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Assessment of Some Heavy Metals in Leafy Vegetables Grown in the Vicinity of Dump Site along River Benue, Mubi Road, Yola, Nigeria

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Abstract:
The quality of vegetables grown in the vicinity of dumpsite along river Benue basin Yola Adamawa state was investigated to determine the effect of the wastes. A total of twenty samples were studied, from each of vegetable, soil and water at different distances 50, 100 and 200m from the dumpsite. Heavy metals concentration examined were found in the following order: Zn>Cu>Cr>Cd>Pb>As. The same order of heavy metals content was found in vegetables and water with slight change in the sequences of the position of Pb and Cr. In the other hand Zn, Cu and Cr was found to decrease with increase in the sampling distance and were also found to be significantly different from each sampling distance at 0.05% significance. Pb, Cd & As, shows slight irregularities and negligible value. The relatively higher level of metals observed in the dump site vegetables compared with the control vegetables show that refuse dump contribute to the metallic levels in the study site. Although the values obtained in the vegetables tissues are not significantly higher to national and international Standards.

1. Introduction

Vegetables are part of daily diets in many households forming an important source of vitamins and minerals required for human health. They are made up of chiefly cellulose, hemi-cellulose and pectin substances that give them their texture and firmness (Arai, 2002) Consumers' demand for better quality vegetables is increasing because; the role of vegetables in nutrition and healthy diets is well recognized. The perceptions of what is regarded as 'better quality' are however subjective, some consumers consider undamaged, dark green and big leaves as characteristics of good quality leafy vegetables. However, the external morphology of vegetables cannot guarantee safety from contaminants. These plants contain both essential and toxic metals over a wide range of concentrations. It is well known that plants take up water, nutrient, and that could include contaminating minerals by absorbing them from environment as well as from deposits on parts of the plants exposed to the air unwholesome (Mapanda *et al.*, 2005) Vegetable plants growing on contaminated soil/water could accumulate high concentrations of non-nutrient trace elements that could result to serious health risk to consumers (Sharma *et al.,* 2007). Excessive content of Pb and Cd in food is associated with etiology of a number of diseases especially with cardiovascular, kidney, nervous as well as bone diseases (Jarup, 2003). Since the dietary intake of food may constitute a major source of long-term low-level body accumulation of heavy metals, the detrimental impact becomes apparent only after several years of exposure. Regular monitoring of these heavy metals from effluents, dump site, sewage, in vegetables and in other food materials is essential for preventing excessive buildup of the metals in the food chain. Heavy metal depositions are associated with a wide range of sources such as small scale industries (including battery production, metal products, metal smelting & Cable coating industries); brick kilns; vehicular emissions; garbage dump sites, re-suspended road dust, diesel generator sets, tanneries, dry-cleaners, and beauty salons. These can all be important contributors to the contamination found in vegetables. Additional potential sources of heavy metals in field locations in urban and per urban areas include irrigation water contaminated by industrial effluent leading to contaminated soils and ultimately the plants that grow in such area and livestock that feed there also.

The aim of this paper is to determine a effect of refuse waste to Heavy metal contamination in fresh leafy vegetables grown in the vicinity of the dump site through assessing the type and nature of waste at the dump site, the volume or quantity of the dump, and finally determine the concentration of selected heavy metals in fresh vegetables (lettuce, spinach and sorrel), soil and water.

2. Study Area

Yola is the capital city and the administrative center of Adamawa State Nigeria. Located on the Benue river, it has a population of 336,648 (2010). With coordinates 9°13'48"N 12°27'36"E/ 9,23000°N 12,46000°E and its elevation is 1,965ft. above sea level (599m) The specific site in river Benue bank in Yola bye pass where variety of vegetables are cultivated and it is chosen because the area is currently undergoing severe degradation resulting from municipal waste disposal.

