ANALYSIS OF HEAVY METALS IN VEGETABLES SOLD IN IJEBU--IGBO, IJEBU NORTH LOCAL GOVERNMENT OGUN STATE.

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MATRIC NO: [illegible]

JANUARY, 2015

TETFUND/THESIS DIGITIZATION/2019-22

ANALYSIS OF HEAVY METALS IN VEGETABLES SOLD IN IJEBU IGBO, IJEBU NORTH LOCAL GOVERNMENT, OGUN STATE.

By

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IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF NATIONAL DIPLOMA (ND) IN SCIENCE LABORATORY TECHNOLOGY.

JANUARY, 2015.

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CERTIFICATION

This is to certify that this research work was carried out by KAYODE Dolapo Mary with Matric No 12/06/2231, in the department of Science Laboratory Technology, Abraham Adesanya Polytechnic, Ijebu Igbo, Ogun State under my supervision.

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Mrs. AKINDELE S.T.

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Date

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DEDICATION

This research work is dedicated to Almighty God for upholding me to make this project possible and to my beloved and worthy parents Mr. and Mrs. KAYODE who laboured to give me the right education in life.

TETFUND/THESIS DIGITIZATION/2017

ACKNOWKLEDGEMENT

The completion of the project was made possible through the immense help received from different people at different level of my education. The project although, appears to be an individual effort it is really a team effort.

First and foremost, my greatest gratitude goes to my creator who has granted me wisdom, knowledge, understanding, privilege and good health for laying my hands on this academic project and for the successful completion of the research work and my education to this level.

My profound gratitude goes to my supervisor, Mrs Akindele S.T. for her valuable suggestion, guidance and advice throughout the period of the project work.

I also appreciate my former Head of Department, Mrs Oluwabiyi and present Head of department, Mr. Okusanya and all amiable lecturers in the department of Science Laboratory Technology.

I also appreciate the moral and financial assistance rendered to me by Mrs. Akintulubo Victoria, I pray that God in his infinity mercy will continue to bless you, and more importantly grant her long life and prosperity.

I am equally grateful to brothers and sisters, Mr. Olatunji, Mr. Kayode Olabode, Mr. Babatunde, Mrs. Omotosho, Akintulubo Tolulope and Tomisin.

My special thanks goes to my loving friends 'A Friend in need is a Friend indeed' I will forever be grateful to Bamgbose Idowu, Oluwaseunfunmi, Majonagbe Bolanle.

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Also, the support and memorable time I shared with my course mates in school and my neighbours in Ijebu Igbo, the Animasahun family, Ajayi Abiodun, Adedayo Tosin, and Foster Gift. May God Almighty continue to be with you all.

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ABSTRACT

A preliminary market study was conducted to assess the level of certain heavy metal in selected vegetable from two main markets in Ijebu-Igbo, Ogun State. (Obada market, Atikori market). These results were then compared with documented value of heavy metal in similar vegetables from other part of land (Ayesan, Dagbolu, Osunbodepo). The result indicate concentration variation of selected heavy metal in the same type of vegetable from different part of land.It shows the concentration of iron present in Ayesan, Dagbolu, Osunbodepo, vegetables, water leaf and flutted pumpkin has the same concentration in Dagbolu.

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CHAPTER ONE

1.1 INTRODUCTION

Heavy metal contamination of vegetables cannot be under-estimated as these foodstuffs are important components of human diet. Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial anti-oxidative effects. However, intake of heavy metal-contaminated vegetables may pose a risk to the human health. Heavy metal contamination of the food items is one of the most important aspects of food quality assurance (Marshall, 2004; Radwan and Salama, 2006; Wang *et. al.*, 2005; Khan *et. al.*, 2008).

International and national regulations on food quality have lowered the maximum permissible levels of toxic metals in food items due to an increased awareness of the risk these metals pose to food chain contamination (Radwan and Salama, 2006). Rapid and unorganized urban and industrial developments have contributed to the elevated levels of heavy metals in the urban environment of developing countries such as China (Wong *et. al.*, 2003) and India (Tripathi *et. al.*, 1997; Khillare *et al.*, 2004; Marshall, 2004; Sharma *et al.*, 2008a, b).

Heavy metals are non-biodegradable and persistent environmental contaminants, which may be deposited on the surfaces and then absorbed into the tissues of vegetables. Plants take up heavy metals by absorbing them from deposits on the parts of the plants exposed to the air from polluted

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environments as well as from contaminated soils (Khairiah *et. al.*, 2004; Jassir *et. al.*, 2005; Kachenko and Singh, 2006; Singh and Kumar, 2006; Sharma et al., 2008).

A number of studies have shown heavy metals as important contaminants of the vegetables (Singh *et. al.*, 2004; Marshall, 2004; Sinha *et. al.*, 2006; Singh and Kumar, 2006; Sharma *et. al.*, 2006, 2007, 2008a). Heavy metal contamination of vegetables may also occur due to irrigation with contaminated water (Singh *et. al.*, 2004; Sharma *et. al.*, 2006, 2007; Singh and Kumar, 2006).

