \pm 700$ ) may constitute pollutant in the soil, though no permissible limit was established, owing to the wide range of value in which manganese can be detected (20 mg/kg to 10,000 mg/kg). However, the mean concentrations of Lead, Chromium, Nickel and Manganese in the control soil were;  $28.8 \pm 26$ ,  $21.9 \pm 8.7$ ,  $16.5 \pm 6.4$  and  $943 \pm 490$  respectively.

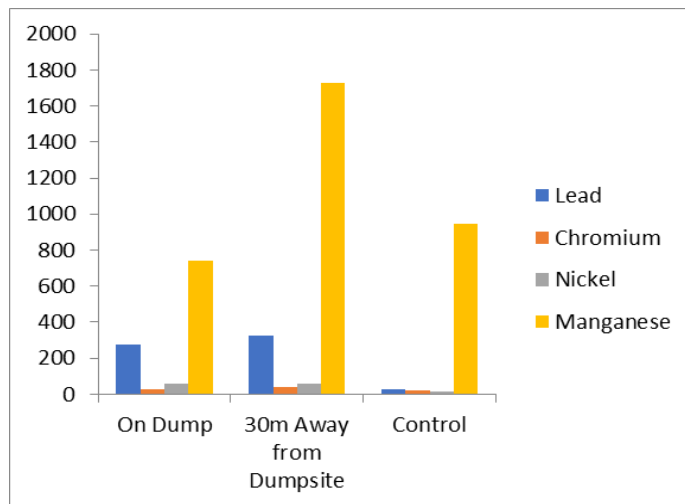


Figure 4.2: Average concentration of Heavy Metals in soils from; Dump, 30m Away and Control (mg/kg).

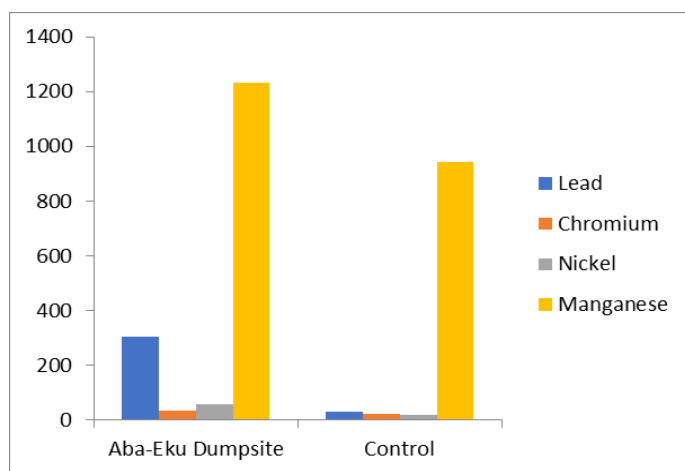


Figure 4.3: Average concentration of Heavy Metals in Aba-Eku dumpsite soil and Control (mg/kg).

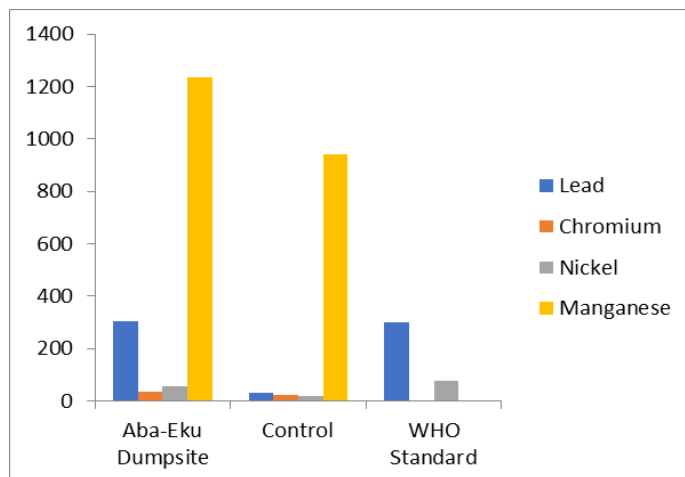


Figure 4.4: Comparison of Aba-Eku dumpsite soil Heavy Metal concentrations with World Health Organization permissible Limit (mg/kg).

#### 4.6 Heavy Metals in *Talinum triangulare*

The analysis of *Talinum triangulare* for heavy metals (Pb, Cr, Ni and Mn) showed that the concentration of lead in the (leaf + shoot) was up to 12 times higher than the permissible limit of 0.3 mg/kg set by the World Health Organization /Food and Agriculture Organization of the United Nations for lead. The average concentration of lead in *Talinum triangulare* was  $3.75 \pm 1.0$  mg/kg ranging from 2.75 to 4.75 mg/kg and that of Chromium was  $0.89 \pm 0.7$  mg/kg ranging from 0.19 to 1.59 mg/kg. This showed that, the average mean concentration of Chromium in *Talinum triangulare* was within the permissible limit of 2.3 mg/kg set by the World Health Organization /Food and Agriculture Organization of the United Nations.

