

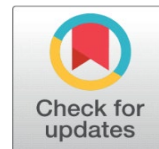
# COMPARATIVE ANALYSIS OF SOME HEAVY METALS LEVELS IN LEAVES, PEELS AND TUBERS OF CASSAVA PLANTED ALONG EAST-WEST ROAD RIVERS STATE



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## ABSTRACT

**Introduction:** Pollution of the environment by heavy metals has caused serious environmental problems, which threatens the existence of various ecological system, agriculture and human health. This study assessed the comparative analysis of some heavy metal's levels in leaves, peels and tubers of cassava planted along East-West Road Rivers State.

**Materials/Methods:** Cassava leaves and tubers samples were collected from farmlands along East-West Road (SX, SY and SZ communities, in Emohua, Tai, and Ahoada West LGA respectively), River's state, Nigeria. The samples were monitored for heavy metals levels to assess the impact of automobiles on cassava peels, leaves and tubers using Solar Thermo Elementary Atomic Absorption Spectrometer, ModelSG 71906. Metals studied were Lead (Pb), Nickel (Ni), Chromium (Cr), Cadmium (Cd), and Arsenic (As).

**Results:** The mean concentration of Ni present in leaf was  $2.81 \pm 0.104$  mg/kg, tubers recorded  $2.23 \pm 0.073$  mg/kg and peels  $3.20 \pm 0.06$  mg/kg. The highest concentration ( $4.064 \pm 0.035$  mg/kg) of Ni was observed in peels while the least concentration ( $1.80 \pm 1.023$  mg/kg) was recorded in the tubers. The mean values of Pb in leaves, tubers and peels were  $2.22 \pm 1.023$  mg/kg,  $1.80 \pm 1.023$  mg/kg and  $2.64 \pm 0.32$ , highest concentration was recorded in tubers. Arsenic values were  $0.16 \pm 0.020$  mg/kg >  $0.51 \pm 0.021$  mg/kg >  $0.38 \pm 0.203$  mg/kg in peels, tubers and leaves respectively. The values of as were above WHO safe limit of 0.1mg/kg. Also, the mean values of cadmium in leaves, tubers and peels were  $0.054 \pm 0.570$  mg/kg,  $0.046 \pm 0.057$  mg/kg and  $0.16 \pm 0.609$  mg/kg respectively. The highest concentration ( $0.138 \pm 0.109$  mg/kg) was in the tubers. Finally, chromium was found to be present in all the cassava samples (leaves, peels and tubers). The mean concentration of chromium (Cr) was  $3.58 \pm 0.023$  mg/kg,  $2.76 \pm 0.005$  mg/kg and  $3.83 \pm 0.203$  mg/kg in leaves, tubers and peels respectively.

**Conclusion:** From the findings, heavy metals were found in the samples and thus, crops should be cultivated far away from major roads.

**Keywords:** Comparative, Metals, Peels, Tubers, Cassava

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## 1. INTRODUCTION

Pollution of the environment by heavy metals has caused serious environmental problems, which threatens the existence of various ecological system, agriculture and human health Wang et al. (2007). Massive loads of pollutants are being introduced into the water, air and land on a daily basis as a result of this development in technology and its related activities Dibofori-Orji, and Edori, (2015). This has led tremendously to global environmental pollution.

Heavy metals are naturally present in soil in relatively low concentrations usually in milligram or nanogram level [Nusseey \(1998\)](#). However, recently, the occurrence of heavy metals in excess of natural quantities has emerged as a result of domestic and industrial effluents, urban storm-water run-offs, smoke from in-use vehicles and leaching of metals from solid waste dump [Biney et al.\(1994\)](#), [Idris et al. \(2014\)](#). The composition of road side sediments shows that it is made up of materials from different sources such as run-off water from surrounding soils and slopes, dry and wet atmospheric deposition, road paint degradation, inputs from the wear of sidewalks, wear from road surface, vehicle wear, vehicle fluid and particulate emissions. Lately, studies have shown that the level of lead in plants and soil have increased by a remarkably large quantity as a result of pollution from automobiles, particularly from usage of leaded petrol and combustion from exhaust [Ano et al. \(2007\)](#), [Ondeet al. 2007](#), [Osakwe \(2009\)](#). The discharge of these contaminants into water bodies, seas and land is having adverse effect on the crops that are planted along the major highways [Ekpete and Festus \(2013\)](#).

