Levels of Heavy Metals in Refuse Dumpsites of Rafin Zurfi, Bauchi State

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ABSTRACT

Soil sample after removing the overlying waste was collected randomly from the fields at 0 – 20 cm depth and homogenized; another set of sample was collected at the same depth randomly from an uncultivated land that is uncontaminated area, at 100 m away from the dumpsite to serve as control. The samples were air-dried for 72 hours, ground, sieved, digested, filtered and made to volume with water in a 100 cm^3 volumetric flasks. The result of heavy metals was obtained using Atomic Absorption Spectrophotometer (AAS) technique and was expressed in mg/kg followed by calculation using relative standard deviation. The concentrations of the metals in both dumpsite and control were far below the World Soil Average. The study revealed significant differences in the concentration of many metals in soil unit at the dumpsites and the control. The variations of the heavy metals in the dumpsite were in the following trend: Mn > Cr > Pb > Cd > Zn and for the control Zn > Mn > Cr > Pb > Cd. The variations of the heavy metals in the dumpsite were in the following trend: Mn (27.7050 ± 0.0294)> Cr (2.9250±0.1658)> Pb (1.1300 ± 0.2212)> Cd (0.0950 ± 0.2632)> Zn (0.000)and for the control Zn (9.4600 ± 0.0396)> Mn (6.5400± 0.0749)> Cr (3.4850± 0.1908)> Pb (1.200±0.2500)> Cd (0.0050± 8.000). The values obtained were far below the World Soil Average for agricultural soil. It is therefore suggested that the dump site may be converted to organic manure which will be favorable for plant cultivation and could be beneficial to plants.

INTRODUCTION

Background of the Study

The proper wastes disposal has been a serious problem in Rafin Zurfi, Bauchi and most cities in Nigeria. In Nigeria, leachates from refuse dumpsites constitute a source of heavy metal pollution to both soil and aquatic environment (Obaliagbon and Olowojoba, 2006). In some cases, wastes are dumped recklessly with no regards to the environmental implications, while in some dumpsites, waste is ‘burnt in the open and ashes abandoned at the sites. The burning of waste gets rid of the organic materials and oxidized the metals, leaving the ash richer in metal contents. After the process of oxidation and corrosion, these metals will dissolve in rain water and leached into the soil from where they are picked up by growing plants, thereby entering the food chain. Improper wastes management methods also pilot the contamination of underground water, while most of the metals are being washed away by runoff into streams and rivers thereby contaminating the marine environment. Consequently, these metals accumulate in fish and other organisms (aquatic), hence posing a health threat to the consumers (Njojju and Ayoka, 2006).

It is amongst the classes of solid wastes that pose the greatest threat to life, since it has the capability of polluting the terrestrial, aquatic and aerial environment. Land pollution by component of refuse such as heavy metals have been of great concern in the last decades because of their health hazards to man and other organisms when accumulated with a biological system (Adekunle *et al.*, 2003). Recent studies have also reviewed that waste dumpsite can transfer significant levels of these toxic and persistent metals into the soil environment. These metals are taken up by plant parts that transfer same into the food chain. Consequently, soil heavy metals concentration can result in higher levels of uptake by plants. Although, the rate of metal uptake by crop plants could be influenced by factors such as metal species, plants species, plant age and plant part. In Rafin Zurfi metropolis, most of the dumpsites are used for the cultivation of some fruits and vegetables. Some farmers collect the decomposed parts of the dumpsites and apply to their farms as manure. These cultivated plants take up the heavy metals either as mobile ion in the soil solution through their roots or through their leaves thereby making it unfit for human consumption (Uzoho and Oti,2006).

Heavy metals are metals with a density at least five times that of water. Heavy metal is the term commonly adopted as a group name for the metals which are associated with pollution and toxicity (Paul *et al.*, 2014). They may also include some elements which are very essential for living organisms at low concentrations. Among these heavy metals, some have been found to be of serious hazard to plants and animals and have been listed by the European Commission to include: Arsenic, cadmium, chromium, copper, lead, mercury, nickel, aluminium and zinc. Heavy metals are stable elements that cannot be metabolized by the body; as such they are passed up in the food chain to human beings (Bioaccumulation). The most common and harmful heavy metals are: aluminium, arsenic, cadmium, copper, lead, mercury and nickel. Heavy metals in general have no basic function in the body and can be highly toxic. They are present in drinking water, food and countless human-made chemicals and products.

The presence of heavy metals in the environment especially in food materials poses a serious threat in both health and socio-economic well-being of man and his environment. With the knowledge that waste dumps are potential sources of heavy metals contamination, it is believed that there would be heavy metals contamination in residential and commercial areas in urban areas (Jekin, 1989).

Significance of Study

The study will provide the baseline data of the level of cadmium, chromium, manganese, lead and zinc in refuse dumping sites. The study will help in forecasting the potential threats caused by their excess or deficiency to animal population in Rafin Zurfi. The outcome of this study will be of great interest to the environmental agency, veterinary agency and agricultural societies particularly in Rafin Zurfi.

Statement of Problem

Agricultural activities, hospitals, household and market activities in Rafin Zurfi generate immense solid wastes daily. Dumping of all categories of wastes and discharging of sewage improperly on the sides pollutes the soil and defaces the aesthetic value of the area. This stands out as a problem that needs urgent research and implementation procedure Wastes are being disposed recklessly on the side without adequate management and concern for the environment. Due to the uncontrolled dumping and disposal of solid wastes in Rafin Zurfi and lack of expected management of solid wastes in the area, it is expected that the soil quality may be adversely affected. This project determines the levels of heavy metals it is believed that the problem of improper solid waste management has affected the soil in the surrounding area, thus there is an urgent need to investigate the effect on soil, the extent to which it has reduced the soil quality in the area and other cognate effects it poses to the environment, hence the need to assessed the presence of heavy metals and levels of toxicity. It entails examining the impact of solid waste on the quality of soil in Rafin Zurfi area and the remedial processes to be employed.

Justification of the Study

Soil is precious natural resources upon which economic activities like agriculture and existence of lives depends The properties and quality of soil can be adversely affected by the over concentration of wastes released from agriculture, Industry, municipality and individual household (Soffianian *et al.*, 2014). These wastes deteriorate the quality of soil and negatively influence sustainable development. Today at global scale, the magnitude of soil deterioration was significantly increased due to rapid rate of industrialization, population increment and urbanization which contributed to the changes in the composition and quantity of wastes generated. According to UNIDO (2011), the increments of waste load are leading to environmental pollution and degradation in many cities of the developing world. It was estimated in 2006, the total amount of Municipal Solid Waste (MSW) generated globally may reach 2.02 billion tones, representing a 7 % annual increase since 2003 (Global Waste Management Market Report, 2007). The UNEP (2009) further estimated that between 2007 and 2011, global generation of municipal waste raised by 37.3 %, equivalent to roughly 8 % increase per year. In urban centers throughout African regions, less than half of the solid waste produced was collected, and 95 percent of that amount indiscriminately thrown away at the various dumping sites on the peripheral urban center (Mohammed, 2003). As a result of poor solid waste management, most African countries including were becoming a dumping ground for electronics and other hazardous wastes containing cadmium, zinc, lead, manganese etc. furthermore small and large scale industries located in urban areas often dispose of their waste along with municipal solid wastes. These heavy metals pose great effects on health of human beings, living organism and natural environmental (Amadi *et al.*, 2010; Zurbrug, 2003) when their concentrations are above the normal threshold. The study area also has such open solid waste dumping /landfills site for municipal and other types of waste which poses both environmental and health problem for communities living around the dumping sites and beyond.

