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Full Length Research Paper

Lead and total hydrocarbon levels in *Vernonia amygdalina* and *Telfairia ocidentalis* along roadside farms in Port Harcourt, Nigeria

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The concentrations of lead (Pb) and Total Hydrocarbon (THC) in bitter leaf (*Vernonia amygdalina*) and pumpkin (*Telfairia ocidentalis*) collected along roadsides in Port Harcourt and environs were determined using GBC Avanta flame Atomic Absorption Spectrophotometer version 2.02 for Pb and Spectrophotometer 21D for THC. The highest concentrations of Pb in bitter leaf were 12.56mg/kg in the dry season and 10.05mg/kg in the rainy season while the highest concentrations of THC in bitter leaf were 25,114mg/kg in the dry season and 20,950mg/kg in the rainy season. The highest concentrations of Pb in pumpkin were 8.28mg/kg in the dry season and 7.08mg/kg in the rainy season while the highest concentrations of THC in pumpkin were 15,784mg/kg in the dry season and 13,768mg/kg in the rainy season. The concentrations of Pb and THC in bitter leaf were higher than the concentrations in pumpkin. Similarly the concentrations measured in the dry season were higher than the concentrations measured during the rainy season. The differences between the dry and rainy seasons concentrations were significant ($P<0.05$). The differences in THC concentrations between bitter leaf and pumpkin were significant ($P<0.05$) while the case of Pb concentrations were not significantly different ($P>0.05$). The concentrations of THC in bitter leaf and pumpkin were considered high while the concentrations of Pb exceeded tolerable and natural limits. The concentrations of Pb and THC in the plants were influenced by traffic densities, season and ages of the plants. Thus the raw consumption of exposed vegetables from markets and roadside farms is discouraged.

Keywords: Total Hydrocarbon, Sample, Bitter leaf, Lead, Pumpkin, Seasonal variation, Roadside.

INTRODUCTION

The two main sources of pollutants in urban areas are transportation (predominantly automobiles) and fuel combustion in stationary sources, including residential, commercial, and industrial heating, cooling and coal-burning power plants (Socha. 2007).

Pollution by heavy metals occurs largely from industrial, domestic and agricultural wastes as well as from combustion of fossil fuels by automobiles and industries (Odukoya *et al*, 2000). Onianwa, *et al* (1983) reported that; in addition, to natural sources, trace metals are emitted through great variety of technical and industrial processes, such as metal smelters and petrochemical plants. The trace metals may enter food chain from soil through mineralization by crops or environmental contamination as in application of agricultural input such in pesticides, fertilizers or use of polluted river for irrigation to water crops (Abdullahi *et al.*, 2008; Miller, 1996; Onianwa *et al.*, 2001; Audu and Lawal, 2005; Mohamad *et al.*, 2006).

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Lead (Pb) is one of the trace metals that accumulate in the body and has variety of harmful effects, including brain damage in high concentrations (Montgomery, 1992). Mild lead poisoning in the nervous system can cause depression, nervousness, apathy and other psychological disorders, as well as learning difficulties. The symptoms of lead poisoning are abdominal pain, nausea, numbness of the hand, feet and muscle cramp. Ideriah, (1996) reported that lead is a non-essential element for man and has toxic potential for all biological systems. The biological effects of lead include effects on haem biosynthesis, the nervous system, kidneys, reproduction, immune system and also cardiovascular, hepatic endocrinal and gastrointestinal effects (WHO, 1987).

UNEP and WHO, (1988) report stated that children show greater susceptibility to lead than adults. The toxicity of lead has long been recognized and the causes of lead poisoning range from acute elemental ingestion to chronic environmental and industrial exposure (Waldron, 1980 and Ajayi *et al*, 2001). Lead is therefore of interest because of its many different sources, high environmental concentrations, high levels of exposure and high toxicity (Chisolm, 1971 and Ajayi et al., 2001).