Emissions of heavy metals from the industries and vehicles may be deposited on the vegetable surfaces during their production, transport and marketing. Jassir *et. al.*, (2005) have reported elevated levels of heavy metals in vegetables sold in the markets at Riyadh city in Saudi Arabia due to atmospheric deposition.

Recently, Sharma *et. al.*, (2008a,b) have reported that atmospheric deposition can significantly elevate the levels of heavy metals contamination in vegetables commonly sold in the market.Regular consumption of unsafe concentrations of heavy metals through foodstuffs may lead to the chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone diseases (WHO, 1992; Jarup, 2003).

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Some heavy metals such as Cu, Zn, Mn, Co and Mo act as micronutrients for the growth of animals and human beings when present in trace quantities, whereas others such as Cd, As, and Cr act as carcinogens (Feig *et. al.,* 1994; Trichopoulos, 1997), and Hg and Pb are associated with the development of abnormalities in children (Gibbes and Chen, 1989; Pitot and Dragan, 1996). Hartwig (1998) and Saplakog¢lu and Iscan (1997) have reported that long-term intake of Cd caused renal, prostate and ovarian cancers.

Monitoring and assessment of heavy metals concentrations in the vegetables from the market sites have been carried out in some developed (Jorhem and Sundstroem, 1993; Milacic and Kralj, 2003), and developing countries (Parveen *et. al.,* 2003; Jassir *et. al.,* 2005; Radwan and Salama, 2006), but limited published data are available on heavy metals concentrations in the vegetables from the market sites of India (Agrawal, 2003; Marshall, 2004; Tripathi *et. al.,* 1997; Sharma *et. al.,* 2008a,b).

Comparison of heavy metal contamination due to atmospheric deposition at production and market sites is, however, not available in the literature till date. It was hypothesized that atmospheric depositions in urban areas may increase the levels of heavy metals during transport and marketing, leading to significant contamination of vegetables at the market sites than that at the production sites. The contribution of the heavy metal contamination

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through dietary intake of the vegetables tested is also assessed based on the average daily consumption of the vegetables.

Heavy metals are defined as a group of elements having a density which is greater than 5 g/cm³. Its contamination issue in human dietary uptakes have elicited significant responses and worldwide concerns pivotally entailing vegetables consumption. The contamination of vegetables with heavy metals poses a critical threat to the society and environment as regards to the increasing concern of food safety issues, potentials health risks and its detrimental effects upon soil ecosystems (Mclaughlin *et. al.,* 1999).

Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, vitamins, minerals as well as trace elements. Accumulation of heavy metals by vegetables may depend on plant species as well as concentration of heavy metal. These heavy metals are not abundant in soil, but they may be an accumulated through disposal of sewage water.

Disposal of sewage water is a great problem. These sewage effluents are considered not only a rich source of organic matter and other nutrients but also they elevate the level of heavy metals like Cu, Pb, Cr and Cd in receiving vegetable of soils. Elevated concentration of heavy metal can affect human being.

Heavy metals are not easily biodegradable and consequently can be accumulated in human vital organs leading to unwanted side effect. This situation causes varying degree of illness based on acute and chronic

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exposures. Among the heavy metals when Cu exceeds its safe value concentrations cause hepatic and kidney damage, haemolytic anaemia and methanoglobinemia. The acceptable for human consumption of copper is 10 ppm.

Cadmium exerts effects on human health when it present at higher concentration and causes severe diseases such as tubular growth, excessive salivation, gastrointestinal irritation, cancer, kidney damage, diarrhoea and vomiting. Lead is sequestered in the bones and teeth, affect nervous bone, liver, weakness in the wrist and figure, pancreases, and gumand also causes blood diseases.

Chromium plays an important physiological role in all animals including human beings. Chromium is present in many pharmaceutical samples and in airborne particulates, causing environmental pollution. Cr (III) is an essential component having an important role in the glucose, lipid and protein metabolism, while Cr (VI) has a definitely adverse impact on living organisms.

Cr (VI) can easily penetrate the cell wall and exert its noxious influence in the cell itself, being also a source of various cancer diseases. As well as Chromium (VI) causes kidney and liver damage , stomach upset and ulcers, skin rashes, lung cancer, weakened immune systems, alteration of genetic material and respiratory problems.

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These metals are dangerous because they tend to bioaccumulation in the food chain and they are harmful to humans and animals. Knowledge of metal-plant interactions is important for the safety of the environment and for reducing the risks associated with the introduction of trace metals into the food chain.

Consequently the metal can inactivate many important enzymes resulting in inhibition of photosynthesis, respiratory rate and other metabolic processes in plants. Low level chronic exposure causes adverse effect on human health.

The present work will be undertaken to obtained information of the levels of heavy metals (copper, lead, iron, chromium, magnesium, calcium, sodium, nickel, zinc, cadmium).

1.2 AIMS AND OBJECTIVE OF THIS STUDY

This research is aimed at investigating the presence and concentrations of some of the heavy metals on the edible vegetables sold in some selected market in Ijebu - Igbo, Ogun State, Nigeria.