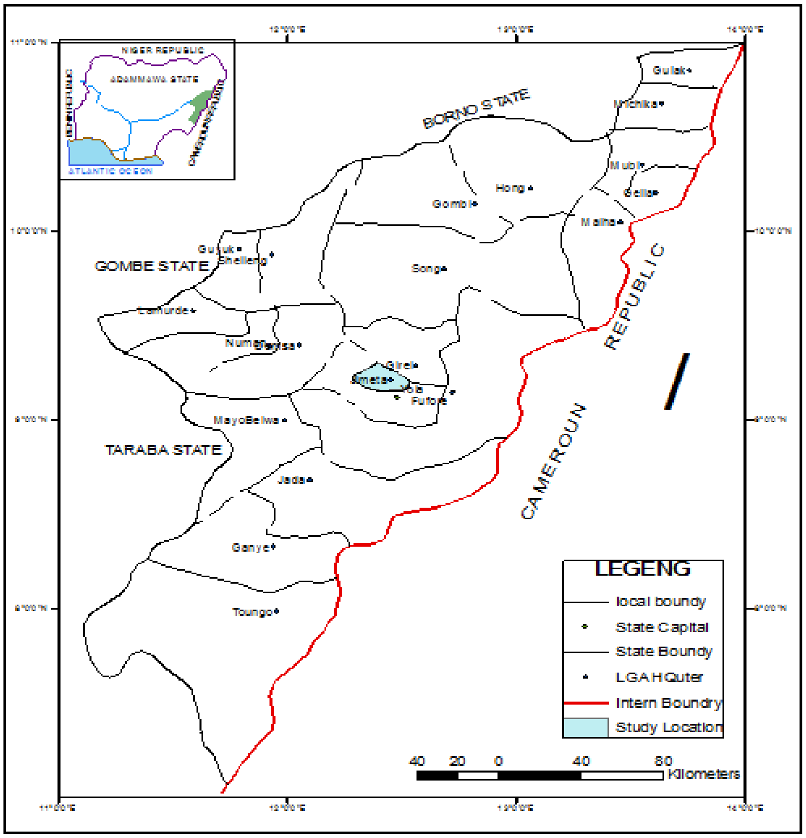

Figure 1: Map Adamawa State Showing the Study Location
Source: Geography department MAUTECH

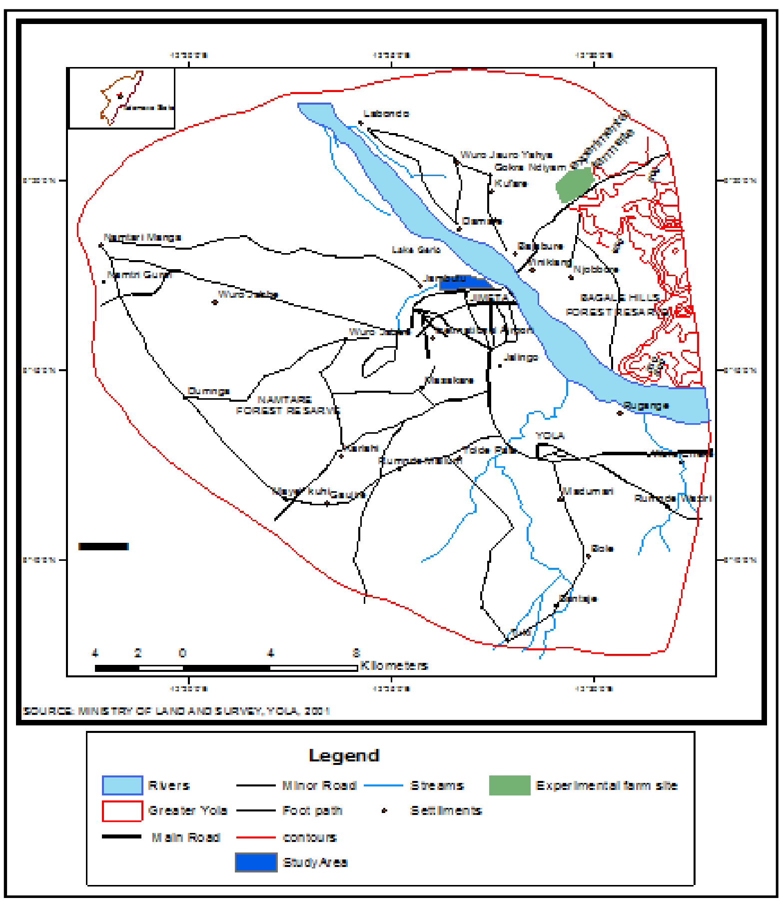

Figure 2: Map of Jimeta Showing the Study Area

2.1. Source of Materials

Representative samples of vegetables, water and soil were obtained from the study site along the River Benue Basin, shinko site. Instruments, tools and general laboratory glass wares were obtained from Food science and Technology laboratory Mautech, Yola and Chemistry Laboratory ATBU Bauchi.