Nigerian soil particularly those along the highways is being bio accumulated by heavy metals giving rise to serious contagious disease to crops, animals and human beings.

Cassava (*Manihot esculenta*) plays a vital role in terms of income generation, employment creation and food security for families in Rivers State, mainly those in the rural environments where these cassavas are abundantly cultivated. Cassava is an important food, sold fresh or processed in such a way that it can easily be stored in different forms such as garri, fufu, flour and starch for domestic use and commercial purposes. Cassava roots and leaves can also be fed to livestock.

One of the major pathways by which contaminant and heavy metals in soils enter the food chain is through soil to plant transfer [Sparg et al. \(2004\)](#). Food crops such as cereal, tuber crops and vegetables cultivated in crude oil impacted soil take up toxic metal from the soil [Harmanescu et al. \(2011\)](#). Basically, most heavy metals are not biodegradable, have long biological half-lives and have the potential for accumulation in different body organs leading to unwanted side effects [Mbong, et al. \(2014\)](#). [Apau et al. \(2014\)](#) posited that accumulation of heavy metals in crop plants is often of great concern due to its potential for food contamination through the soil root interface ([Apau et al. 2014](#)).

Urbanization, fast and unorganized industrialization has contributed to the increased level of metals in the urban area in the developing nations. These heavy metals which are non-biodegradable and are pollutant are deposited on the soil surfaces are being absorbed into the tissues of plants. Plant takes up these heavy metals by absorbing them [Amoah \(2008\)](#).

Smokes from automobiles often contains high concentration level of heavy metals, these elements at high concentration exceeding the physiological demand of plants could discharge toxic in the plants and also could enter the food chain, get biomagnified and pose a potential threat to human's health. Thus, this research was designed to investigate heavy metals accumulation in cassava leaves (*Manihot esculenta*) cultivated along east-west road in River's state, Nigeria.

## **2. MATERIALS AND METHODS**

### **2.1 DESCRIPTION OF STUDY AREA**

The study area East-West Road is a major road that connects different Local Government Areas in Rivers State. The specific areas of study include Ndele, Nonwa, and Odhiolugboji in Emohua, Tai, and Ahoada West L.G.A respectively, Rivers State, Nigeria.

Ndele is a town located in Emohua L.G.A of Rivers State. Ndele is located approximately between latitude 04058'05"-040 58'08" N and longitude 0060 44'

44'-0060 45'05"E. It is bounded to the north by Elele alimini and then to the south by Rumuekpe.

Ahoada West is a city in Orashi Region of Rivers State, Nigeria, located northwest of Port Harcourt. It is located between Latitude: 5° 4' 58.1412" N and Longitude: 6° 39' 30.4812" E.

Nonwa is a town located in Tai L.G.A of Rivers state. It is located between Latitude 4.71670N and Longitude 7.30000E.

### **2.2 SAMPLE COLLECTION AND TREATMENT**

Fresh cassava leaves, cassava tubers and peels were randomly collected from six spots (25 meters apart) from three different farmlands cultivated along east-west road, in Rivers State (farm SX, SY, and SZ). The samples were identified and packed into polyethylene bags. Each of the cassava samples were pooled together to obtain good representation and then divided into three portions for composite replicate analyses (Alinnor, 2004). The samples were washed with tap water to remove any surface deposits (dust and any other particles that may act as contaminants), and rinsed with distilled water. They were sliced using knife to aid drying at room temperature. The samples were air dried for four days in the laboratory to remove moisture and oven-dried at 60 ° C to a constant weight. The dried samples were pulverized to fine powder using a mortar and pestle. Each of the processed powder was subjected to acid digestion (Alinnor, 2004) and the concentrations of the heavy metals Cd, Cr, Pb, As and Ni in the solutions were determined using Solar Thermo Elementary Atomic Absorption Spectrometer, ModelSG 71906.