Scope of the Study

The scope of this study is wide, ranging from collection of sample, digestion and the use of Atomic Absorption Spectrophotometer (AAS) to determine the heavy metals such as: chromium, cadmium, manganese, lead, and zinc.

Solid Waste and Disposal of Solid Waste

According to Oxford Advanced Learners Dictionary of current English (2000), wastes are materials that are no longer needed and are thrown away‘. Waste is any substance that could be solid, liquid or gas or mixture for which no direct use is envisaged, but which is transported for processing, dumping, elimination or other methods of disposal (Yakowitz, 1988). Waste is directly linked to human development, both technologically and socially (Adriano, 2005). Solid waste could be any non-liquid and non-gaseous product of human activities, regarded as being useless, it could take the forms of refuse, garbage and sludge (Leton and Omotosho, 2004). Sources of solid waste in Nigeria among others are commercial, industrial, household, agricultural and educational establishments.

The solid waste types include pesticide containers, paint cans, batteries, nylon, various cleaning agents, dead animals, disposable diapers, grease and oils, bottles, woods, bones, electronic gadget wastes and rubber among others. Out of the total solid wastes generated in Ibadan, 66.1 % are domestic, 20.3 % commercial and 11.4 % Industrial (Adewumi *et al.*, 2005).

Solid waste management has remained an intractable environmental sanitation problem in Nigeria. This problem has manifested in the form of piles of indiscriminately disposed heaps of uncovered waste and illegal dumpsites along major roads and at streets.

Effects of Some Heavy Metals on the Environment

Contamination in the Soil: The most prevalent group of elements in the sub-soils is the transition metals otherwise called heavy metals. Examples include: chromium, lead, nickel, etc. These metals may occur in soil due to Industrial or from refuse dumps.

Lead (Pb)

Lead (Pb) is a well-known neurotoxin. Impairment of neurodevelopment in children is the most critical effect of lead poisoning. Exposure in the uterus, during breastfeeding and in early childhood may all be responsible for the effect. Lead accumulates in the skeleton and its transfer from bones during pregnancy and lactation causes

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exposure to foetuses and breastfed infants (ATSDR, 2007). Chronic exposure to lead can affect physical growth and cause anaemia, kidney damage, headache, hearing problems, speaking problems, fatigue or irritable mood (Simeonov *et al*., 2010). The toxicity by lead has multiple biochemical effects. It has the ability to inactivate enzymes, compete with calcium for incorporation into bones and interfere with nerve transmission and brain development (Ediin *et al*., 2000). It has been suggested that lead on a cellular and molecular level may permit or enhance carcinogenic events involved in DNA damage, DNA repair and regulation of tumour suppressor and promoter genes (Silbergeld, 2003).

The common sources of lead are car batteries, tyre materials, coals, plastics and insecticides. The high level of lead in soil could be attributed to lead from car exhaust fumes, derived from leaded petrol (Alloway, 1996). The main sources of lead in the environment include dust from leaded paints of older houses, leaded gasoline and tap water from soldered pipes (Ediin *et al*., 2000). The maximum allowable limits of lead in the soil in UK and USA are 100 mg/kg and 200 mg/kg respectively (Mamtaz and Chowdhury, 2006), while it is 0.05 mg/kg in Nigeria (FEPA, 1991).

Chromium (Cr)

The most common forms of chromium are chromium (VI) and chromium (III) (Hilgenkamp, 2006). Although, chromium toxicity in the environment is rare. It still presents some risks to human health since chromium can be accumulated on skin, lungs, muscle, fat, in liver, dorsal spin, hair, nails and placenta where it is traceable to various health conditions (Adeleken and Abegunde, 2011).

The health effects brought about by the exposure to chromium (VI) include lung cancer, malignant neoplasia, chromium dermatitis and skin ulcers (Sarkar, 2005). Perforations and ulcerations of the nasal septum and bronchial asthma have also been reported. In one of the studies, a four-fold increase in childhood leukemia was attributed to possible consumption of water with chromium (VI) levels above standard recommended value of 300 mg/kg (Sarkar, 2005). The sources of chromium in the environment include cement, leather, plastics, dyes, textiles, paints, printing ink, cutting oils, photographic materials, detergents, wood preservatives among others (Hilgenkamp, 2006). Other sources of chromium are power plants, liquid fuels, brown and hard coal and Industrial and municipal wastes. Non biodegradability of chromium is responsible for its persistence in the environment and once mixed with soil; it undergoes transformation into various mobile forms before ending into environmental sink (Adeleken and Abegunde, 2011). The maximum allowable limit of chromium in the soil set by United Kingdom is 300 mg/kg (EU, 1986), while the limit set by FEPA (1991) is 0.03 mg/kg in Nigeria.

Nickel (Ni)

Nickel is an essential trace element in animals, although the functional importance of nickel has not been clearly demonstrated. However, there is evidence of uptake and accumulation in certain plants. Nickel deficiency is manifested primarily in the liver. Its effects include abnormal cellular morphology, oxidative metabolism and increase and decrease in lipid levels. The essentiality of nickel in humans has not been established and nickel dietary recommendations have not been established for humans (ATSDR, 2003). Nickel compounds are known carcinogens in both human and animal models (Feder *et al*., 1996). There is evidence that the geno-toxic effects of nickel compounds may be indirect through the inhibition of DNA repair systems. As a result of this inhibition it was suggested that accumulation of nickel in breast tissue may be closely related to malignant growth process (ATSDR, 2005).

Copper (Cu)

Copper is an essential nutrient that is incorporated into a number of metalloenzymes involved in hemoglobin formation, drug/xenobiotic metabolism, carbohydrate metabolism, catecholamine biosynthesis, the crosslinking of collagen, elastin and hair keratin, and the antioxidant defense mechanism. Copper-dependent enzymes, such as cytochrome C oxidase, superoxide dismutase, ferroxidases, monoamine oxidase and dopamine β-monooxygenase, function to reduce activated oxygen species or molecular oxygen. Symptoms associated with copper deficiency in humans include normocytic, hypochromic anaemia, leukopenia, and osteoporosis (ATSDR, 2004).

Although, copper homeostasis plays an important role in the prevention of copper toxicity, exposure to excessive levels of copper can result in a number of adverse health effects including liver and kidney damage, anaemia, immunotoxicity and developmental toxicity. Many of these effects are consistent with oxidative damage to membranes or macromolecules. Copper can bind to the sulfhydryl groups of several enzymes, such as glucose-6-phosphatase and glutathione reductase, thus interfering with their protection of cells from free radical damage (ATSDR, 2004). A few examples of human activities that contribute to copper release are mining, metal production, wood production and phosphate fertilizer production. Because copper is released both naturally and through human activity, it is very widespread in the environment. The metal is often found near mines, industrial settings, landfills and waste disposals (Schult and Kelling, 1999).