2.2. Sampling Procedure

Three (3) popular vegetables namely Lettuce, Sorrel and spinach with their associated soil, water was taken at a distance of 50 meters, 100 meters, 200 meters from the edge of the selected area. Reference vegetable sample was taken from a farm in Loko song L.G.A where refuge is not close by. All the Soil samples was collected from the upper soil layer of 0-5cm to the laboratory for analysis.

2.3. Study Design

The research was carried out in two phases; the first phase was preliminary investigations involving the history of the dumping site, the variety of materials dumped at that site and the estimate of the size or volume of the dump.

The second phase was the analytical process which involves the sample collection, preparation and laboratory work.

2.4. Preliminary Investigation of the Refuse Dump

The information was collected through interviews, field survey measurements, direct observation of the type and nature of waste, as well assess the volume of the dump site and then evaluate the role of government and community in managing the site.

2.5. Analytical Methods

The concentration of the selected heavy metals was determined in vegetables, water and soil samples. The analytes was extracted in to acid solution and analyzed by Atomic Absorption spectrometer (A A S) and the results were compared with the control samples to establish a case.

2.6. Experimental Design

Figure 3 is a 5x4 factorial design for the study of the concentration of some selected heavy metals in soil samples, leafy vegetables and water used in irrigation.

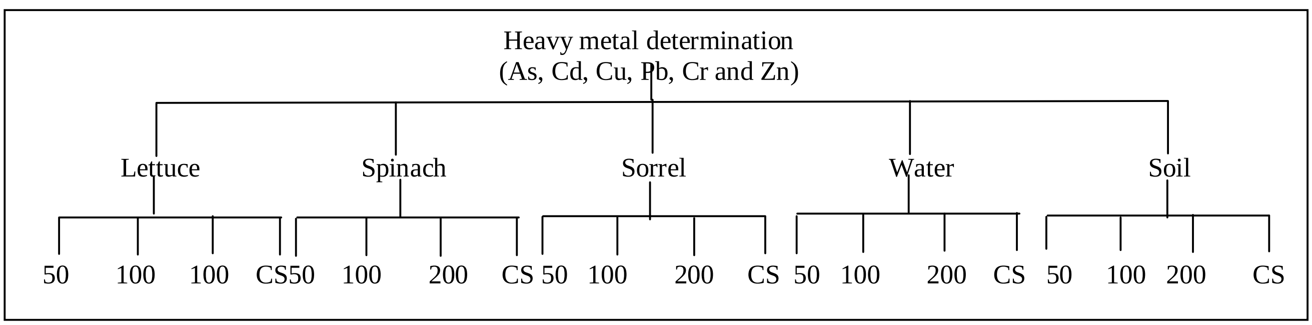

Figure 3

All distances in meters, CS =control sample

2.7. Photos Showing Figures of the vegetables under Study

Figure 4: Lettuce (Leutuca sativa)

Figure 5: Spinach (amaranthus chlorostachy)

Figure 6:Sorrel (Hibiscus sabdariffa)

2.8. Digestion of Samples

Soiland vegetables samples (1g) were digested after adding 15ml of tri-acid mixture (HNO_3, H_2SO_4, and HCL_4 in 5:1:1 ratio) at 80^{o}C until a transparent solution was obtained as described by Allen *et al.*, (1986). After cooling, the digested sample was filtered using Whatman No.42 filter paper and the filtrate was finally maintained to 50 ml with distilled water.

The irrigation water sample(50ml) was digested with 10ml of concentrated HNO_3 at $80^{O}C$ until the solution becomes transparent as reported by APHA, (2005). The solution was filtered through Whatman No.42 filter paper and the total volume was maintained to 50ml with distilled water.

2.9. Analysis of Heavy Metals

Concentration of Cd, Cu, Pb, Zn Cr and As in the filtrate of digested soil, water and vegetables samples were estimated by using an atomic absorption spectrophotometer (model 2380, Perkin Elmer.inc., Norwalk, CT. USA). The instrument was fitted with specific lamp of particular metal. The instrument was calibrated using manually prepared standard solution of respective heavy metals as well as drift blanks. Standard stock solutions of 1000ppm for all the metals were obtained from Sisco Research Laboratories Pvt. Ltd., India. These solutions were diluted for desired concentrations to calibrate the instrument. Acetylene gas was used as the fuel and air as the support. An oxidizing flame was used in all cases.