### **2.3 ACID DIGESTION OF THE SAMPLES**

A measured weight (2 g) each of ground samples (leaves, peels and tubers) was put into separate beakers, digested with 12 ml of aqua regia HNO<sub>3</sub>/ HCl (1:3) on a hot plate at 70° C until the brown fumes disappeared. Heating was continued until the brown fumes turned to white. 20 ml of distilled water was added and heated until a colourless solution was obtained. The solution was allowed to cool and after cooling, the digested samples were filtered using Whatman No1 filter paper. The filtrates were made up to 100mls mark in volumetric flasks with distilled water (Alinnor, 2004). The concentrations of the heavy metals (Cd, Cr, As, Ni and Pb) in the cassava samples were determined using Solar Thermo Elementary Atomic Absorption Spectrometer, ModelSG 71906.

### 3. RESULTS

**Table 1 Concentration of Nickel (Ni) mg/kg in cassava leaves, cassava peels and cassava tubers sourced from different farmlands cultivated along east-west road.**

Cassava samples	SX	SY	SZ
Cassava Leaves	2.110±0.880	3.916±0.903	2.417±0.892
Cassava tubers	1.532±0.091	2.107±0.099	2.607±0.076
Cassava Peels	2.472±0.072	4.064±0.035	3.077±1.231
WHO safe limit	67.00		

Data are presented as mean ± SD, <0.001 = below detection limit, SX= Samples from Ndele, SY= Samples from Nonwa, SZ = Samples from Odhiolugboji

#### 3.1. NICKEL (NI)

From the research, nickel was found to be present in all the cassava samples (leaves, peels and tubers) that were analyzed. The estimated concentration of nickel (Ni) present in leaves ranged from 3.916±0.903 mg/kg > 2.417±0.892 mg/kg > 2.110±0.880 mg/kg in SY, SZ, and SX respectively, with samples from SY having the highest concentration while SX had the least concentration. In tubers, SZ (2.607±0.076 mg/kg) had the highest concentration followed by SY (2.107±0.099 mg/kg) and SX (1.532±0.09 mg/kg). Also, SY, SZ and SX had values of 4.064±0.035 mg/kg, 3.077±1.231mg/kg and 2.472±0.072 mg/kg respectively. The concentrations of nickel (Ni) in the samples were below the maximum permissible concentration of 67 mg/kg set by WHO. Analysis of variance (one way ANOVA) findings among the three communities showed statistically significant difference (p>0.05).

The mean value of nickel obtained in this study is however slightly higher than the work of Matthews – Amune and Kakulu 2013 (0.06±0.005 mg/kg) [Mathews-Amune and Kakulu \(2012\)](#), Ubwa et al., 2013 (0.1031 mg/kg) [Ubwa et al. \(2013\)](#), but lower than the work of Oguntimehin and Ipinmoroti 2007 (25.01 mg/kg) [Oguntimehin and Ipinmoroti \(2007\)](#), [Ogundiran and Osibanjo \(2009\)](#) (24.4±10.1 mg/kg) [Ogundiran and Osibanjo, \(2009\)](#), [Nwachukwu et al. \(2013\)](#) (25.12mg/kg) [Nwachukwu et al. \(2013\)](#), [Pam et al. \(2013\)](#) (18.4mg/kg) [Pam et al. \(2013\)](#) and that of Ajiwe et al., 2018 (45.25 mg/kg and 20.25 mg/kg in tubers and leaves respectively) [Ajiwe et al. \(2018\)](#). Nickel was not detected by [Akaniwor et al. \(2005\)](#). Similar observation has been reported [Ano et al. \(2007\)](#), [Osakwe \(2009\)](#), [Nabulo et al. 2006](#).