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CHAPTER TWO

2.0 LITERATURE REVIEW

Vegetable is an edible plant or its part, intended for cooking or eating raw. Vegetables are important part of diets in the Nigeria. Consumption of vegetables exposed to heavy metals contamination may lead to serious health complications. Heavy metals occur as natural constituents of the earth crust and are persistent environmental contaminants since they cannot be easily degraded or destroyed (Loan *et. al.,* 2008).

The four different types of vegetable used are bitter leaf, flutted pumpkin, water leaf and jew mallow.

Bitter leaf (*Vernonia amygdalina*) is a shrub or small tree that can reach 23 feet in height when fully grown. Bitter leaf has a grey or brown coloured bark, which has a rough texture and is flaked. The vegetable is an indigenous African plant; which grows in most parts of sub-Saharan Africa.

It is a medicinal plant and fresh bitter leaf is of great importance in human diet because of the presence of vitamins and mineral salts (Sobukola *et. al.,* 2007).It is a very important protective food and useful for the maintenance of health and prevention and treatment of various diseases. Some principal chemical constituents found in bitter leaf herb are a class of compounds called steroid glycosides- type *vernonioside* B1 –these chemical substances possess a potent anti-parasitic, anti-tumour, and bactericidal effect.

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The bitter leaf is mainly employed as an agent in treating *schistsomiasis,* which is a disease caused by parasitic worms. It is also useful in the treatment of diarrhoea and general physical malaise. Remedies made from bitter leaf are used in treating 25 common ailments in sub- Saharan African; these include common problems such as fever, and different kinds of intestine complaints, as well as parasite-induced diseases like malaria.

Bitter leaf also helps to cleanse such vital organs of the body like the liver and the kidney. Bitter leaf is also used in the treatment of skin infections such as ringworm, rashes and eczema. However, bitter leaf and other vegetables contain both essential and toxic metals over a wide range of concentrations (Radwan and Salama, 2006).

Flutted pumpkin (*Telfeiria occidentalis)* is a creeping vegetable that spreadlow across the ground with lobed leaves and long twisting tendrils. It is a warm weather crop which grows well in low lands and tolerates elevation of some few Materials and Methods meters above the ground. It thrives best in soils rich in organic matter.

Fluted pumpkin as it is commonly known in southern Nigeria plays important role in human and livestock nutrition. It is a source of protein, oil, fats, minerals and vitamins (Oyenuga, 1968; Ifon, 1977, Okoli *et. al.,* 1988; Aletor and Adeogun, 1995). The leaves of this vegetable are used in the preparation of several delicacies in southern Nigeria, one of which is

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"Edikang Ikong Soup" (a popular delicacy of the Efiks/Ibibios in Cross River and Akwa Ibom States in Nigeria).

It thrives better in the early part of the rainy season. It can also be planted between August and October which are the latter months of the rainy season. *T. occidentalis* can be grown in garden and farmed as a vegetable. It can survive for 3-4 years if there is moisture in the soil (Achinewu, 1987).

Water leaf (*talinum triangulare*) is an herbaceous, perennial, coalescent and glabrous plant widely grown in tropical regions as a leaf vegetable (Adewunmi *et. al.,* 1987). It is consumed as a vegetable and constituent of a sauce in Nigeria.

In Nigeria, it is widely distributed and consumed as a leafy vegetable in the Southern ecological zones. Its leaves are used as softener of other vegetable species in vegetable soup. Jew Mallow plants are tall, usually annual herbs reaching a height of 2–4 m, unbranched or with only a few side branches.

The leaves are alternate, simple, lanceolate 5–15 cm long, with an acuminate tip and a finely serrated or lobed margin. The flowers are small (2–3 cm diameter) and yellow, with five petals; the fruit is a many-seeded capsule. It thrives almost anywhere, and can be grown year-round.

Heavy metals enter the body system through food, air and water and bio-accumulate over a period of time. (Duruibe *et. al.,* 2007). Excess heavy metal accumulation in the environment is capable to have toxicological

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implication in humans and other animals. Heavy metal pollution is of significant ecological/environmental concern.

The term "heavy metals" refers to any metallic element that has a relative density greater than 4 g/cm^3 (Grant and Grant, 1987). Heavy metals include; Lead (Pb), Cadmium (Cd), Zinc (Zn), Mercury (Hg), Arsenic (As), Silver (Ag), Chromium (Cr), Copper (Cu), Iron (Fe) and the Platinum group elements.

This is due to the fact that they are not easily biodegradable or metabolized, thus precipitating far reaching effects on the biological system such as human, animals, plants and other soil biota (Yoon, 2003).

Researchers have also stressed that these metals could bio-accumulate in crops, especially when cultivated along construction sites and are consumed by man and livestock (Tulonen *et. al.,* 2006). Human exposures to heavy metals have been the focus of increasing attention among researchers, health and nutrition experts due to their impact on public health.

According to World Food and Organization, utilization of inorganic fertilizers in agricultural vegetables has increased 100 times of mean usage and exceeded the world's average by 2.5 times (Shi, 1992) whereby, prolonged intake of those heavy metals may lead to the detrimental bioaccumulation in physiological system.