2.10. Statistical Analysis

The heavy metal data were analyzed by analysis of variance (ANOVA) and the Duncan multiple range test was used to compare differences among means at the 0.05 level ($p \leq 0.05$) of significant. SPSS version 20 statistical software was used for this analysis.

3. Results

The information on the existence and management of the dump site was obtained through interviews with the major stakeholders. It has been reported that vegetable farming started over one hundred years ago. Initially, there was no refuse dumping at the site but, with urbanization and population growth refuse dumping come in to existence. Actually, it started not long ago it was after the bridge construction around 1986. Farmers cultivate cassava in the inner part of the flood plain and vegetables by the road site.

The site has been managed by the Local Government since inception even though it has been declared an illegal dump site due to unsanitary methods of refuse disposal. Now, the site has been registered as legal refuse dump Government, dresses the refuse dump and according to the supervisor monthly evacuation and dressing is done.

3.1. The Volume or Quantity of the Refuse Dump

The volume or quantity of the dump was estimated by the number of tonnes evacuated monthly. The truck takes nine (9) tonnes per trip and for total evacuation, its normally takes thirty (30) trips monthly therefore, refuge generation at that dump site monthly is estimated to be about 270 tones (9x30) and in a year is about 3240 tones (9x30x12). The dressing may sometime reach two months and in that situation, the number of tones may be more than 270 tones. It is observed that the dump is sometimes burnt which pollute the surrounding with smoke and the place has an offensive odor during rainy season.

3.2. Type and Nature of Waste in the Dump Site

The type or nature of the refuse dump materials have been classified in to two bases on their organic and inorganic nature

Organic material from the refuse	**Description of materials**
Paper and Cardboard	Office and colored paper, construction paper, tissue and toilet paper, newspapers, magazines, paperboard, corrugated cardboard, waxed papers
Other Putrescible	Leaves, twigs, flowers, soil, dead animals, fecal matter, ashes, hair
Foods	All whole foods and peels, but not bones
Wood, Bones, and Straw	Lumber, matchsticks, firewood, furniture legs, hay and broom straws, bones cooked, raw bones
Leather Textiles	Shoe upper, belts, cured leather Fabrics, clothing, shoe uppers, cotton, upholstery, cords, ropes
Cigarette Butts	Filters probably composed of cellulose acetate, a form of plastic

Table 1: Organic material in the refuse dump

Inorganic material from the refuse	**Description of materials**
Metals	Ferrous and non-ferrous materials, including iron, steel, tin cans and foil, copper, brass, lead, aluminum, batteries
Glass and ceramics Plastics Rubber Rocks	Clear glass, colored glass, ceramic, china All grades of plastic bags, all types of hard and soft plastics Scrap tires, shoe soles, engine belts, gaskets Rocks, asbestos, tiles
Diapers	Disposable diapers made of fluff pulp, polypropylene, polyethylene, super absorbent polymer (SAP), elastics and adhesives.
Styrofoam	Extruded or expanded polystyrene foams

Table 2: Inorganic materials in the refuse dump

3.3. The Role of Government and Community in Managing the Dump Site

The Local Government under ideal circumstances is responsible for the management of refuse within its domain. Other tiers of government, NGO intervene in refuse management due to deficiencies identified in the waste management practices of the Local Government.

Government responsibility includes:-

i. The periodic schedules of Health education sessions on handling of waste, proper storage and disposal through workshop and seminars on how to keep their surrounding clean during and after sanitation days.
ii. The supplies of inputs or equipment for example big container skip vehicles for collection, proper storage and disposal of waste.
iii. Employment and training of the staff to manage the dump site through evacuation and dressing the dump site.
iv. Drafting refuse management policies, edits, bye-laws regulations and enforcing them with low enforcement agent's like police, NSCDC and other voluntary organizations.
v. Proper supervision of the dump site by government monitoring team.

3.4. Role of Community in Managing the Dumpsite

i. Proper collection and disposal of waste
ii. The involvement of none governmental organization and community work by the people around the dumpsite
iii. Restriction of children and animal in scavenging the refuse dump.
iv. Report to government any failure to evacuate the refuse dump
v. Prevent open defecation within the refuse dump site.
vi. Prevent burning activities in dump site to control environmental pollution.