Though this study did not reveal any risk of acute toxicity, the slight increase in the concentration of Ni in the cassava plants may represents a risk in the future.

**Table 2 Concentration of Lead (Pb) mg/kg in cassava leaves, cassava peels and cassava tubers sourced from different farmlands cultivated along east-west road.**

Cassava samples	SX	SY	SZ
Cassava Leaves	1.406±0.971	3.372±1.059	1.869±1.029

<b>Cassava tubers</b>	0.633±0.102	2.548±0.084	2.671±0.121
<b>Cassava Peels</b>	1.764±0.064	3.749±0.051	2.415±1.065
<b>WHO safe limit</b>	0.30		

Data are presented as mean ± SD, <0.001 = below detection limit, SX= Samples from Ndele, SY= Samples from Nonwa, SZ = Samples from Odhiolugboji

### 3.2. LEAD (PB)

This study revealed that lead (Pb) was detected in the cassava samples from the three farmlands.

The concentration of lead in cassava leaves varies from one community to another as shown in [Table 2](#), the highest concentration of lead in leaves was observed in SY (3.372±1.059 mg/kg) followed by SZ (1.869±1.029 mg/kg) and SX had the least value (1.406±0.971mg/kg). Concentration of lead (Pb) was also observed in the cassava tubers as follows; 2.671±0.121mg/kg, 2.548±0.084 mg/kg and 0.633±0.102 mg/kg for SZ, SY and SX respectively with SZ (2.671±0.121 mg/kg) having the highest concentration while SX (0.633±0.102 mg/kg) had the least. Concentration of Pb in cassava peels ranged from 3.749±0.051 mg/kg > 2.415±1.065 mg/kg > 1.764±0.064 mg/kg in SY, SZ and SX respectively. Analysis of variance (one way ANOVA) findings among the three communities showed no statistically significant difference (p>0.05).

This research work is in consonant with Udiba et al., 2019 (3.75 mg/kg, 2.59 mg/kg and 0.43mg/kg of lead in cassava peels, cassava tubers and cassava leave respectively) [Udiba et al. \(2019\)](#). The detection of Pb in various cassava samples (leaves, peels and tubers) may be attributed to the pollution from automobiles due to the proximity of the farmlands to a highway. Other likely sources of Pb are pollutants in irrigation water or farm soil on which the cassava was grown [Qui et al. \(2000\)](#). The concentration of Pb in the cassava is enough to cause toxicity as they are above WHO recommended permissible limit of 0.3mg/kg. The concentrations of lead in the cassava tubers recorded in the study were also higher than the available reported human toxicity levels of 1.00 mgPb/day [Abah et al. \(2013\)](#).

Consumption of cassava from these communities thus poses significant risk of lead toxicity. The results obtained in this research work were higher than the work of Nwocha et al., 2011(1.93mg/kg) [Nkwocha et al. \(2011\)](#), Abah et al., 2013 (0.840±0.230 mg/kg, 0.850±0.270 mg/kg and 0.870±0.250 mg/kg) [Abah et al. \(2013\)](#), [Osabohien et al. 2013](#) (0.012 mg/kg to 0.018 mg/kg) [28], and Ogbolu et al., 2019 (0.60-0.90mg/kg) [Ogbolu et al. \(2019\)](#), and lower than the work of Okoronkwo et al., 2005 (76.6±19.94 mg/kg) [Okoronkwo et al. \(2005\)](#).

However, chronic poisoning may not be ruled out since cassava peels are feed directly to livestock. The metal is thus introduced into the food chain through livestock. After absorption and distribution in the blood, Pb is initially distributed to soft tissues throughout the body. Eventually the bones accumulate the toxic metal over a much longer period [Idakwoji \(2016\)](#). As it is the custom to consume the whole animal when slaughtered, the consumption of edible tissues of food animals fed with cassava peels from the area over time might also cause high accumulation of lead. In Nigeria and many other countries of the world, meat and milk from cattle, goats and sheep are some of the most common sources of animal protein [Ogabiela, et al. \(2011\)](#). Plants readily bio-accumulate large quantity of Lead through their roots

without much changes in their total yield and appearances [Park et al. \(2011\)](#), [Oti and Nwabue \(2013\)](#).