A tolerable quantity of 3mg weekly Pb intake was reported by Waquar (2006) who asserted that the maximum concentration of Pb which is permitted in prepared foods specifically intended for babies or young children is 200µg/kg (FAO/WHO, 1993). Cunningham and Saigo (1997) reported that many metals such as mercury, lead, cadmium and nickel are highly toxic.

Hart *et al*, (2005) reported lead concentration range from 2.4µg/g to 8.6µg/g for pumpkin (*Telfairia Ocidentalis*) grown in highly industrialized areas like Trans-Amadi and oil polluted environment in Rivers State (e.g. Ebocha and Aghada-Alu). The report further stated that these results effect higher concentration of metals in crops from the industrialized locations with the green vegetables, particularly pumpkin leaves, having the highest uptake. These findings give cause for concern, particularly a serious health risk to man and animals.

Gbaruko and Friday (2007) in their report, showed a high level of Pb in the leaves of bitter leaf (*Vernonia amygdalina*). Pb in the bitter leaf was 0.41 ± 0.02 µg/g in oil and industrialized (polluted) areas. This level is far beyond the tolerable level of 0.001µg/g set by WHO and is of great public health concern.

Ideriah, (1996) studied the lead concentrations in food crop found along roadsides and reported that some stations exceeded the natural limit of 0.05- 3ppm. The report also showed that the crops lead concentrations were very low compared to the threshold limit of 12-20ppm.

Hydrocarbons (HC) are a group of chemical compound composed of carbon and hydrogen. When in a gaseous form, HC are called Volatile Organic Compounds (VOC). Several HC and VOC are heavy gases or volatile compounds with a strong odour. They are mostly the result of the incomplete combustion of gasoline or by-products of the petrochemical industry. They include methane (CH_4), gasoline (C_8H_{18}) and diesel vapours, benzene (C_6H_6), formaldehyde (CH_2O), butadiene (C_4H_6) and acetaldehyde (CH_3CHO), (Jean-Paul *et al,* 2009). Volatile organic compounds are emitted from a variety of sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products, and other industrial sources. Volatile organic compounds are also emitted by natural sources such as vegetation. (http://www.mde.state.md.us/Programs/AirPrograms/Mobile).

Contaminants in the air can cause the stomata or pores of a plant leaf to close. Stomata are where gas exchange occurs with the atmosphere. If plants cannot get adequate carbon dioxide from the air, photosynthesis ceases. In effect, a plant cannot exist without this means to make food and produce energy. Even a reduction in photosynthesis can have ill effects. Reduced growth in leaves and fruit make plants less productive. In turn, the wildlife that uses these plants is affected. Chemicals building up in leaves and soil can further impact wildlife. (http://www.ehow.com/about_5456523_effects-air-pollution-plants.html, 2010).

Air pollution injury to plants can be evident in several ways. Injury to foliage may be visible in a short time and appear as necrotic lesions (dead tissue), or it can develop slowly as a yellowing or chlorosis of the leaf. There may be a reduction in growth of various portions of a plant. Plants may be killed outright, but they usually do not succumb until they have suffered recurrent injury (Heather, 2009).

MATERIALS AND METHODS

STUDY AREA

The study area, Port-Harcourt, is a highly industrialized city of Nigeria, a major industrial center as it has a large number of multinational firms as well as other industrial concerns, particularly businesses related to the petroleum industry. It is the chief oil-refining city in Nigeria, oil being one of Nigeria's most important commodities and the main foreign exchange earner.

Port-Harcourt lies within latitudes 4 º43' and 4 º54'N and longitudes 6 º56' and 7 º03'E, 59 feet (18 meters) above sea level with a mean annual rainfall of over 2000mm and mean annual temperature of about 29ºC (NMS 1998). Port-Harcourt city covers an area of 186km^2 (71.8sq mi). Land area of 170km^2 (65.6sqmi), Water, 16km^2 (6.2sqmi) and Metro, 462km^2 (178.4sqmi). (http://en.wikipedia.org/wiki/Port-Harcourt, 2009). The population of Port-Harcourt is estimated at 1,620,214 in the year 2007 (http://en.wikipedia.org/wiki/PortHarcourt,