Vegetables	Distances	Cr (mg/l)	Cd	Pb	Cu	As	Zn
Lettuce	50m	0.053±0.001[a]	0.007±0.001[a]	0.128±0.001[a]	0.263±0.001[a]	ND	2.300±0.017[a]
	100m	0.029±0.001[b]	0.005±0.002[a]	0.015±0.003[a]	0.260±0.001[a]	ND	1.900±0.023[b]
	200m	0.007±0.001[c]	0.005±0.001[a]	ND	0.257±0.001[a]	ND	1.700±0.011[b]
	Control	ND	0.006±0.005[a]	ND	0.074±0.003[b]	ND	ND
Spinach	50m	0.039±0.002[a]	0.010±0.002[a]	ND	0.760±0.001[a]	0.001±0.000[a]	2.800±0.029[a]
	100m	0.012±0.001[b]	0.008±0.002[a]	ND	0.418±0.002[b]	ND	1.700±0.001[b]
	200m	ND	0.005±0.002[a]	ND	0.328±0.001[c]	ND	1.200±0.001[b]
	Control	ND	0.007±0.002[a]	ND	0.034±0.001[d]	ND	ND
Sorrel	50m	0.060±0.002[a]	0.009±0.001[a]	ND	0.266±0.001[a]	0.007±0.001[a]	1.800±0.001[a]
	100m	ND	0.009±0.001[a]	ND	0.213±0.003[a]	ND	1.700±0.001[a]
	200m	ND	0.005±0.002[a]	ND	0.124±0.002[b]	ND	1.400±0.001[a]
	Control	0.018±0.002[b]	0.005±0.002[a]	0.012±0.002[a]	0.141±0.009[b]	ND	1.400±0.002[a]
Water	50m	0.053±0.004[a]	0.006±0.002[a]	0.005±0.002[a]	0.114±0.002[a]	0.011±0.002[a]	0.800±0.001[a]
	100m	0.011±0.002[b]	0.005±0.002[a]	ND	0.090±0.001[b]	ND	0.400±0.001[b]
	200m	0.007±0.001[b]	0.006±0.002[a]	ND	0.075±0.002[c]	ND	0.300±0.001[b]
	Control	ND	0.008±0.001[a]	ND	0.071±0.002[c]	ND	0.200±0.001[b]
Soil	50m	0.198±0.001[a]	0.023±0.001[a]	0.358±0.003[a]	1.670±0.002[a]	0.010±0.004[a]	5.600±0.020[a]
	100m	0.143±0.004[b]	0.021±0.002[a]	0.296±0.003[b]	1.423±0.003[b]	ND	5.400±0.020[a]
	200m	0.102±0.001[c]	0.008±0.002[b]	0.156±0.002[c]	0.822±0.001[c]	ND	5.000±0.010[a]
	Control	0.053±0.002[d]	0.005±0.002[b]	ND	0.244±0.002[d]	0.001±0.000[b]	1.600±0.001[b]

Table 3: Mean concentration of heavy metals in vegetables (lettuce, spinach and sorrel), soil (mg/kg) and water (mg/l)at dumpsite

ND= not detected

a, b, c, d = Means with different superscripts are significantly different from each other at ($P<0.05$). Means with the same superscripts are not significantly different from each other at ($P<0.05$)

4. Discussion of Result

Heavy metals concentration in the soil at the various distances from the refuse dump was found in the following order: Zn>Cu>Cr>Cd>Pb>As. The same order of heavy metals content was found in vegetables and water with slight change in the pattern of the position of Pb and Cr.

Zn, Cu and Cr was found to decrease with increase in the sampling distance and were also found to be significantly different from each sampling distance at 0.05% significance. Pb, Cd & As, shows slight irregularities and negligible values such that the A.A.S model was not able to detect it in some distances.

4.1. Chromium

In lettuce all the distance showed significant difference in chromium concentration at 0.05% significance. The control sample is below detectable limit of the instrument. Chromium concentration at 50m distance is (0.053mg/kg) and is the highest. This is because it is closer to the dumpsite soil and the road traffic as reported by (Habib *et al.*, 2012).