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Humans gain sources of minerals, vitamins and fibres by consuming vegetables. However, these plants may contain both essential and toxic metals in wide ranges of concentration. Accumulation of excessive heavy metals in human body can lead to the exposure towards risk factor for cancers, cardiovascular and gastrointestinal diseases.

In addition, heavy metals like lead (Pb) and cadmium (Cd) have been shown to bear carcinogenic effects (Trichopoulos, 1997) and they are also implicated in causing carcinogenesis, mutagenesis and teratogenesis (IARC, 1993; Pitot and Dragan, 1996).

These are due to uncontrolled and excessive production of free radicals in the body, thus, can cause peroxidation of lipids, inactivation of enzymes and DNA damage in cells. Most of these changes accelerate senescence in the affected plants (Mancini *et. al.*, 2006).

Generally, vegetables contamination with heavy metals derives from factors such as the application of fertilizers, sewage sludge or irrigation with wastewater (Devkota and Schmidt, 2000; Frost and Ketchum, 2000; Mangwayana, 1995).

Furthermore , the uptake and bioaccumulation of heavy metals in vegetables are influenced by a number of factors such as climate ,atmospheric depositions , the concentration of heavy metals in soil ,the nature of soil on which the vegetables are grown and the degree of maturity of the plants at the time of harvest [Lake *et. al.*,1984;Sctt *et. al;*1996].

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Crops which are raised on the metal-contaminated soils accumulate metals in quantities that excessive enough to cause clinical problems both to animals and human being whom do consume these metals- riched plants [Tiller, 1986] . Since food chain contaminati0n is one of the major routes for entry of metals into the animals system, monitoring the bioavailability pools of metals in contaminated vegetables has generated a lot of interest (Datta *et. al*., 2000; Yadav *et. al*., 2002).

Pertaining to this awareness, a lot of studies have been conducted on determining levels of heavy metals in vegetables that are contained in people's daily intakes. Since there are various methods being used in determining levels of heavy metals concentrations, one of the applicable techniques used particularly for vegetables is 'Market Basket Study'.

This is a peculiar way of focusing on wet markets as sites of sampling in order to acquire samples. Wastewater irrigation is known to contribute significantly to the heavy metal contents of soils (Mapanda et al., 2005).

Although problems occur in water-ways when pollutants are leached out of the soil, if the plants die and decay, heavy metals taken into the plants are redistributed, so the soil is enriched with the pollutants. Uptake and accumulation of elements by plants may follow two different paths i.e., through the roots and foliar surface (Sawidis *et. al*., 2001).

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The uptake of metals from the soil depends on different factors such as their soluble content in it, soil pH, plant growth stages types of species, fertilizers and soil (Sharma *et. al.*, 2006; Ismail, *et. al.*, 2005).

Plant species have a variety of capacities in removing and accumulating heavy metals, so there are reports indicating that some species may accumulate specific heavy metals, causing a serious health risk to human health when plants based food stuff are consumed (Wenzel & Jackwer, 1999).

Disposal of sewage water and industrial wastes is a great problem. Often it is drained to the agricultural lands where it is used for growing crops including vegetables. These sewage effluents are considered not only a rich source of organic matter and other nutrients but also they elevate the level of heavy metals like Fe, Mn, Cu, Zn, Pb, Cr, Ni, Cd and Co in receiving soils (Singh *et. al.,* 2004).

As a result, it leads to contamination of the food chain, because vegetables absorb heavy metals from the soil polluted air and water. One important dietary uptake pathway could be through crops irrigated with contaminated wastewater.

Heavy metals are not easily biodegradable and consequently can be accumulated in human vital organs. This situation causes varying degrees of illness based on acute and chronic exposures (Demirezen & Ahmet, 2006). Vegetables are an important part of human's diet. In addition to a potential source of important nutrients, vegetables constitute important functional food

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components by contributing protein, vitamins, iron and calcium which have marked health effects (Arai, 2002).

Vegetables, especially those of leafy vegetables grown in heavy metals contaminated soils, accumulate higher amounts of metals than those grown in uncontaminated soils because of the fact that they absorb these metals through their leaves (Al Jassir *et. al.*, 2005).

Demirezen & Ahmet (2006) investigated the concentrations of heavy metals such as Cd, lead (Pb), Zinc (Zn), Cu and Ni in different vegetables, grown in various parts of Turkey. The levels of heavy metals (lead, cadmium, copper and zinc) were examined in selected fruits and vegetables sold in the local markets of Egypt (Radwan & Salama, 2006). Fytianos et al., (2001) studied the contents of heavy metals in vegetables grown in an industrial area of North Greece.

This study therefore aims to determine the levels of heavy metals such as cadmium (Cd), copper (Cu), Lead (Pb) and zinc (Zn) in some selected vegetables grown and sold in selected farm and markets respectively and soils in various industrial, residential and commercial areas in Ijebu local government. Enrichment of heavy metals in vegetables is relatively high. Farmers use much higher rates of fertilizers in their vegetable production than that in grain crops.

Long-term and excessive fertilization, especially phosphorus fertilizers and organic manures, can lead to more serious potential heavy metal pollution

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in vegetables. In addition, environment of city suburbs can be easily affected by the waste air, water and residue from industry, and the tail gases emitted by automobiles.