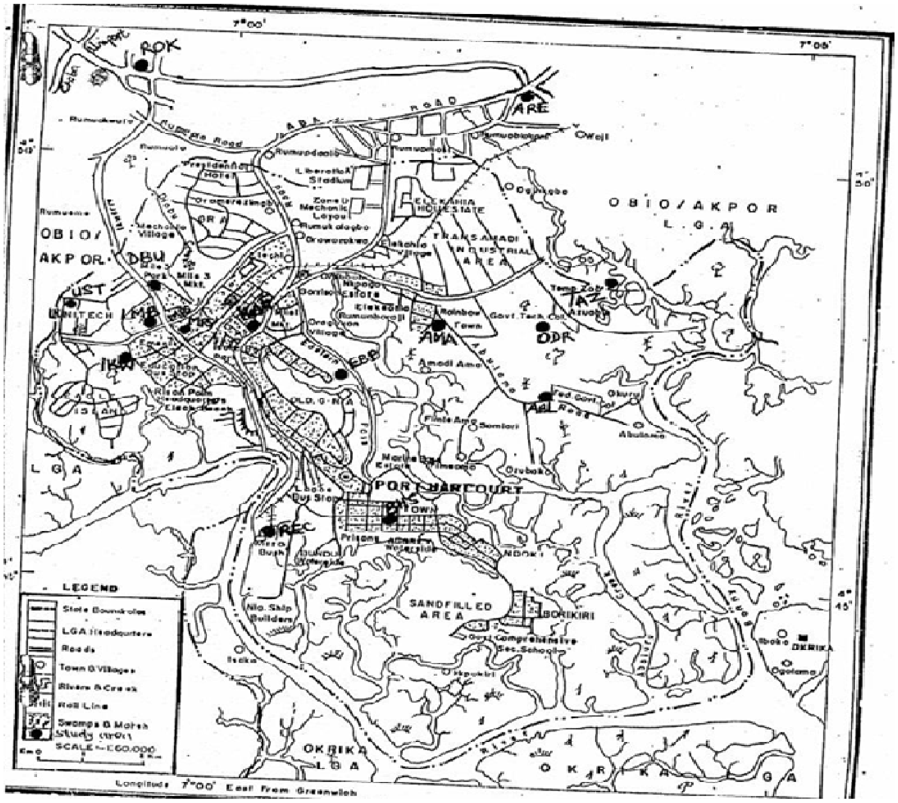

Figure 1. Map of Port Harcourt showing study area

2009). Port-Harcourt urban area is 2.7 million while the greater Port-Harcourt is almost 3.7 million in population (http://en.wikipedia.org/wiki/Port-Harcourt, 2009). The main city of Port-Harcourt is the Port-Harcourt town in the Port Harcourt City Local Government Area, consisting of the former European quarters now called Old Government reservation area (GRA) and New layout areas. The Port Harcourt Urban Area (Port-Harcourt metropolis) is made up of the city itself and parts of Obio/Akpor Local Government Area. Important neighbouring towns are Diobu which is a Rebisi settlement, Abuloma which is an Okrika settlement, Woji which is an Ikwere settlement, Alesa Eleme which is an Ogoni settlement and many other Ikwerre clans. All these settlements are collectively known as Greater Port-Harcourt. Some of Port-Harcourt's more popular and well known residential areas are the Port-Harcourt Township also known as Town, G.R.A phases 1-5. Abuloma, Amadi-ama, Amadi Flats, and Borikiri. The main industrial area is located in Trans Amadi (http://en.wikipedia.org/wiki/Port_Harcourt, 2009).