In spinach chromium concentration in 50m distance is (0.039mg/kg) which is the highest compared with the 100m distance that has 0.012mg/kg the 200m distance and the control samples were below detectable limit of the instrument. These results suggest that spinach has lower accumulation capacity of chromium than lettuce as reported by (Long *etal.,* 2003) that plant species vary in their capacity for heavy metal accumulation.
For sorrel only the 50m distance that has chromium concentration of 0.06mg/kg. The 100m and 200m distances were below detectable limit of the instrument.
Chromium concentration in water showed similar trend with that of lettuce this suggest that pollution of chromium is from the refuse dump not the irrigation water. The highest concentration was observed from the 50m distance 0.053mg/kg and lowest from the 200m distance0.007mg/kg chromium mean concentration in water showed a decreasing trend as the distance increases from the dump site. These also contained in the report of (Habib *et al.,* 2012).
Chromium concentration in the soil was the highest observed among entire environmental medium analyzed. The highest concentration is at the 50m distance 0.198mg/kg and the concentration reducing towards the 200m distance 0.102mg/kg. All the samples of the soil analyzed were significantly different at 0.05% degree of significance.
Plant species and varieties vary in their capacities for heavy metal accumulation (Long *et al.,* 2003). Lettuce in this work showed higher accumulation capacity of chromium than spinach and sorrel. Chromium concentration in soil was high because of the refuse dump. The refuse dump accumulates heavy metals from electronic parts in the refuse, batteries, computer disposed parts, fuel in the form of oil, grease and emission from the heavy traffic as reported by (Habib *et al.,*2012).
Other studies conducted on accumulation of heavy metals in vegetables in particular chromium demonstrated that toxicity symptoms cause by chromium were visible in humans and plants as reported by (Avena, 1979) that elevated concentration of chromium in the body cause skin disease rashes, stomach upset, ulcer, respiratory problems weakened immune system kidney and liver damage. In the samples analyzed non-exceeded the 1mg/kg of the national and international standard of heavy metals as recommended byCODEX STAN. (*Amendment: 2010*)

4.2. Cadmium

Cadmium concentration level in the sample studied was independent of the distance from the dump site. The values range between 0.004-0.010mg/kg in the vegetables and the highest values in soil is ranging between 0.005-0.023 mg/kg. there is no significant difference between the values at 0.05% degree of significance. This indicates that cadmium contamination in the soil is not due to the dumpsite. Average cadmium level in the dump site vegetables are represented in table 3. Cadmium mean concentration observed in this work is below the national and international standards. This finding agrees with the earlier report by (Habib *et al.,*2012). In heavy metal pollution of soil and vegetables grown near roadside at Gazipur Bangladesh. which found that the concentration of cadmium was independent of the distance from the road.
The concentration of cadmium in lettuce was observed to be lower than concentration in spinach and sorrel this is because plant species has various capacities to accumulate minerals as reported by (Iwegbue *et al.,* 2011) vegetable crops harvested from different locations in Nigeria (Agbogidi and Enujeke, 2011) who reported increased heavy metal contents of three common vegetables sold in the markets of Asaba metropolis, Nigeria. That the observed variation in metal accumulation could be attributed in part to the innate behaviors of the species studied. This finding also agrees with prior report of (Agbogidi and Ofuoku, 2005) that plant respond differently, to contamination depending on their genetic makeup as influenced by other environmental factors.
(Ni *et al.,* 2002) studied the effect of Cd on the growth of three vegetable crops i.e. Chinese cabbage (*Brassica chinensis* L. cv. Zao-Shu 5), winter greens (*B. rosularis* var. Tsen et Lee cv. Shang-Hai-Qing), and celery (*Apiumg graveolens* L. var. dulce DC). Their results indicated that the cadmium concentrations varied both with different Cd levels and type of vegetable. Generally Cd accumulation in various vegetable crops increased with the increasing cadmium concentrations in the growth medium.
High concentration of cadmium in the body exert detrimental effects on human health and cause severe disease such as tabular growth, kidney damage, cancer, diarrhea and incurable vomiting (Abbas et al., 2010).

4.3. Lead (Pb)

Among the environmental medium analysed soil showed high concentration of Pb it range between 0.156- 0.358 mg/kg but it is not above the maximum limit for soil lead concentration threshold of 50mg/kg recommended by interdepartmental commutee for redevelopment of contaminated land (ICRCL) as reported by (Nabulo, *et al.,*2008)
Lead concentration in vegetables was found to decrease with increased in the sampling distance, there were significant difference between the distribution of lead in the soil samples with various distances it is seen that the mean lead (Pb) in water is between 0.000 - 0.005mg/l. The introduction of Pb into the food chain may affect human health, and thus, studies concerning Pb accumulation in vegetables have increasing importance (Coutate, 1992). Lead if exceeding the maximum permissible limits in humans affect nervous system, bones, liver, pancreas, teeth and gum and also cause blood diseases (Abbas *et al.,* 2010).
Although a maximum Pb limit for human health has been established for edible parts of crops to be (0.2 mg/kg) (Chinese Department of Preventive Medicine, 1994). Lead is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield. In many plants, Pb accumulation can exceed several hundred times the threshold of maximum level permissible for human (Wierzbicka, 1995). 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 lead concentration in vegetables in this work is not significant that the AAS model cannot detect it in some distances. The mean concentration of Pb in soil and water are below the national/international standard as reported by Choi, (2011). This finding correspond with the one recorded by (John and Samuel, 2012) stated that the city farm soils were moderately enriched with Pb and Ni, due to anthropogenic contributions.