Water and soils in the suburbs of cities have suffered from heavy metal pollution to some extent, which might lead to excessive accumulation of one or several heavy metals, such as Cd, Hg, Cr, As, Pb, in vegetables (Zhao et al. 2001; Zhang and Yang 2001; Zhang and Bai 2001; Peng et al. 2002; Zhou and Chen 2002; Li et al. 2005; Huang et al. 2005).

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CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 STUDY AREA

Four types of leafy vegetables were randomly picked from two markets located in industrial, residential and commercial areas in Ijebu - Igbo, Ogun state Nigeria in August (wet season), 2014.

The vegetables include bitter-leaf *(Vernonia amygdalina)*, flutted pumpkin *(Talfaria occidentalis)*, water-leaf *(Talimum triangulare)*, jew mallow *(Cochorus olitorus)*. The markets are located at Obada station, Atikori, while the farm sites are situated at Ayesan, Dagbolu, Osunbodepo.

3.2 SAMPLE COLLECTION

The four vegetables (flutted pumpkin, jew mallow, water leaf and bitter leaf) were harvested from three different farm-land located at Ijebu North Local government which are Ayesan, Dagbolu and Osunbodepo.

They were put into separate polythene bags and labelled accordingly. They were then taken immediately to the laboratory for preparation and analysis.

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3.3 SAMPLE ANALYSIS

The vegetables samples were destalked, washed with tap water and thoroughly rinsed with distilled water, then dried in an oven at 105°C. They were then pulverized to fine powder using a laboratory grinder. The fine powder was put into polythene bags and preserved in the desiccator.

3.0 g of each sample was accurately weighed into clean platinum crucible and ashed at 450-500°C then cooled to room temperature in a desiccator. The ash was dissolved in 5 ml of 20% hydrochloric acid and the solution was carefully transferred into a 100 ml volumetric flask. The crucible was well rinsed with distilled water and transferred to the flask and made up to the mark with distilled water and shaken to mix well.

The samples were then analysed for heavy metal determination using Atomic Absorption Spectrophotometer (AAS, Perkin Elmer model 2130). The determination of the following heavy metals (Cr, Mn, Ni, Co, Cu, Cd, Zn, Pb, and Fe) contents of the sample solutions was carried out in accordance with the procedure of the AOAC (1984).

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CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

TABLE 4.1: The results of Cr in four Vegetable Samples from the Three Locations.

	Locations		
Samples	**Ayesan**	**Dagbolu**	**Osunbodepo**
Jew Mallow	1.50	1.25	1.25
Flutted Pumpkin	1.75	2.75	0.75
Water Leaf	4.75	6.40	5.75
Bitter Leaf	2.20	4.30	3.25

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TABLE 4.2: The results of Mn in four Vegetable Samples from the Three Locations.

	Locations		
Samples	**Ayesan**	**Dagbolu**	**Osunbodepo**
Jew Mallow	8.50	11.00	9.75
Flutted Pumpkin	40.50	44.00	43.00
Water Leaf	50.75	48.70	88.80
Bitter Leaf	30.00	44.50	37.25

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TABLE 4.3: The results of Ni in four Vegetable Samples from the Three Locations.

	Locations		
Samples	**Ayesan**	**Dagbolu**	**Osunbodepo**
Jew Mallow	15.25	23.25	19.25
Flutted Pumpkin	16.75	12.70	2.80
Water Leaf	90.00	17.00	21.00
Bitter Leaf	10.75	20.75	15.75

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TABLE 4.4: The results of Co in four Vegetable Samples from the Three Locations.

Samples	Locations		
	Ayesan	**Dagbolu**	**Osunbodepo**
Jew Mallow	3.25	3.75	3.50
Flutted Pumpkin	1.75	2.75	0.75
Water Leaf	2.00	2.00	5.70
Bitter Leaf	1.25	1.25	4.25

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TABLE 4.5: The results of Cu in four Vegetable Samples from the Three Locations.

	Locations		
Samples	**Ayesan**	**Dagbolu**	**Osunbodepo**
Jew Mallow	8.75	8.70	11.80
Flutted Pumpkin	10.00	9.00	14.00
Water Leaf	6.75	6.70	9.80
Bitter Leaf	5.00	7.00	12.00

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TABLE 4.6: The results of Cd in four Vegetable Samples from the Three Locations.

	Locations		
Samples	Ayesan	Dagbolu	Osunbodepo
Jew Mallow	1.25	1.50	1.75
Flutted Pumpkin	1.25	0.25	7.25
Water Leaf	0.50	2.50	1.50
Bitter Leaf	1.25	1.75	1.50

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TABLE 4.7: The results of Zn in four Vegetable Samples from the Three Locations.

	Locations		
Samples	Ayesan	Dagbolu	Osunbodepo
Jew Mallow	100.23	122.20	111.26
Flutted Pumpkin	79.75	77.70	81.82
Water Leaf	180.75	192.70	186.80
Bitter Leaf	70.50	110.50	90.50

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ABLE 4.8: The results of Pb in four Vegetable Samples from the Three Locations.