Sample Collection and preparation

Samples of pumpkin (*Telfairia Occidentalis*) leaves and Bitter leaf (*Vernonia Amygdalina*) from farms located along roadsides were collected from fifteen locations (Figure 1) in November 2010 (Dry season) and June 2011 (Rainy season). The leaves were dried to constant weight in an oven at 90ºC, pulverized to fine powder using a laboratory mill and stored in airtight plastic containers. The sampling locations and their codes are Trans Amadi/Zoo (TAZ), Banham street (BHS), Reclamation road (REC), Eastern By-pass (EBP), Amadi Ama/Rainbow (AMA), Federal Government College Abuloma (ABL), Aba road/Eleme junction (ARE), Kaduna/Afam street (KAF), Ikwerre street (IKW), Lumumba street (LMB), Diobu mile 3 park (DBU), Rumuokoro (RUM), Manilla Pepple street (MPS), Peter Odilli road (POR) and University of Science and Technology road E (UST).

Sample Analyses

Two grams (2.0g) each of powdered leaf samples was weighed into a 50ml beaker and digested with 10ml of nitric acid (HNO_3) and 2ml of perchloric acid ($HC1O_4$). The entire content was heated to a temperature of 125ºC for 2 hours. The digest was filtered with Whatman filter paper into a 50ml standard flask. Two 5ml portions of

Table 1. Concentrations (mg/kg) of Lead and Total Hydrocarbon in Bitter leaf and Pumpkin measured at the study locations

Location	**Code**	**Bitter leaf**				**Pumpkin**			
		THC		**Pb**		**THC**		**Pb**	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Trans Amadi/zoo	TAZ	15,340	12,808	10.56	10.05	10,440	8,780	7.89	6.80
Banham Street	BHS	2,619	1,260	7.72	6.89	1.940	1,222	6.59	5.26
Rumuokoro Jnc.	ROK	25,114	20,950	8.28	8.00	15,784	13,768	7.56	6.98
Diobu Mile 3 park	DBU	13,610	10,988	6.76	4.15	7,160	5,952	3.08	2.46
UST Road E	UST	2,288	2,029	5.28	1.57	1,442	1,148	9.50	7.88
Aba road/Eleme Jnc.	ARE	18,619	15,260	12.56	9.62	12,682	8,860	8.28	7.08
FGC Abuloma	ABL	5,618	2,942	4.56	3.02	4,594	4,054	6.83	6.06
Eastern By-pass	EBP	3,560	2,946	5.32	3.66	3,105	2,950	3.02	2.47
Amadi Ama/Rainbow	AMA	6,745	4,580	5.55	3.97	3,567	2,988	3.96	3.21
Peter Odili Road.	POR	8,248	5,622	7.20	5.46	5,460	4,748	4.67	3.78
Kaduna /Afam Street	KAF	1,224	945	6.24	5.46	874	689	2.78	2.06
Ikwerre Street	IKW	840	389	56.3	45.8	711	627	6.9	5.4
Lumumba Street	LMB	688	474	2.75	1.69	601	496	2.00	1.26
Manila Pepple Street	MPS	561	423	2.48	1.22	497	384	1.72	1.05
Reclamation Road	REC	514	419	1.86	0.94	409	362	1.50	0.77

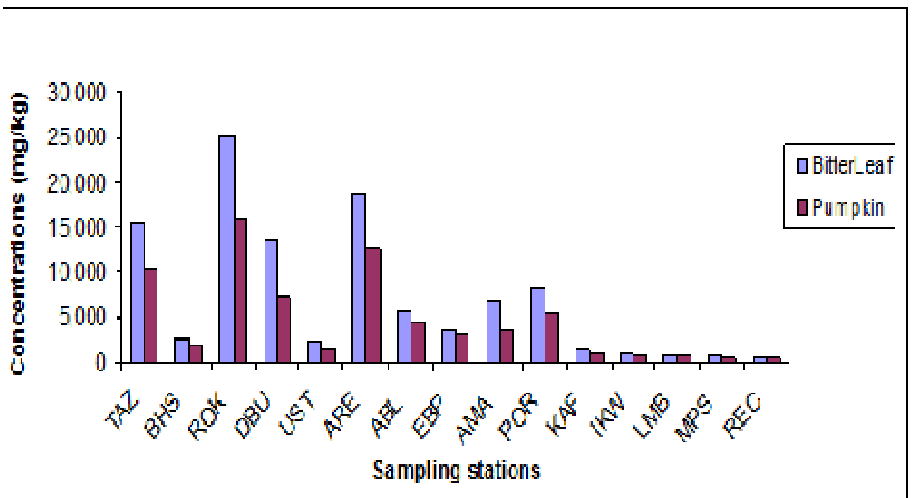

Figure 2. Variation in concentration of THC in Bitter leaf and Pumpkin at sampling station (Dry season)