4.4. Copper

The levels of copper concentration found in the samples studied was observed to be higher in the soil samples, when the result of the soil samples were compared with the three sampling distances it was observed that 50m distance become the higher concentration with value of 1.670mg/kg followed by the 100m distance with value of 1.423mg/kg and the concentration continues to decrease with distance away from the dump site this suggest that indeed the refuse dump have influence on the concentration of the heavy metals in the environmental medium around the dumpsite.

It was also observed that the vegetable were having higher concentration of Cu when compared with the water samples their values range between 0.124- 0.760mg/kg. This indicates that absorption of heavy metals depends on the available concentration in the soil as reported by (Agbogidi and Erhenhi, 2013). This finding agrees with the earlier reports of (Zhang and Zhou, 2005). That there was however, no relationship in the metal type and the concentration accumulated in the plants the higher concentration of a particular metal in the soil the higher the accumulation of the metal by plants.

From the Cu result water samples showed lower concentration than the entire environmental medium with values between 0.071 – 0.114mg/kg. These indicate that copper pollution is from the solid waste to the soil before it is accumulated in the plants.

High copper levels in growth medium caused toxicity to crops plants, resulting in condition called chlorosis in new leaves, brown stunted coralloid roots, and plant growth was inhibited (Yang *et al.,* 2002). In human beings exposure to excessive levels of copper can result in a number of adverse health effects including liver and kidney damage, anemia, imminotoxicity, and developmental toxicity. (ATSDR, 2004a). In the entire finding, this study collaborate with the reports of (Sharma *et al.,* 2009) that many metals are natural component of the ecosystem which become toxic to the system when taken in quantities above the desired amount.

It was observed that the concentration of copper in this result was within the safe limit as recommended by (WHO, 1985) that 1-2mg/kg is the tolerable limit.

4.5. Arsenic (As)

The average concentration of Arsenic (As) in the studies ranges from 0.000 – 0.010mg/kg only the distance 50m from the dumpsite was detected with a trace of the metal but, most samples that were from 100- 200m distances were below detectable limit of the instrument in the entire environmental medium analyzed.

The result shows that there is limited amount of arsenic in the soil as well as in the vegetables. The finding of this report collaborate with the report of (Ogbonna P. C. and Ukiwe, E.O, 2010) in the assessment of heavy metals in soil and uptake in selected woody plants species in Umuahia, Nigeria which reveals that the contents of heavy metals in plant leaves
were a reflection of their contents in soil at Municipal solid waste dumpsite.

Various studies have been conducted to evaluate the heavy metal uptake by plants in relation to soil pollution and atmospheric deposition on the surface of soils (Haghiri, 1973), Institute for Soil Fertility (1988), (Muller and Anke, 1994), (Ward and Savage, 1994), and (Voutsa, 1996). Variable results are reported. (Larsen*et al.* 1992) found elevated concentrations of Cr and As in soils and plants around a wood preservation factory in Denmark.

Arsenic (As) are known to pose a variety of health risks such as cancer, mutations, or miscarriages as reported by (Weigert, 1991).

4.6. Zinc(Zn)

Zinc concentration result showed the highest concentration in all the heavy metal analysed. In the soil samples Zn range between 5.00– 5.600mg/kg showing a wide variation with the control sample which has the value 1.600mg/kg. This indicate that Zinc accumulation in the soil is from therefuse waste and it enters the refuse from the disposed waste material such as paints, textile materials, preservative, disinfectant bleaches etc. (Abgofidi, 2013) Other source of metals in the environment include urbanization, global development, expansion of economic, agricultural and industrial development as well as authropogenic activities occasioned by the earth teeming population as reported by (Nkwecha *et al.,* 2011).