Cadmium (Cd)

Cadmium is a heavy metal characterized by high mobility in biological systems. It is emitted to the atmosphere in combustion processes, mainly in the form of oxides (Wieczorek et al., 2004). Cadmium uptake by plants is partly limited by the presence of calcium, phosphorus and chelating compounds in the soil (Wieczorek *et al.*, 2004). The metal is a lustrous, silver-white, ductile and very malleable. It is soluble in acids, but not in alkalis. It is usually found as a mineral combined with other elements such as oxygen as cadmium oxide, chlorine as cadmium chloride, or sulphur as cadmium sulphate and cadmium sulfide (Schult-Schreeppimg and Piscator, 2000). The sources of cadmium in the environment include: mining and smelting of metal ores, fossil fuel combustion and also phosphate fertilizers (Challa and Kumar, 2009). Cadmium is used in the production of nickel- cadmium rechargeable batteries and when this is deposited in sewage sludge, it raises the levels of cadmium in the environment (Challa and Kumar, 2009).

Farming practices such as tobacco growing also increases the level of cadmium in the environment, as tobacco is known to accumulate cadmium in its tissues (Selinus and Alloway, 2005). The sources of Cd in the urban areas are much less well defined than those of lead, but metal plating and tire rubber are considered the likely sources of cadmium (Jaradat and Momani, 1999). Cadmium is also found in lubricating oils as part of many additives and car tyres as a result of the vulcanization process. The metal is also widely used in electroplating, pigments, plastics, stabilizers and battery Industries (Mehbrahtu and Zebrabruk, 2011). Cadmium is highly toxic and responsible for several cases of poisoning through food. Small quantities of cadmium cause adverse changes in the arteries of human kidney. It replaces zinc biochemically and causes high blood pressures and kidney damage (Mehbrahtu and Zebrabruk, 2011). The recommended concentration of cadmium in soil is 3 kg/mg (EU, 1986).

Zinc (Zn)

In some respects zinc is chemically similar to magnesium: both elements exhibit only one normal oxidation state (+2), and the Zn^{2+} and Mg^{2+} ions are of similar size. Zinc is the 24th most abundant element in earth's crust and has five stable isotopes. The most common zinc ore is sphalerite (zinc blende), a zinc sulfide mineral. The element was probably named by the alchemist Paracelsus after the German word *Zinke* (prong, tooth). Zinc is an essential mineral perceived by the public today as being of "exceptional biologic and public health importance", especially regarding prenatal and postnatal development. Zinc deficiency affects about two billion people in the developing world and is associated with many diseases. In children, deficiency causes growth retardation, delayed sexual maturation, infection susceptibility, and diarrhea. Enzymes with a zinc atom in the reactive center are widespread in biochemistry, such as alcohol dehydrogenase in humans. Consumption of excess zinc can cause ataxia, lethargy and copper deficiency (Prasad, 2003).

Exposure of Humans to Heavy Metals

Since the Industrial revolution, the production of heavy metals such as lead, zinc etc. has increased exponentially, production of this metals has increase nearly 10 – fold with emissions rising in tandem, once emitted, metals can reside in the environment for hundreds of years or more human beings may be exposed to these metals through the food chain after the food has been contaminated. Heavy metals have been used in a variety of ways for at a long time, for example, lead has been used in plumbing and lead arsenate has been used to control insects in apple orchards. Lead was added to wine to improve its taste and mercury was used to alleviate teething pain in infants; many metals are essential to life and only become toxic when exposures to life become excessive, i.e. exceed some threshold for the introduction of adverse effect (Nwajei *et al.*, 2007).

Bioaccumulation of Heavy Metals in Living System

The word environment and society where we live have made bodily contamination impossible to ignore – through eating, smoking, breathing, skin absorption and every day exposure to limitless products and chemicals made and used by human, contaminants find their way into the body (Benajamin and Kaana, 2014). Over time these heavy metals, toxic chemicals and residues, plagues and other unnatural intruder continue to slowly accumulate. If the body natural detoxification pathways (such as blood lymph and cerebral spinal fluid) cannot eliminate them faster that they enter the body, the buildup can eventually reach toxic levels. “Bioaccumulation of metals is the process whereby organisms stored up metals from the surrounding medium into their tissues by chelating process”. It is the product of equilibrium between the concentration of the metal in organisms, environment and the rate of ingestion and excretion, for example inorganic mercury present in product like pesticide, insecticides, fungicides etc. usually deposit in water to form sediments. These chemicals may be absorbed by aquatic organisms and the organisms are eventually eaten up by fish, the fish are caught and eaten by man, as such the chemicals may bio-accumulate in man on exposure for a long time. The consequence of this may result to various ailments which are most times life threatening (Osuji and Onojake, 2004).

Natural Chelating Agents

The word, chelates, means to grab onto something. Thus, chelating agents are substances that have a strong ability to grab onto metals and dislodge them from the tissues so they can be removed. The human body has its own cleansing mechanism utilizing chelating agents. Each cell in the body manufactures its own chelating agents such as cysteine, histidine, glutathione and other metallothioneins designed to remove heavy metals and other toxins (Kaana, 2014).

These chelating agents involved in natural chelation are amino acids. Our bodies can only synthesize these amino acids from a sufficient amount of dietary protein. For example, our bodies synthesize cysteine from the amino acid methionine found in garlic and onions. Additionally, sugars, lipids (i.e. fat) and other proteins can act as chelating agents. As we age, our cells produce less and less of these chelating agents. So, over our lifetime, supplementation becomes increasingly important to remove heavy metals and other toxins from our bodies. For instance, older adults should greatly increase their supplementation of these chelating agents from plants, clay and fermented foods. Therefore an increased dietary intake of plant and animal proteins is highly recommended to keep natural chelation going otherwise the body may be exposure to toxins ingested (Kaana, 2014).

I’m and Objectives of the Study

The aim of the research is to determine the levels of heavy metals in refuse dumpsites of Rafin Zurfi, Bauchi state; while the objectives are to determine:

i. The concentrations of chromium, cadmium, manganese, lead, and zinc, in the soil sample from no refuse dumping sites,
ii. The concentrations of the same in soil from refuse dumping sites.