Research on the field have also shown that Lead accumulation could be anthropogenic, can also be very chronic when occurred above permissible limits, causes body ailments and easily leads to the weariness of the body tooth and bones [Onyedika and Nwosu \(2008\)](#), [Ezeh and Chukwu \(2011\)](#), [Oti and Nwabue \(2013\)](#).

Lead is a non-essential heavy metal. Lead causes oxidative stress and contributes to the pathogenesis of lead poisoning by disrupting the delicate antioxidant balance of the mammalian cells. High level accumulation of Pb in body causes anemia, colic, headache, brain damage, and central nervous system disorder [Rehman et al. \(2013\)](#). Consumption of Pb in edible plants poses a health risk to consumers. Lead is the most common of the heavy metals, accounting for 13 mg/kg of the earth's crust. Lead has no known biological function [Wepener et al. \(2001\)](#). The absorption of Pb is influenced by food intake with higher rates of absorption. Lead is a classical chronic or cumulative poison. In humans, Pb is known to cause a lot effects in the body system depending on the level and duration of exposure [Idakwoji \(2016\)](#). Due to the rapid rate of absorption in children, they are often more vulnerable to the effects of lead than adults [Idakwoji \(2016\)](#).

**Table 3 Concentration of Arsenic (As) mg/kg in cassava leaves, cassava peels and cassava tubers sourced from different farmlands cultivated along east-west road.**

Cassava samples	SX	SY	SZ
Cassava Leaves	0.024±0.961	0.849±0.781	0.246±0.917
Cassava tubers	<0.001	1.384±0.089	0.160±0.075
Cassava Peels	0.142±0.012	1.528±0.172	0.308±0.987
WHO safe limit	0.1		

Data are presented as mean ± SD, <0.001 = below detection limit, SX= Samples from Ndele, SY= Samples from Nonwa, SZ = Samples from Odhiolugboji

### 3.3. ARSENIC (AS)

From [Table 3](#), the levels of arsenic in leaves were 0.024±0.961 mg/kg, 0.849±0.781 mg/kg and 0.246±0.917 mg/kg in SX, SY and SZ respectively with SY (0.849±0.781 mg/kg) had the highest concentration. The results shows that arsenic was not detected in cassava tubers from SX (<0.001) as it was below detection limit but present in SY (1.384±0.089 mg/kg) and SZ (0.160±0.075 mg/kg). Also, the results obtained in cassava peels were 0.142±0.012 mg/kg, 1.528±0.172 mg/kg and 0.308±0.987 mg/kg in SX, SY and SZ respectively with SY having the highest concentration (1.528±0.172 mg/kg) while SX had the least concentration (0.142±0.012 mg/kg). It was observed from the result that the concentration of arsenic was above FAO/WHO permissible level of 0.1mg/kg except in cassava tubers from SX. Analysis of variance (one way ANOVA) findings among the three communities showed no statistically significant difference ( $p>0.05$ ).

High level of arsenic can cause death [Galadima and Garba \(2012\)](#). It was also reported that arsenic exceeding permissible limit (0.1mg/kg) in food stuff could cause in the short term (nausea, vomiting, diarrhea, cough and headache) long term

(cardiovascular diseases, diabetes and vascular diseases) human health effects [Galadima and Garba \(2012\)](#). The values obtained correspond with that of Essumang 2015 (0.017 mg/kg and 0.0 1mg/kg) [Essumang \(2015\)](#), Makanjuola 2016 (0.32mg/kg and 0.36mg/kg) [Makanjuola \(2006\)](#) and Ogbolu et al 2019 (0.24 mg/kg) [Ogbolu et al. \(2019\)](#). Consumption of cassava from these communities thus poses significant risk of arsenic toxicity as they were above FAO/WHO permissible level of 0.1 mg/kg. High level of arsenic can cause death [Col et al. \(1999\)](#).