	Locations		
amples	Ayesan	Dagbolu	Osunbodepo
ew Mallow	4.00	12.00	8.00
lutted Pumpkin	11.75	6.75	1.75
Water Leaf	50.00	9.00	7.00
Bitter Leaf	6.25	5.20	7.30

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TABLE 4.9: The results of Fe in four Vegetable Samples from the Three Locations.

Samples	Locations		
	Ayesan	Dagbolu	Osunbodepo
Jew Mallow	4.10	7.10	4.10
Flutted Pumpkin	1.75	6.75	11.75
Water Leaf	1.75	11.75	6.75
Bitter Leaf	2.95	1.95	3.95

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TABLE 4.10: The Arithmetical Means of the Heavy Metals in the four Vegetable Samples from the Three Locations.

Sample	Cr	Mn	Ni	Co	Cu	Cd	Zn	Pb	Fe
Jew Mallow	1.50	9.75	19.25	3.50	9.75	1.50	111.23	8.00	5.10
Flutted Pumpkin	1.75	45.50	16.75	1.75	11.00	1.25	79.75	6.75	6.75
Water Leaf	5.27	6.75	19.00	3.00	7.75	1.50	186.75	7.00	6.75
Bitter Leaf	2.25	37.25	15.75	2.25	8.00	1.50	90.50	6.25	2.95

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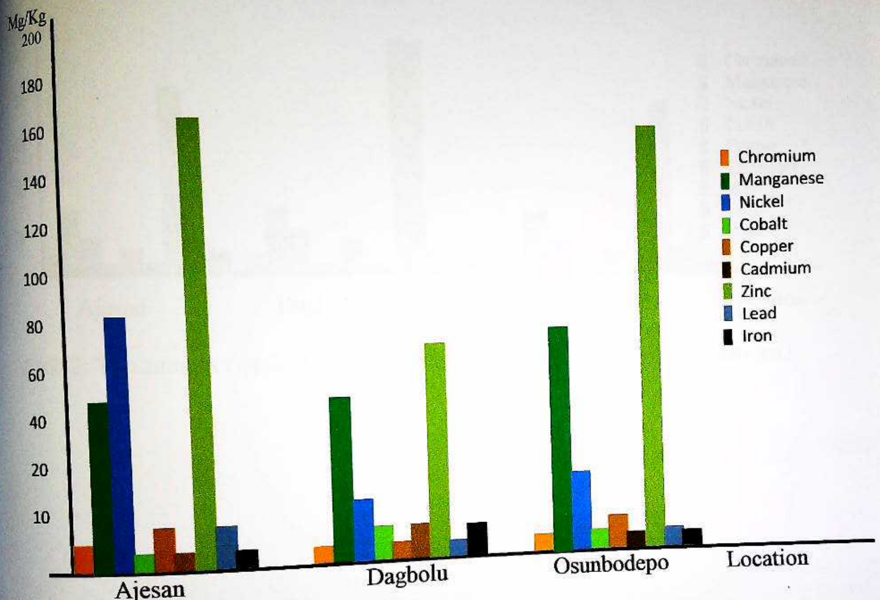

FIG. 1: The amount (mg/kg) of Heavy metal in water leaf in the three locations.

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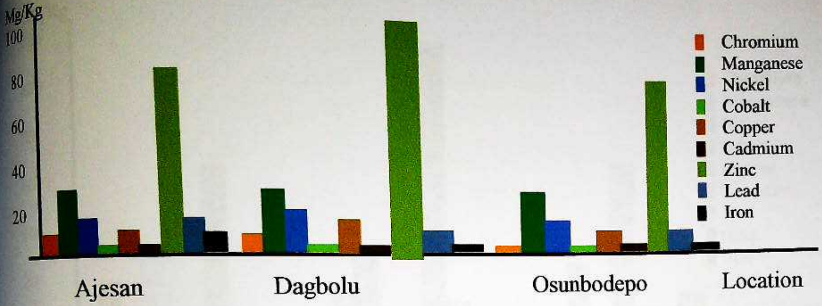

FIG. 2: The amount (mg/kg) of Heavy metal in Bitter leaf in the three locations.

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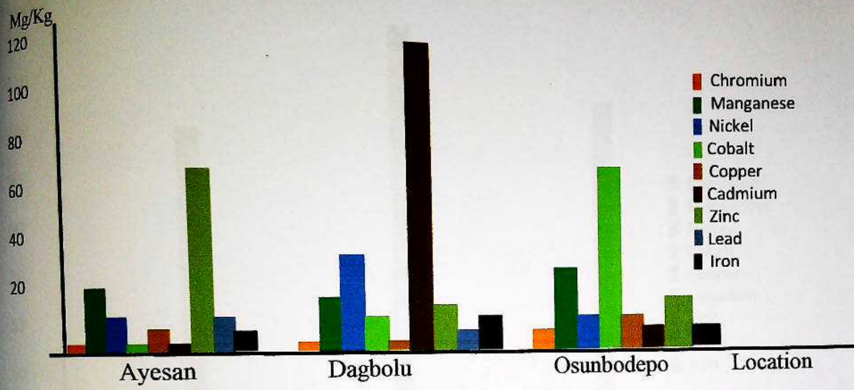

FIG. 3: The amount (mg/kg) of Heavy metal in Jew Mallow in the three locations.