LITERARTURE REVIEW

Assessment of Some Heavy Metals and Physiochemical Properties in Surface Soil of Municipal Open Waste Dumpsite in Yenogoa, Nigeria was evaluated (Amos *et al.,* 2013). The study was designed for the assessment of lead, cadmium and chromium and some physiochemical properties of soils collected from an open dumpsite in Yenogoa, Nigeria. Surface sample at two depths (0-10 and 10-20 cm) were randomly collected at the dump field and control site, and were analyzed for physiochemical parameters and contamination of lead, chromium and cadmium using standard analytical methods. The result shows that main dumpsites have higher sand (> 8.0 %) and lower clay silt content than the control site. Soil mean pH varied between 4.89 ± 0.05 in the control and 7.60 ± 0.02 in the dump. Total nitrogen content of the dump soils ranged from 0.06 ± 0.07 to 0.24 ± 0.09 % and is slightly higher than that of the control soil. This is reflected in the high value of organic matter (4.71 ± 0.85 %) in dump soils. Available P was quite high ranging from 35.00 ± 0.011 to 84.20 ± 1.02 mg/kg. Cation Exchange Capacity (CEC) varied between 12.98 ± 0.31 and 91.07 ± 0.11 cmolkg^{-1}. CEC levels were moderate to high ranging from 14.10 ± 0.10 to 91.47 ± 0.11 Cmolkg^{-1}. All the soil samples had very high base saturation (> 90.0 %) and exchangeable Ca, Mg, K and Na, far above the critical levels set by FAO for agricultural soil. Average levels of pH ranged from 14.75 ± 0.05 to 16.14 ± 0.04 mg/kg in the dump and 8.35 ± 0.05 to 8.78 ± 0.07 mg/kg in the control. Mean concentration of chromium in the dump soil varied between 0.05 ± 0.01 and 0.06 ± 0.01 mg/kg and is slightly higher than the control (0.005 ± 0.01 mg/kg). It is suggested that the dumpsite and the control area with their adequate soil nutrients and low levels of metals should eventually be converted to agricultural farmland. No remediation is needed at this time.

Effect of Solid Waste Source (Dump Site Type) on Heavy Metals Contaminations in Urban Soils of Bauchi, Nigeria was evaluated (Eze, 2015). Heavy metal constitutes major threat to humans due to the fact that they unlike some other pollutants are not biodegradable. Different sources of these metals when dumped with municipal solid wastes raise the level of heavy metals in dumpsites. A study of the effect of solid waste source on heavy metals contamination in urban soils in Bauchi, Nigeria was carried out using Atomic Absorption Spectrophotometer. Single and integrated pollution indices were used to assess the impact of human activities on the concentration of heavy metals in soils. The results obtained shows that heavy metals contamination of urban soils in Bauchi is strongly affected by the source area of waste materials or the dumpsite type. Heavy metals contaminations based on single pollution indices used give the following trend:

Lead > Cadmium > Nickel > Zinc > Chromium > Manganese > Copper > Iron for residential soils,

Lead > Nickel > Cadmium > Zinc > Chromium > Manganese > Copper > Iron for commercial soils and

Lead > Cadmium > Nickel > Zinc > Copper > Chromium > Manganese > for Industrial soils.

In view of the discrepancies in results obtained when different reference values were used, the development of a unified contamination classification model named Unified Contamination Classification by Eze at Bauchi (UCCEB) was undertaken resulting in interesting coherence among single pollution indices. The application of UCCEB model enabled the differentiation of anthropogenic-related contamination from lithogenic-related inputs. The studied sites gave the following results using UCCEB: Residential Dump Site (RES): moderate pollution with respect to cadmium, nickel, lead, zinc; low pollution with respect to chromium, copper, manganese; and deficient pollution with respect to iron. Commercial Dump Sites (COM): moderate pollution with respect to cadmium, chromium, nickel, lead, zinc; low pollution with respect to copper, manganese and deficient pollution with respect to iron. Industrial Dump Site (IND): moderate pollution with respect to cadmium, chromium, copper, nickel, lead, zinc; low pollution with respect to manganese; and deficient pollution with respect to iron. Thus the order of multi-element contamination can be summarized as IND > COM > RES.

Contributions of Municipal Refuse Dumps to Heavy Metals Concentrations in Soil Profile and Groundwater in Ibadan, Nigeria was studied (Adelekan & Alawode, 2011). Soil and ground water samples from 7 municipal refuse dumps and a green uncontaminated control site at the Institute of Agricultural Research and Training in Ibadan, Nigeria were analyzed for cadmium, cobalt, lead, chromium, and nickel. Soil samples were obtained in triplicates and at depths of 0 – 15, 15 – 30, 30 – 45, and 45 – 60 cm. Water samples were obtained from dug wells at the dump sites. The values of cadmium, cobalt, lead, nickel, and chromium in the dumpsites sample ranged from 0.75 - 16.30, 3.45 – 21.00, 45.00 – 624.50, 4.35 – 49.80, and 13.15 – 75.55 mg.kg, respectively. Evidence of contamination of these soils by cadmium, lead, nickel, and chromium was obvious when compared to the control sites. Nickel was below detection limit in all control samples while lead and cadmium were less than 0.05 and 0.02 mg/kg respectively. Chromium ranged from 6.25 – 19.75 mg/kg; the range obtained for cobalt at the dumpsites was comparable to that of the control soil which was 7.22 – 28.15 mg/kg compared to established limits set for soils in some countries. The values measured were higher, particularly for lead, cobalt conformed to the only established limit cited in Austria, values measured in the ground water samples were lower than the limits set by WHO for drinking water, except cadmium which was detected in 3 of the samples at a concentration close to the WHO limit. The study found that there is an ongoing buildup of heavy metals in soil at the waste dumps studied and concentrations were already higher than established limits for some metals. The recommendations of the study include formulation and enforcement of other environmental protection regulations to stop the ongoing buildup of these metals on those locations. Findings from this study will be of immense help to researchers and environmental regulators in developing countries.

Comparative Study of Heavy Metals in the Soil around Waste Dumpsites within University of Uyo was studied (Nkop *et al.,* 2016). The high concentration of heavy metals in soils is reflected by higher concentrations of metals in plants consequently in animals and human bodies. Small amounts of many heavy metals are required by plants to remain healthy assessment of the levels of iron, lead, cadmium, zinc and nickel in dumpsite. Soils and vegetation around solid waste dumpsites within University of Uyo environment was carried out using atomic absorption spectrophotometric techniques. This study focused on the investigation of soil contamination (iron, lead, cadmium, nickel). In dumpsite, soil and accumulation in plant growing in the environment within University of Uyo. Total of six soil samples were collected three dumpsites in which three were control and nine plants samples were collected at the three different dumpsites. Soil samples were randomly collected by depth profile (0 – 5 cm). Both soil and plant samples were analyzed with Atomic Absorption Spectrophotometer (AAS) equipped with graphite furnace. Concentrations of the metals in the dumpsite soil and plant were found to be in higher concentrations compared to control.

However, continuous exposure to these metals might bring about bioaccumulation and thus harmful health effects on the population.

Assessment of Heavy Metals Pollution in Dumpsites in Ilorin Metropolis was carried (Abdulsalam, 2009). Specialization and distribution of heavy metals in soil controls the degree to which metals and their compounds are mobile, extractable and plant available. Eight strategically located dumpsites in Ilorin metropolis (an averagely growing city and State capital) were chosen for dumpsites-soil characteristics study. Both the estimated total and potentially available metals were studied using EPA 1311 and Ressier's *et al.* methods respectively. It was observed that the groundwater is vulnerable to contamination as no treated basement to absorb toxic metals was provided for in the sites. About 70 % of Mn, Fe, Zn, Cd and Pb were found in the exchangeable bound to carbonate and bound the iron/manganese oxide fractions. These fractions represent the mobile and lethal portions of the total metals to the ecosystem. The metal enrichment factor revealed that zinc, cadmium and lead were of anthropogenic source while iron is of natural and anthropogenic sources. The dumpsites in Ilorin therefore pose negative consequences on the soil and groundwater environment.