Spinach among the vegetables showed higher concentration of Zn with values (1.200-2.800) than lettuce and sorrel with values (1.700-2.300) and (1.400 – 1.8) respectively. This could be attributed in part to the innate behaviors of the species studied as reported by (Agbogidi and Enujeke, 2011). In their report of increased in heavy metal contents of three common vegetables sold in the market of Asaba metropolis Nigeria.

Zinc result in water showed lowest concentration compared to soil and the three vegetables the concentration values range between 0.300 – 0.800mg/kg. The control sample is lower than the three sampling distance. This showed that refuse dump affected the result.

Soil pollution by metals has been widely reported by researcher as causing deteriorations effect on agricultural lands there by having significant effects on plant growth, and yields as well as destruction of crops plants resulting in poor soil conditions, immobilization of nutrients as well as constituting health risk when, affected food materials are ingested by man and his animals.

Although zinc concentration was found to be higher in all the heavy metals analyzed the values are still within the tolerable limit of WHOand FEPA standard of heavy metal 10.75mg/kg in vegetables and 75mg/kg respectively.

Knowledge of zinc toxicity in human is minimal. The most important information reported in interference with Cu metabolism (Barone *et al.*, 1998). The symptoms of an acute oral Zn dose may provoke include: - Tachycardia, vascular shock, dyspeptic nausea, vomiting, diarrhea, pancreatitis and damage of hepatic parenchyma (Salgueiro *et al.*, 2000).

5. Summary

A total of twenty samples were collected for the study, three samples from each of vegetable, soil and water were taken from three different distances and each with their control sample. For the microbial analysis total bacterial count, mold and yeast count, and coliform bacteria count were determined. And for the heavy metals analysis the concentration of Cr, Cd, Pb, Cu, As and Zn were examined.

The result shows that total bacterial count was found to be significantly higher in the soil ranging from $4.3 \times 10^5 – 4.78 \times 10^6$ followed by irrigation water ranging from $1.0 \times 10^4 – 3.66 \times 10^6$ and the least was the vegetable ranging from $1.0 \times 10^4 – 9.0 \times 10^4$. Coliform bacteria count was found to be higher in the irrigation water ranging from $2.0 \times 10^4 – 1.2 \times 10^5$ followed by the vegetables ranging from $1.0 \times 10^4 – 2.0 \times 10^4$ and no growth of coliform was found in the soil. Mold and yeast was found to be significantly higher in the soil ranging from1.0×10^4 – TNC and was absent in the vegetables and water respectively.

Heavy metals were examined and were found in the following order: Zn>Cu>Cr>Cd>Pb>As. The same order of heavy metals content was found in vegetables and water with slight change in the pattern of the position of Pb and Cr. In the other hand Zn, Cu and Cr was found to decrease with increase in the sampling distance and were also found to be significantly different from each sampling distance at 0.05% significance. Pb, Cd & As, shows slight irregularities and negligible values such that the A.A.S model was not able to detect it in some distances.

The relatively higher level of metals observed in the dump site vegetables compared with the control vegetables show that refuse dump contribute to the metallic levels in the river Benue basin. Although the values obtained in the vegetables tissues are not significantly higher by national and international Standards, but with time and gradual bio magnifications process, the values may rise to a lethal level that may constitute health risks to the consumers.

6. Conclusion

Regular monitoring of contamination is very important in food industry to prevent food poisoning and other health hazards. In the present work, the observed concentrations of heavy metals in the studied vegetables were below the FAO/WHO limit guideline for food. The higher level of metals observed in the dump site vegetables compared with the control vegetables and also the decrease in concentration with increase in distance away from the dumpsite show that refuse dump contribute to the metallic levels in the study site.

The heavy metal content of the dumpsites at present could be said to pose no significant threat directly but, the continuous dumping of refuse waste especially electronic and metallic waste, will eventually lead to an increase in the heavy metal burden of the dumpsites soils.

7. Recommendation

Since the dumpsite was found to directly contribute to the pollution of the soils, vegetables and irrigation water, and the fact that it is an illegal entity, as such dumping should be stopped and the site properly closed.

As a result of the above, government should put in place certain monitoring processes and empower relevant institutions such as the ministry of Local governments that deal with solid waste disposal management at the local council, to be able to assess solid waste disposal practices and impose penalties if good practices are not followed in the disposal of solid waste.

Furthermore, modern wastes disposal facilities should be acquired by the authorities concerned and appropriate waste disposal sites chosen by experts to avoid indiscriminate dumping of wastes within our farms.

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