#### V CONCLUSION AND RECOMMENDATION

The results of the physico-chemical parameters investigated in this study showed that the soil has high values for all the physico-chemical parameters studied thereby encouraging leaching from the dumpsite. In the assessment of the soils for pollution by chromium, lead, nickel and manganese, it was observed that the heavy metals ranged from low level of heavy metals to levels that suggest gross contamination. The concentrations of heavy metals were observed to be higher in soils at the dumpsite compared to those obtained at Botanical garden (University of Ibadan) which is the control site. This implies that the dumpsite has a significant impact on the environment.

The high levels of some of the metals relative to some available standards suggests contamination due to anthropogenic activities from various sources such as industrial, domestic and agricultural waste, including metal scraps, and battery treatment.

The study was able to successfully show that heavy metals in soils at waste dumpsites eventually end up in the vegetable cultivated on such land. The four heavy metals, Lead, Chromium, Manganese and Nickel were present at the dumpsite in measurable quantities. The concentration of the most toxic heavy metal, lead, that ended up in the vegetable from the soil far exceeded the World Health Organization /Food and Agriculture Organization of the United Nations recommended guidelines since the level of the toxic heavy metal was very alarming. Farmers at this site should be restricted from or banned by the metropolitan authorities and the Environmental Protection Agency from using this waste dumpsite in the metropolis for vegetables cultivation. Also, for Aba-Eku dumpsite, in-situ techniques of remediation involving destruction or transformation of the contaminant or by immobilization to reduce the

bioavailability and separation of the contaminant from the bulk soil should be done by the government through the Environmental Protection Agency since the method is cost-effective and can reduce impact on the ecosystem.

#### REFERENCES

- [1] C. Tacoli, 2012. Urbanization, Gender and Urban Poverty: Paid Work and Unpaid Carework in the City. International Institute for Environment and Development: United Nations Population Fund, London, UK.
- [2] W. O. Odiete, 2000. Environmental physiology of animals and pollution. Lagos Diversified Resource Limited. Pp. 204 – 218.
- [3] M. Sharloly, K. Ahmad, G. Mahmoud, and R. Trivedi, 2008. Municipal solid waste management in Indian cities. – A review. *Waste management*, 28 (2): 459 – 467.
- [4] G. Kachenko, and B. Singh, 2006. Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia. *Water Air Soil Pollut.*, 169:101-123.
- [5] Arora, B. Kiran, S. Rani, A. Rani, B. Kaur., and N. Mittal, 2008. Heavy Metal accumulation in vegetables irrigated with water from different sources *Food Chem.*, 111: 811-815.
- [6] ATSDR., 2007. Toxicological profile for lead. United States Public Health Service Agency for Toxic Substances and Disease Registry.
- [7] European Commission, 2002. Heavy metals in wastes. Project ENV. E.3/ETU/2000/0058 Final Report.
- [8] K. Kardivelu, 2000. Removal of heavy metal from industrial wastewaters by adsorption onto activated carbon prepared from an agricultural solid waste *Biores. Technol.*, 76: 63 – 65.
- [9] F. J. Stevenson, 1999. Humus chemistry. Genesis, composition and reactions. New York: Wiley – Intersc. Publications.
- [10] A. Oyenuga, and B. L. Fetuga, 1975. First National Seminar on Fruits and vegetables, In process and Recombination by NIHORT, Ibadan, Nigeria, 13-17 Oct., 1975. pp: 122-123
- [11] P. O. Egwin, A New Biochemical Rating System for Vegetable Food Protein, *Nig. J. Sci*; 1979, 13:323-329.
- [12] C. O. Akachuku, and M. A. O. Fawusi. Growth Characteristics, Yield and Nutritional Value of Waterleaf, *Talinum triangulare* (Jacq) Wild in a Semi-Wild Environment, *Discovery and Innovation*; 1995, 7:163-172.
- [13] A. Banjoko, and R. A. Sobulo, 1994. Particle size distribution of Fe, Mn Zn, and B in some Nigeria soils. *Nig. J. of Sci.*, 34:60-163.
- [14] I. I. Udousoro, I. U. Umoren, and E. D. Asuquo, 2010. Survey of some heavy metal concentration in selected soils in south Eastern part of Nigeria. *World Journal of Applied Science and Technology*, 2(2): 139-149.