Some physico-chemical and heavy metal levels in soils of waste dumpsites in Port Harcourt municipality and environs were reported (David *et al.,* 2009). Various physico-chemical techniques were used to investigate the characteristics and heavy metals concentration of soils in some selected dumpsites in Port Harcourt. This is because the soils act as vehicles for the permeability of leachates into various levels of aquifers in the environment. The results showed that soils are moderately acidic with a mean pH value of 5.5 for the 1m subsoil and 5.8 for 30 cm soil depth in the various dumpsites, while the Total Organic Carbon (TOC) levels showed that it was low with 3.41 % and 2.90 % for depths 30 cm and 1m respectively. The Cation Exchange Capacity (CEC) of the soils showed a range of 21.36 – 28.79 meq/100g for a depth of 30 cm and 20.94 – 26.44 meq/100g for a depth of 1 m soil level across the waste dumpsites. The textual classes of the soils were observed to be a mixture of sand, clay and loam in all the sites. Low sand fractions (> 40 %) was observed for almost all sites except for Elekahia and Eleme roads that had 64.7 % and 56.4 % respectively. The results of heavy metals concentration in all the locations of the waste dumpsites were above permissible limits.

Levels of Heavy Metals on Soil and vegetable growing on or near Refuse Dumpsites in Abeokuta, Ogun State was evaluated (Awe, John and Omotayo, 2012). The objectives of this study was to determine the concentrations of lead, copper, chromium, iron and zinc on samples collected at 22 refuse dumpsite soil and vegetables grown on it in Abeokuta, Ogun State, Nigeria and also to compare the results obtained from refuse dumpsites soil and vegetable with those of the control samples collected at FUNNAB campus. The heavy metals in the soil were extracted by digestion with HNO_3. The concentrations of these metals in the soil were determined using Atomic Absorption Spectrophotometer A-Analyst 200. The determined concentration of the heavy metals in the dumpsite soil and vegetable samples were compared with those of the soil and vegetable from ten control sites. The concentration of the heavy metals in the dumpsite soil samples ranged from 9.57 mg/kg and 62.02 mg.kg for copper, 31.28 mg/kg and 88.44 mg/kg for cadmium, 15.60 mg/kg and 88.44 mg/kg for chromium, 15.60 mg/kg and 316.00 mg/kg for lead, 9.63 mg/kg and 71.14 mg/kg for iron and 1.02 mg/kg for zinc.

The concentration of metals in the control samples ranged from 3.79 to 30.75 mg/kg for copper, 3.70 to 239.70 mg/kg for lead, 18.82 to 52.48 mg/kg for chromium, 28.12 to 60.75 mg/kg for iron and 2.84 to 10.07 mg/kg for zinc. While the concentration of metals in the vegetable samples ranged from 10.20 to 44.10 mg/kg for Cu, 2.90 to 150.00 mg/kg for iron and 8.35 to 64.49 mg/kg for zinc. The concentration of metals in the control vegetable samples ranged from 8.80 to 15.70mg/kg for copper, 40.80 to 95.30 mg/kg for chromium, 10.00 to 52.00 mg/kg for lead, 26.20 to 67.10 mg/kg for iron and 5.93 to 33.24 mg/kg for zinc. The F-test conducted at 95 % confidence levels shows a significant difference in the concentration of copper, chromium, iron, lead and zinc between the samples and the controls.

The determination of some heavy metals in Dumpsites soil and *Abiomochus esculentus* fruit grown near dumpsites in Kafanchan Metropolis, Kaduna State was reported (Shemang, 2016). In this study, the seasonal variations in concentrations of cadmium, chromium, copper, nickel, and lead in soil and *Abelmochus esculentus* fruit grown near five (5) dumpsites in Kafanchan Metropolis, Nigeria were investigated using Atomic Absorption Spectrophotometry. The dumpsite soils and control sites were sandy loam in nature and alkaline in the wet season. The Cation Exchange Capacity (CEC), soil particles size distribution, pH, nitrogen, phosphorous, and organic matter had higher values in the dry season compared to the wet. The mean levels of cadmium in the dumpsite soils in the wet season was 21.86 – 58.27 mg/kg, copper 41.33 – 81.21 mg/kg, chromium 25.86 mg/kg, nickel 31.44 – 77.44 mg/kg, lead 23.62 – 56.63 mg/kg, while in the dry season, the ranges were cadmium 11.38 – 30.67 mg/kg, copper 106.52 – 158.42 mg/kg, nickel 52.09 – 119.69 mg/kg, lead 94.19 – 308.35 mg/kg and zinc 98.48 – 332.83 mg/kg. The concentration of the heavy metals studied increased from wet to dry season at most dumpsites. The speciation of the soil indicated higher concentration of heavy metals in the residual fractions (wet season 3.18 – 24.03 mg/kg; dry season 4.08 – 132.37 mg/kg); while the water-soluble fractions had at least concentrations (wet season 0.55 – 17.35 mg/kg; dry season 26 – 82 %) had higher percentage than the residual (wet season 5 – 6 %; dry season 18 – 74 %). The concentration of the heavy metals in the dumpsite soils were at levels above the Federal Environmental Protection Agency (FEPA, 1991) and European Commission (1986) maximum tolerable limits for these heavy metals in soils with few exceptions. The soil pollution load index in the wet season was 1.95 and 1.73 in dry: contamination factor was 0.90 – 4.55 in the wet season and 0.59 – 5.78 in the dry season, while the Geo-Accumulation Index (wet season: 0.51 – 1.11; dry season: 0.92 – 1.35), showed that the soils of the dumpsites were polluted with the heavy metals studied.

Heavy metals content in soil and plants at dumpsites: A Case Study of Awotan and Aja kanga Dumpsite, Ibadan, Oyo State, Nigeria was evaluated (Hammed *et al.,* 2017). This study investigated the heavy metals content in soils and plants at Awotan and Aja kanga dumpsites in Ibadan with particular reference to physiochemical and heavy metal levels of the underlying soils. The relationship between the dumpsite soil metal content and rate of bioaccumulation by plants. A systematic sampling of twelve (12) soils sample (four per site) of twenty (20m) interval and forty-eight (48) dominant plants/vegetable species were collected, uprooted from sample plot from Awotan and Aja kanga dumpsites and Ide-Ose farm land area which serves as control site of 20m. The soil samples were collected at each plot using clean stainless-steel shovel at a depth of 0 – 30 cm. The level of heavy metals (arsenic, cadmium, cobalt, copper, iron, nickel, lead and zinc) in soil plants and vegetables from dumpsites and control site were determined using Atomic Absorption Spectrophotometric (AAS) method. The Transfer Factor (TF) revealed that plants grown on dumpsite soils accumulated higher metal concentration than their counterpart obtained from normal agricultural soil (control site).

Generally, the result showed that there was an increase in the concentration of heavy metals in the two dump sites than of the soils at the control site; the heavy metal (Fe and Zinc) contents in plants were higher at the two

(2) dumpsites than control sites; while the concentration of lead and cadmium in plants were higher at the dumpsites than control sites. 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 concentration of heavy metals which are later absorbed and accumulated by the plants growing within such sites.