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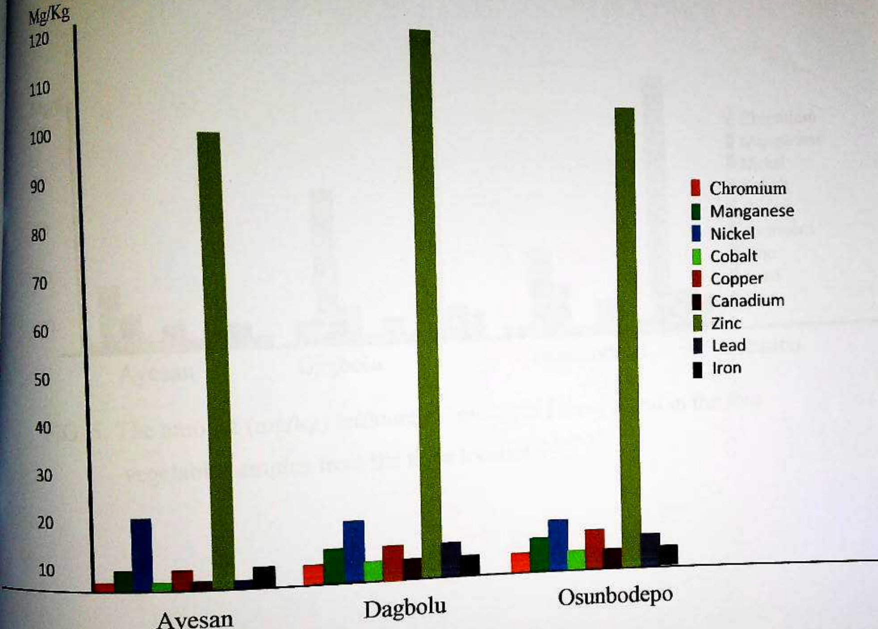

FIG. 4: The amount (mg/kg) of Heavy metal in Flutted Pumpkin in the three locations.

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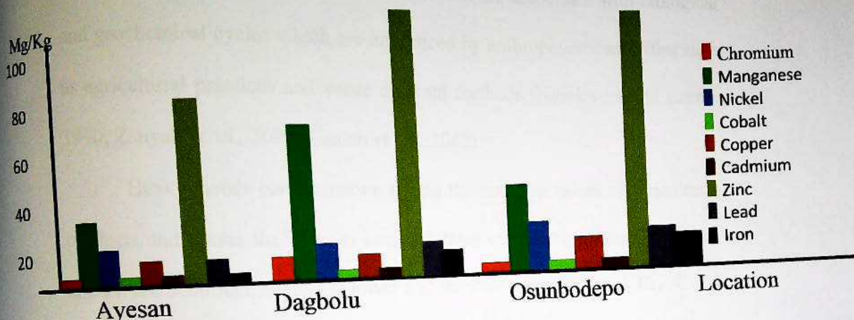

FIG. 5: The amount (mg/kg) arithmetical means of Heavy metal in the four vegetable samples from the three locations

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CHAPTER FIVE

5.0 DISCUSSION AND CONCLUSION

5.1 DISCUSSION

Heavy metals concentrations in the soil are associated with biological and geochemical cycles which are influenced by anthropogenic activities such as agricultural practices and waste disposal methods (Ndiokwere and Ezehe, 1990; Zauyah *et. al.*, 2004; Usman *et. al.*, 2002).

Heavy metals contamination affects the nutritive values of agricultural products and erases the benefits required from consuming them. Cr, Cu, Ni and Zn are beneficial to man at lower and standard concentrations. Cr, Ni and Zn have been suggested as essential trace elements in nutrition. Their functions include regulation of apoptosis, activation of depressed immune system and as co factors for metaloenzymes (Gbaruko and Friday, 2007).

Cr (III) is an essential element required for normal sugar and fat metabolism. It is effective to the management of diabetes and it is a cofactor with insulin. Cr (III) and its compounds are not considered a health hazard, while the toxicity and carcinogenic properties of Cr (VI) have been known for a long time (Barceloux, 1999).

High concentrations can be found in the liver, kidney, spleen and bones. Cr (VI) is not beneficial to man and it is the one most prevalent in the environment. The acute toxicity of Cr (VI) is due to its strong oxidative properties. In the blood stream, it damages the kidneys, the liver and blood

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cells through, oxidation reactions. Haemolysis, renal and liver failure are the results of these damages (Dayan and Paine, 2001).

Mn is an important element responsible for the function of the pituitary gland and promotes hepatorenal functions. However, it is capable of causing brain and nerve damage, forgetfulness and other health problems when present in high concentrations, as is seen in the result presented in diagrams. Jew mallow has the least concentration (9.75 mg/kg) and waterleaf the highest (62.75 mg/kg).