**Table 4 Concentration of Cadmium (Cd) mg/kg in cassava leaves, cassava peels and cassava tubers sourced from different farmlands cultivated along east-west road.**

Cassava samples	SX	SY	SZ
Cassava Leaves	0.029±0.570	0.098±1.057	0.038±0.609
Cassava tubers	<0.001	0.138±0.109	<0.001
Cassava Peels	0.0138±0.002	0.435±0.076	0.021±1.089
WHO safe limit	3.0		

Data are presented as mean ± SD, <0.001 = below detection limit, SX= Samples from Ndele, SY= Samples from Nonwa, SZ = Samples from Odhiolugboji

### 3.4. CADMIUM (CD)

From [Table 4](#), Cadmium concentrations in leaves were 0.029±0.570 mg/kg, 0.098±1.057 mg/kg and 0.038±0.609 mg/kg in SX, SY and SZ respectively. In tubers, cadmium was not detected in SX and SZ as they were below detection limit; however, cadmium was only detected in SY (0.138±0.109 mg/kg). The result also showed that 0.0138±0.002 mg/kg, 0.435±0.076 mg/kg and 0.021±1.089 mg/kg were found in peels from SX, SY and SZ respectively. The mean concentration of cadmium in leaves (0.055±0.745 mg/kg), tubers (0.138±0.109 mg/kg) and peels (0.157±0.389 mg/kg) in the various samples and were below W.H.O permissible limit of 3.0mg/kg. Analysis of variance (one way ANOVA) findings among the three communities showed no statistically significant difference ( $p>0.05$ ).

The mean concentrations of cadmium in the various cassava peels, leaves and tubers were within the range of the values recorded by Dioborfori-Orji and Edori 2015 (0.04± 0.00 mg/kg) [Dibofori-Orji and Edori \(2015\)](#), Essumang 2015 (0.002 mg/kg) [Essumang \(2015\)](#), Enemugwem et al., 2016 (0.18 mg/kg), Idakwoji 2016 (0.02± 0.01mg/kg) [Idakwoji, 2016](#), and lower than 2.6 mg/kg reported by Mbong et al., 2014 (2.6mg/kg) [Mbong et al. \(2014\)](#).

Although the values recorded in this research were below W.H.O safe limit of 3.0 mg/kg in the long term, toxicity might however, arise from chronic accumulation of Cd if these plants are continuously consumed. The kidneys and liver store about 50 to 85% of Cd in the body with 30 to 60% being stored in the kidneys [Anyakora et al. \(2011\)](#). Cd has no known biological functions in the body but it interferes with some essential function of Zn, thereby inhibiting enzyme reactions and nutrient utilization. It catalyzes oxidation reactions, generating free-radical tissue damage [WHO \(World Health Organisation\). \(1996\)](#).

**Table 5 Concentration of Chromium (Cr) mg/kg in cassava leaves, cassava peels and cassava tubers sourced from different farmlands cultivated along east-west road.**

Cassava samples	SX	SY	SZ
Cassava Leaves	2.968±0.102	4.763±0.089	0.038±0.609
Cassava tubers	1.693±0.18	3.914±0.061	2.672±0.098
Cassava Peels	3.182±0.110	5.075±0.063	3.243±1.013
WHO safe limit	30.00		

Data are presented as mean ± SD, <0.001 = below detection limit, SX= Samples from Ndele, SY= Samples from Nonwa, SZ = Samples from Odhiolugboji