Heavy metals pollution at Municipal Solid Waste Dumpsties in Kano and Kaduna States in Nigeria was evaluated (Anake *et al.*, 2009). Soil samples collected from two major dumpsites each in Kano and Kaduna states were investigated for heavy metals pollution. Each of the dumpsites was divided into North, South, East and West. Four soil samples from reserve areas within the same geographical locations at the dumpsites were collected as control. Acid-extractable cadmium, chromium, nickel and lead were determined using 2 m nitric acid solution and Atomic Absorption Spectroscopy. The ranges of cadmium, chromium, nickel and lead levels for all the dumpsites were 0.30 - 49.8, 5.76 – 139, 0.39 – 19.1 and 42.6 – 9662 mg/kg respectively. Kano dumpsite 2 was found to pollute most cadmium, chromium and lead in 50 – 100 % soil samples collected having concentrations higher than the threshold limits set by regulatory body. Paper and food scraps showed higher percentage in both Kano and Kaduna dumpsites. The soil was high in sand for all the dumpsites implying high reaching potentials of the heavy metals pollutants.

Heavy Metals Contamination of Foods by Refuse Dumpsites in Awka, Sout-Eastern Nigeria was reported (Nduka *et al.*, 2008). The impact of heavy metals from refuse dumps on soil, food, and water qualities in Awka, Nigeria was studied. Soil samples (top and 1.35 m deep) were collected from five refuse dumps, digested with concentrated HNO_3 and $HClO_4$. The heavy metals (lead, manganese, arsenic, chromium, cadmium and nickel), in vegetables (spinach, fluted pumpkin), root crop (cocoyam) and surface ground water were determined using Atomic Absorption Spectrophotometery (AAS). Chemical properties of the soil and bacteria were determined. Heavy metals were found to be more concentrated at a depth of 1.35 m. Manganese was high in shallow wells and borehole water samples with the highest levels as 0.538 and 0.325 mg/l respectively. Nickel levels in the borehole sample ranged from 0.001 – 0.227 mg/l; whereas the highest level of lead was 0.01 mg/l. the Obibia Stream had the highest levels of manganese and lead. Linear regression analyses showed that he relationship between soil heavy metals and farm produce. Heavy metals were strong; taken together. We may conclude that the consumption of leafy vegetables and crops produced on contaminated soils may pose a health risk to those that reside around the refuse dumps.

The Effects of Solid Waste on the Quality of Soil in Ugwuaji Dumpsite (Ezeoha Uchenna, 2009) was evaluated. This study examined the heavy metal concentration in the study sample. Six heavy metal considered to be hazardous to human and environmental health were chosen for analysis. These include lead, cadmium, copper, iron, manganese and nickel. The six elements were analyzed in soil samples using Atomic Absorption Spectrophotometer (AAS) machine at Elochem Scientific Laboratory. Targeted sampling method was used in the collection of the soil samples from the dumpsites. The sampling depth was about 170 – 200 m deep into the ground.

The study revealed that the soil is heavily contaminated with lead (Pb), cadmium (Cd), copper (Cu), iron (Fe), manganese (Mn) and nickel (Ni) with Contamination Factor as 16.26, 25.06, 270.5, 245.25, and 1.20 respectively. These heavy metals are very high from the waste dump when compared with NESREA heavy metal threshold limit. Further findings in the study revealed that heavy metals pollutants in *Ugwuaji* decreases as the distance increased.

Assessment of Physico-chemical Properties and Heavy Metals Bioavailability in Dumpsites along Enugu-Port Harcourt Expressway, South-East, Nigeria was evaluated (Obasi *et al.*, 2012). Bioavailability of heavy metals (copper, cadmium, manganese, lead, zinc, iron, nickel and chromium) in refuse waste soils of some dumpsites along Enugu-Port Harcourt expressways, South-East, Nigeria were investigated and compared with control soils from the same terrain using standard analytical methods. Results showed significant ($p > 0.05$) higher changes in the soil physico-chemical properties relative to the controls; thus, implicating the waste soils to be more fertile. The mean total extractable metals in the samples analyzed for cadmium, copper, manganese, lead, zinc, iron, nickel, and chromium ranged from 23.41 – 107.18, 10.58 – 238.50, 141.21 – 442.03, 35.11 – 635.31, 186.38 –

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505.57, 76.46 – 371.73, 13.00 – 221.97, and 13.55 – 26.77 mg/kg dry weight respectively. Cadmium followed by iron and then lead were mostly found to be in the mobile phase of sample indicating that the metals were potentially more bio-available to the environment than the other metals studied. Overall, the order of mobility and bioavailability of the metals was Cd > Fe > Pb > Mn > Zn > Cr > Ni > Cu.

Environmental Fate of Heavy Metals in Soil of Ido-Osun Waste Dumpsite, Osogbo, Osun, Nigeria was studied (Olayiwola *et al.*, 2015). Waste if not properly managed can cause severe complications within the ecosystem. Farmers used soil from dumpsites without regards for health implications the heavy metal contents of such soil type may pose. The levels of these heavy metals need to be ascertained to know their fate; five heavy metals (chromium, nickel, zinc, lead and copper) were analyzed for their levels in soil at four different directions (east, west, north and south) by wet digestion spectrophotometrically. The levels of heavy metals in the soil were: zinc (1133 ± 897 mg/kg), nickel (26.3 ± 51.1 mg/kg), copper (110 ± 90 mg/kg), lead (137 ± 64 mg/kg) and chromium (3.63 ± 2.46 mg/kg). Concentrations in sampling sites were higher than soils from background with factors of 67 (zinc), 18 (copper) and 20 (lead). Index of geo-accumulation revealed soil to be moderately to strongly polluted with zinc, copper, and lead; inter-element correlation ranged 0.90 – 0.99. Nearby farmlands are exposed to these heavy metals; surface water near the site will not be usable for irrigation and other categories of water usages. Wastes from the dumpsite can be reduced, reused and recycled.

Open Dumping of Municipal Solid Waste and its Hazardous Impacts on Soil and Vegetation Diversity at Waste Dumping Sites of Islamabad City was evaluated (Syedamaria, 2014). Deteriorating soil quality and decrease in vegetation abundance are grave consequences of open waste dumping which have resulted in growing public concern. The focus of this study is to assess the contribution of open waste dumping in soil contamination and its effect on plant diversity in one of the renowned green cities of Pakistan. Surface soil samples (n = 12 ± 12) were collected from both the open waste dumping areas allocated by Capital Development Authority (CDA) and sub-sectors of H-belt of Islamabad City (representative of the control site). The diversity of vegetation was studied at both sampling sites, significant modifications were observed in the soil properties of the dumping sites. Soil at the disposal sites showed high pH, TDS and EC regime in comparison to control sites. Various heavy metals concentrations, that is, lead (Pb), copper (Cu), Nickel (Ni), chromium (Cr) and zinc (Zn) were also found to be higher at the dumping sites except for cadmium (Cd) which had a higher value in site. A similar trend was observed in plant diversity; control sites showed diversified variety of plants, i.e. 44 plant species at the disposal sites. This is attributed to changes in soil characteristics at disposal sites and in its vicinity areas.