The average value is 38.1 mg/kg which is very high. Ni is involved in fat metabolism and acid in fat deposition (Goyer, 1995). It also plays some role in body function including enzyme functions and occurs naturally more in plants than in animal flesh. It activates some enzymes systems in trace amount but its toxicity at higher levels is more prominent (Divrikli *et. al.*, 2006). It functions as a biocatalyst required for body pigmentation in addition to iron, maintains a healthy central nervous system, prevents anaemia and interrelates with the function of Zn and Fe in the body (Akinyele and and Osibanjo, 1982).

Some Ni metal dust and soluble compounds are believed to be carcinogenic (Kasprzak *et. al.*, 2003; Dunnick *et. al.*, 1995). The concentration range for Ni is 15.75 mg/kg (Bitter leaf) to 19.25 mg/kg (jew mallow) and an average of 17.69 mg/kg. Cu is an essential authentic micronutrient which functions as a biocatalyst required for body pigmentation

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in addition to iron. It helps maintain a healthy central nervous system, prevents anaemia and interrelated with the functions of Zn and Fe in the body (Akinyele and and Osibanjo, 1982).

High concentration of Cu may be linked to liver cancer and brain tumors (Ellis and Salt, 2003). Cu does not break down from the environment therefore it accumulates in plants. The average concentration of Cu found in the four vegetable samples is 9.13 mg/kg with a range of 7.75-11.00 mg/kg. The lowest concentration is recorded for water leaf and the highest is fluted pumpkin respectively.

Co is an integral component of the vitamin B12molecule. It is required in the manufacture of red blood cells and in preventing anaemia. An excessive intake of cobalt may cause the overproduction of red blood cells. Though Co is an essential element in minute quantities at higher levels of exposure it shows mutagenic and carcinogenic effects similar to Ni.

The concentration range for these vegetable samples is from 1.75-3.50 mg/kg in fluted pumpkin and jew mallow, respectively. The average concentration is 2.63 mg/kg. Cd is a nonessential element and very actually displaces Zn in some of its important enzymatic and organ functions. Thus the Zn-Cd ratio is very important as Cd toxicity and storage are greatly increased with Zn deficiency. It accumulates principally in the kidneys and liver (Divrikli *et. al.*, 2006).

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Cd and several Cd compounds are known carcinogens and can induce many types of cancer. (Saplakogelu and Iscan, 1997) have reported that long-term intake of Cd caused renal, prostrate and ovarian cancers. Long period of exposure may lead to kidney failure and permanent lung damage (Cobb *et. al.,* 2000). The results revealed that bitter leaf, jew mallow and waterleaf had Cd concentrations of 1.50 mg/kg while fluted pumpkin had 1.25 mg/kg.

These levels are 15 to 12.5 times higher than the WHO acceptable limits. Zinc is one of the important metals needed by the body for normal growth and development of the sexual organs. It stimulates the activity of vitamin formation of red and white corpuscles (Claude and Paule, 1979). Zinc facilitates the process of wound healing. High levels of Zn can lead to urinary tract infection, kidney stones and even kidney failure. Concentrations of Zn in the vegetable samples are outrageously high (79.75-186.75 mg/kg).

The lowest being recorded for fluted pumpkin and the highest for waterleaf. Bitter leaf and jew mallow recorded 90.50 mg/kg and 111.25 mg/kg, respectively. These high concentrations are similar to the observed results by Odukoya *et. al.,* (2000).

They attributed the source of Zn to domestic refuse, construction materials, motor vehicle emissions and motor vehicle wear. Large quantities of Zn may cause anaemia, nervous system disorders, and damage to the pancreas and low levels of "good" cholesterol. Pb is toxic to the body and is not required even in the smallest quantity. It accumulates in the bones and

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teeth causing weakness in the wrist and joints leading to brittle bones. It affects the central nervous system, kidney and liver. The concentration of Pb in the four vegetables studied is 6.25 to 8.00 mg/kg (bitter leaf and jew mallow, respectively)

Waterleaf had a concentration of 7.00 mg/kg and fluted pumpkin, a concentration of 6.75 mg/kg. Figure 1 shows concentrations of these metals in bitter leaf (*Vernonia amygdalina*) in the order of Zn>Mn>Ni>Cu>Pb>Cr = Co>Cd. Figure 4 shows the metal concentrations for Jew mallow in the order of Zn>Ni>Mn = Cu>Pb>Co>Cr = Cd. Concentrations of the metals in waterleaf (*Talinum triangulare*) are presented in Fig. 2 and are in the order of Zn>Mn>Ni>Cu>Pb>Cr>Co>Cd. Results for fluted pumpkin (*Telfairia occidentalis*) are presented in Fig. 3 and the metal concentrations are in the order of Zn>Mn>Ni>Cu>Pb>Cr = Co>Cd. Water leaf has the highest concentration of the metals Zn, Mn, Ni, Co, Cr and Cd followed by jew mallow. Fluted pumpkin ranks second in the concentrations of Mn and the highest for Cu.

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5.2 CONCLUSION

The results obtained for the four vegetables under study for the nine heavy metals imply that the consumption of these vegetables is risky as this will lead to a lot of health problems. As regular consumption of these vegetable will expose the consumers to heavy metal toxicity as the years go by.

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