### 3.5. CHROMIUM (CR)

From the results in [Table 5](#), chromium was found to be present in all the cassava samples (leaves, peels and tubers). The concentration of chromium (Cr) present in leaves ranged from 4.763±0.089 mg/kg>2.968±0.102 mg/kg>0.038±0.609 mg/kg in SY, SX, and SZ respectively, with samples from SY (4.763±0.089 mg/kg) having the highest concentration while SZ (0.038±0.609 mg/kg) had the least concentration. In tubers, SY (3.914±0.061 mg/kg) had the highest concentration followed by SZ (2.672±0.098 mg/kg) and SX (1.693±0.18 mg/kg). Also, SY, SZ and SX had values of 5.075±0.063 mg/kg, 3.243±1.013 mg/kg and 3.182±0.110 mg/kg respectively in the peels. Analysis of variance (one way ANOVA) findings among the three communities showed no statistically significant difference ( $p>0.05$ ).

The mean values recorded in this research were lower than WHO permissible limits of 30.0 mg/kg but higher than those reported by Ubwa et al., 2013 (0.05 mg/kg) [Apau et al. \(2014\)](#), Osakwe et al., 2014 (0.40±0.13 mg/kg) [Osakwe et al. \(2014\)](#), Dioborfori-Orji and Edori 2015 (0.14± 0.01 mg/kg) [Dibofori-Orji & Edori \(2015\)](#), [Makanjuola 2016](#) (0.08mg/kg and 0.11mg/kg) [Makanjuola \(2006\)](#), and [Ogbolu, Nwachukwu et al. \(2019\)](#) (0.04-0.09mg/kg) [Ogbolu et al. \(2019\)](#) and lower than the work of [Asaah et al. \(2006\)](#) (60.6 mg/kg) [Asaah et al. \(2006\)](#), Oguntimehin and Ipinmoroti 2007 (30 mg/kg- 45mg/kg) [Oguntimehin and Ipinmoroti \(2007\)](#). High level of chromium in industrial effluents has been reported by [Rawat et al. \(2003\)](#). Chromium is commonly found at contaminated sites in form of chromium (VI) and it is the dominant form of chromium in shallow aquifers where aerobic conditions exist [Wuana and Okieimen \(2011\)](#).

Chromium plays a vital role in the metabolism of cholesterol, fat, and glucose. Its deficiency causes hyperglycemia, elevated body fat, and decreased sperm count, while at high concentration it is toxic and carcinogenic [Chishti et al. \(2011\)](#). Chromium is associated with allergic dermatitis in humans [Scragg \(2006\)](#). Epidemiological studies have shown that some chromium components have carcinogenic effects [Moore and Ramamoorthy \(1984\)](#).



## 4. CONCLUSION AND RECOMMENDATIONS

### 4.1 CONCLUSION

This study revealed the various concentrations of some metals: Pb, Cd, As, Ni, and Cr in cassava leaves, peels and tubers collected from different farmlands along major highways in Rivers State, Nigeria. It was seen from the results obtained that the cassava leaves; peels and tubers from the three different farmlands had different levels of heavy metals as a result of the smokes from automobiles.

Comparative analysis reveals different level of heavy metals from the three communities and samples from Nonwa community (SY) had the highest level of heavy metal in its cassava peel. This may be due to the excessive influx of automobiles that moves towards the Ogoni axis.

Finally, this study revealed that arsenic and cadmium were not detected in cassava tubers samples from SY community and that the major pollutant for cassava leaves, peels and tubers were Pb, Ni and Cr. The concentrations of these heavy metals were not statistically significant, except for Ni. There is need to monitor more closely the environment under study, to ensure that appropriate distance is given before cassava is cultivated in order to reduce the availability of these heavy metals in consumable crops consumed by inhabitants of these communities thereby preserving the health of these inhabitants.

### 4.2 RECOMMENDATION

The influence of motor vehicle emission on cassava planted along major highways was evaluated by comparing the level of heavy metal on cassava leaves, peels and tubers from farmlands in three communities in River's state. There were substantially higher levels of Pb, Ni and Cr in the cassava samples (leaves, peels and tubers). It is therefore recommended that agricultural farms should not be situated close to highways to prevent excessive build-up of heavy metals in the food chain.

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