Heavy Metals Content in Soil Reclaimed from a Municipal Solid Waste Landfill was carried out (Jain *et al.*, 2005). Residues reclaimed from a Municipal Solid Waste (MSW) land fill were characterized for the concentrations of a number of heavy metals. The residue fractions analyzed included a fine fraction (< 0.425 mm), an intermediate fraction (> 0.425 mm and < 6.3 mm) and a fraction consisting of paper products that could ultimately degrade to a smaller size. The intermediate fraction appeared to be organic in nature, while the fine fraction was more soil-like. In general, the metal concentrations were greatest in the intermediate fraction and lowest in the fine fraction. The effect of sample age on the elemental content was also investigated. The concentrations of several elements were greater in older samples (samples approximately 3 years in age). Limitations associated with the land application of residual soil (composed of the fine and intermediate fractions) were assessed by comparing measured concentrations to regulatory threshold values.

In general, most metal concentrations were below regulatory thresholds for use in unrestricted settings. At the concentrations measured however, several elements might limit reuse options, depending on which regulatory threshold serves as a benchmark. Elevated concentrations of arsenic presented the greatest limitation with respect to common US thresholds while elevated cadmium concentrations presented the greatest limitation when compared to UK thresholds. The source of the arsenic was determined to be the waste, not the cover soils.

Assessment of Heavy Metal Species in some Decomposed Municipal Solid Wastes in Bida, Niger State, Nigeria was evaluated (Idris *et al.*, 2012). Soil samples collected from three decomposed municipal solid waste dumpsites located in Esso, Gbangbara and Eyagi areas of Bida town were analyzed for some heavy metals (copper, iron, manganese and chromium) using Atomic Absorption Spectrophotometry. The analysis of the *aqua* *regia* digestion showed an average mean concentration (mg/kg) of Cu (342.22 ± 7.6), Mn (570.00 ± 1.0) and Fe (371.11 ± 1.2) in the three dumpsites were exceptionally high.

The analysis of the weak sodium acetate solution digestion showed that Cu (5.47 ± 0.2), Mn (1.88 ± 0.0), and Fe (1.47 ± 0.1) exhibited high concentrations in the dumpsites. Most of the copper, manganese and iron were found to be associated with the exchangeable fraction, which is very soluble and mobile. Based on the Federal Environmental Protection Agency and Land Disposal Restrictions Standard Regulations, these metals exhibited hazardous concentrations.

Heavy Metals Pollution of Soil around Solid Waste Dump Sites and its Impact on Adjacent Community: the Case of Shashemane Open Landfill, Ethiopia was reported (Getachew Demie and Habtamu, 2015). The study was aimed at determining the status of heavy metal pollution of soil around open landfill of Shashemane city and its potential impact on environment and local community. Accordingly, forty soil samples (among which four were control samples) and one leachates sample was collected using two-meter circular diameter. The collected soil sample were allowed to dry under normal temperature within soil sample preparation room of Wondo Genet College of Forestry and Natural resources. The analysis of heavy metals was conducted at Hawassa University, Chemistry laboratory suing Atomic Absorption Spectrophotometry. The results indicated that he concentration of manganese, cadmium, cobalt, chromium, nickel and lead were 0.88, 0.08, 0.06, 0.29, 0.08 and 0.08 mg/kg respectively within the study areas. These levels of concentrations varied across soil sampling depth among sampling points. It was also varied between control, leachate and soil samples. Based on their contamination and degree of contamination, this also showed that the area was considerably polluted and deteriorated in terms of its quality.

Kanmani *et al.*, (2012) reported the assessment of heavy metals contamination in soil due to leachate migration from an open dump site. The concentration of heavy metals was studied in the soil samples collected around the Municipal Solid Waste (MSW) open dumpsites, Ariyamangalam, Tiruchirappali, Tamilnadu to understand the heavy metal contamination due to leachate migration from an open dumping site. The dumpsite receives approximately 400 – 470 tonnes of municipal solid waste.

Solid waste characterization was carried out for fresh and old municipal waste which is dumped in the dumping site. The heavy metal concentrations in the municipal solid waste find fraction and soil samples were analyzed. The heavy metal concentration in the collected soil sample was found in the following order: Mn > Pb > Cd. The presence of heavy metals in soil samples indicated that there is appreciable contamination of the soil by leachate migration from an open dumping site. However, these pollutants species will continuously migrate and attenuate through the soil strata and after certain period of time they might contaminate the ground water system if there is no action to prevent this phenomenon.

MATERIALS AND METHODS

In the preparation of the solutions, chemicals of analytical reagent grade purity and distilled water were used. All the glass and plastic wares used in the research work were washed with detergent solution repeatedly rinsed with water and the solution to be used in them.

Reagents

Distilled water, Concentrated $HClO_4$ and Concentrated HNO_3 in the ratio of ratios (1:2) and HCl

Sampling of Soil Samples

Soil samples were collected from three different dumpsites at Rafin Zurfi on 13th September, 2017. The areas are ATIL Guest Inn, Benco and ECWA respectively.

Sampling Technique

Surface soil sample after removing the overlying waste was collected randomly four different dump site at 0 –

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20 cm depth and homogenized. Another set of samples were collected at the same depths from uncultivated land that is uncontaminated area at 100 m away from the dumpsite to serve as control. Soil samples were collected round a particular refuse dump and blended (mixed) to obtain a representative sample. These samples were obtained using hoe for digging, trowel for fetching and the meter rule for measurement. The samples collected were packaged in polyethylene bags and taken to the laboratory for preparation and analysis.

Sample Preparation

The wet soils were air-dried by spreading on sheets of papers for 72 hours. Samples were mixed frequently to expose fresh surface to dryness. The samples were ground and sieved through a 2 mm mesh sieve and the coarse particles discarded. The powdered form were then stored for digestion and subsequent analysis.

Sample Digestion

A 0.20 g of the ground and sieved soil sample was weighed into an empty clean conical flask and digested using 10 cm^3 of $HClO_4$ and HNO_3 in a ratio of 1:2. The conical flask and its content were heated on a hot plate in a fume cupboard until a clear solution was formed (Breder, 1982).The flask and its content was allowed to cool and 1.00 cm^3 of concentrated HCl acid was added and heated until a clear solution was formed. The flask and its content was allowed to cool and 20 cm^3 of water was added to the digest residue and filtered using Whatman filter paper number 1 into a 100 cm^3 volumetric flask and made to volume with water. The sample solution was then transferred into a screw capped polyethylene bottle. The solution was analyzed for heavy metals at their respective wavelengths using Buck Scientific Atomic Absorption Spectrophotometer Model 210. The same procedure was repeated for all the other samples.

RESULT AND DISCUSSION

Result

The levels of some heavy metals determined in refused dumpsite and no refuse dumpsite of Rafin Zurfi, Bauchi are shown in table 4.1.

Table 4.1: Concentration of some heavy Metals (mg/kg) in test samples and controls gotten Rafin Zurfis

	Sample	Control
Cadmium	0.0950 $\pm$ 0.2632	0.0050 $\pm$ 3.2000
Manganese	27. 7050 $\pm$ 0.0249	6.5400 $\pm$ 0.0749
Chromium	2.9250 $\pm$ 0.1658	3.4850 $\pm$ 0.2500
Lead	1.1300 $\pm$ 0.2212	1.2000 $\pm$ 0.2500
Zinc	0.0000 $\pm$ 0.0000	9.4600 $\pm$ 0.0396

Values are mean ± relative standard deviation (n=4)

DISCUSSION OF RESULTS

Table 1 shows the mean concentrations of some heavy metals analyzed in soil samples from Rafin zurfi and control site.

The mean level of cadmium at the dump sites is found to be 0.0950 $\pm$ 0.2632 mg/kg and control site 0.0050 $\pm$ 3.200 mg/kg the values of the metal concentration obtained from both sites are all far below the calculated world soil average of 0.41 mg/kg (Kabata-pendias, 2011). This is in agreement with the findings of Asawalam and Eze (2006) and Njoku and Ayoka (2007) who investigated the trace metals concentrations and heavy metals pollutions from dump soils in Owerri, Nigeria. Even through these heavy metals concentration fell below the critical permissible concentration level it seems that their persistence in the soils of the dump site may leads to increased uptake of these heavy metals by plant .

Manganese is among the abundant elements in the earth is crusts and is widely distributed in soils, sediments, rocks and water (Shrivastavak and Mishrasp, 2011) manganese analysis gave mean values of 27.7050 $\pm$ 0.0294 mg/kg and the control site gave (6.5400 $\pm$ 0.0749 mg/kg) in comparison with the control sample indicated that manganese concentration in the study are four times higher them manganese content in the control soil: sources of manganese include metal alloy, batteries, glass and ceramic materials. The higher value in the dumpsite may be attributed to these sources.

The mean concentration of chromium at the dumpsite is 2.9250 $\pm$ 0.1658 mg/kg. Although the values were below the world soil average 59.50 mg/kg (Kabata-pendias, 2011) which is slightly lower than the control (3.4850 $\pm$ 1.908 mg/kg) this can be attributed to the dumpsite carrying waste of low chromium concentration. or There may have been less human activities capable of generating chromium and the main sources of chromium are industrial activities such as metal plating, anodizing dyes, pigment, ceramics, glues, tanning, wood preserving and textiles (Alloway, 1995) which may not be present in a residential area, making the concentration of chromium lower in the dumpsite.

The mean level of lead in soil sample from the dumpsite is 1.13 $\pm$ 0.2212 mg/kg and 1.200 $\pm$ 0.25 mg/kg in the control. The observed values are lower than the calculated world average of unpolluted soils 27.00 mg/kg (Kabata-pendias, 2011). This is in agreement with the result obtained from similar study by Uman and Etim (2013) for soils from dumpsites within Ikot-Ekpene in Akwa Ibom state Nigeria concentration of lead in soil samples could be as a result of it sources from automobile, exhaust fumes, dry cell, run off of wastes, etc.

In comparison with the control, the soil sample from the dumpsite is slightly lower than the control. This is because lead is an anthropogenic metal and without external interference are normally not abundant in upper layer soil (A1-Turki and Helal, 2004; Ren *et al.*, 2005) lead may not be present in the depth of (0 – 20 cm). It could also be as a result of waste carrying less concentration of lead.

The mean level of zinc in the soil sample from dumpsite is 0.0000 $\pm$ 0.000 mg/kg and 9.4600 $\pm$ 0.0396 mg/kg from the control, the observed values shows that zinc is completely absent in the dumpsite. This is in line with (A1-Turki and Helal, 2004; Ren *et al.*, 2005) zinc contamination is as a result of anthropogenic effect and without external interference are normally not abundant in upper layer soil and also in line with Yahaya (2009) which confirmed that the concentration of heavy metals in soil is higher in dry season than in wet season because of more heavy metals loss due to run off and infiltration in wet season. And the sources of zinc such as mechanical abrasion of vehicles, brake linings, oil leak sumps and cylinder head gasket (Jiries *et al.*, 2001) and also vehicle emission and tyre and brake abrasion (Imperato *et al.*, 2003) probably was not present in the dump site.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

The study investigates the levels of heavy metals in waste dumpsites in Rafin Zurfi Bauchi State Nigeria. The result indicates that the dumpsite area was shown to have concentration of heavy metals, though one of the metal was not detected in the dumpsite. It was observed that the metals have higher concentration than others and this could be attributed to the presence of waste carrying heavy amount of these heavy metals. Other side has low concentration of these heavy metals. This may be as a result of less contamination with those metals due to human activities. The implication of the metal that was not detected is that the concentration of this metal is below detection limit or not presence at all. These heavy metals have concentration below the allowable limit as a result may not appear to pose a very serious environmental problems at the moment therefore there is cause for some concern as continuous accumulation in the levels of heavy metals may occur with time and may result in health challenges.

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Conclusion

The concentration of metals (cadmium, manganese, chromium, lead and zinc) are all far below the world soil average for agricultural soil. The study revealed significant differences in the concentration of heavy metals in soil units at the dump sites and the control the variation of these heavy metals in the dump site were in the following trend: Mn > Cr > Pb > Cd > Zn and for the control: Zn > Mn > Cr > Pb > Cd. The low levels of heavy metals in the studied soil samples are consistent with the waste generated in Rafin Zurfi environs. The result also shows that the soil is not polluted by various pollutants and not harmful for recreational and agricultural purposes. It is therefore suggested that the dump site and control area with their adequate soil nutrients and can be converted to an agricultural farmland. No remediation is needed at this time.

Recommendations

The following recommendations are made based on the findings:

1. The background values as defined here is the concentrations of the elements in control site free from contaminations usually loom away from the dumpsite. A separate control site should be located for each dump site; when the dumpsite are in different areas, taking control samples from the same crustal base as the dumpsite ensures that both the dump site and control site poses similar lithogenic-based concentration of the elements. This will help in differentiating contaminations associated with anthropogenic (human) activities from elemental concentrations based on lithogenic (natural) inputs.
2. Waste sorting policy should be introduced at point source to separate waste as degradable and non-degradable; while degradable domestic wastes can be used as manure in farm land, Revitalization and support of waste recycling and reuse at the waste dump is important.
3. Periodic soil evaluation and treatment especially before planting to help ridit of the contamination by solid waste should be considered.
4. There is need for community policing and vigilance in Rafin Zurfi to help check indiscriminate dumping of wastes in the site. If this recommendation is considered, pollution of soil and contamination by heavy metals would be reduced significantly.

CERTIFICATION

This is to certify that the project titled “Levels of heavy metals in refuse dumpsites of Rafin Zurfi Bauchi State” was carried out by Diana Anthony with registration number 12/29199/U/1 was duly supervised and approved by Dr. U.F. Hassan having met the requirements for the award of the degree of Bachelor of Technology B.Tech (Hons) in Industrial Chemistry.

Dr. U. F. Hassan Date

(Project Supervisor) Date

Internal Examiner

External Examiner Date

Dr. A. M. Kolo Date

Head of Department

Dedication

I dedicate this project work to God Almighty who has been My strength throughout My degree programme, may His name be praised. Also, to My late Father Mr. Anthony Bulus Kyom and My lovely Mother, Mrs. Kyom (JP) and My Siblings; Samuel, Anita, Charis and Henrietta.

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