distilled water were used to rinse the beaker and the content filtered into the 50ml flask. The filtrate was allowed to cool to room temperature before dilution was made to the 50ml mark with distilled water. The digests were analysed for Pb on Perkin Elmer AS 3100 Atomic Absorption Spectrophotometer.

One gram (1g) each of the pulverized leaf samples was extracted with 10ml of toluene and determined for THC using a 21D spectrophotometer at 410nm.

RESULTS AND DISCUSSION

The results of analyses of Pb and THC in bitter leaf and pumpkin samples from the sampling stations are presented in Table 1 while Figure 2-5 show the variations in the concentrations of the parameters in the dry and rainy seasons.

The concentrations of THC in bitter leaf varied between 514mg/kg at Reclamation road and 25,114mg/kg

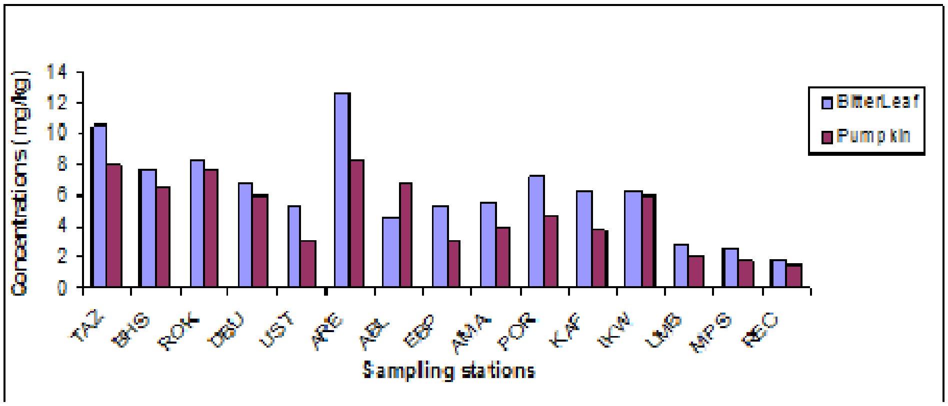

Figure 3. Variation in concentrations of Pb in Bitter leaf and Pumpkin at sampling station (Dry season)

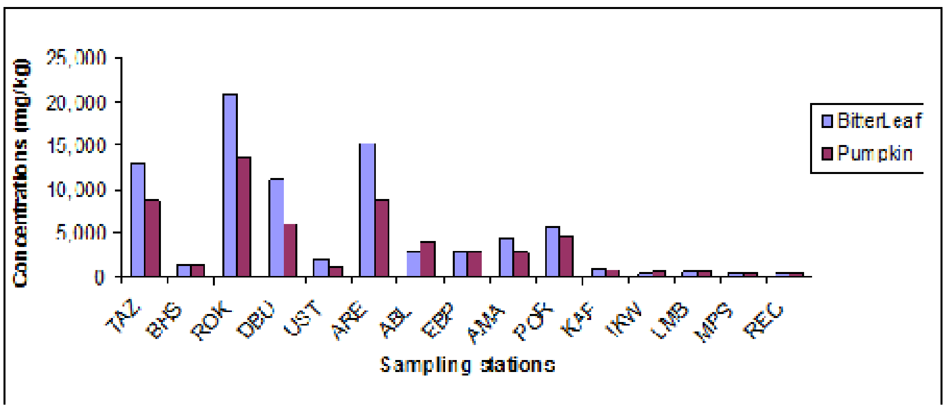

Figure 4. Variation in concentration of THC in Bitter leaf and Pumpkin at sampling station (Rainy season)

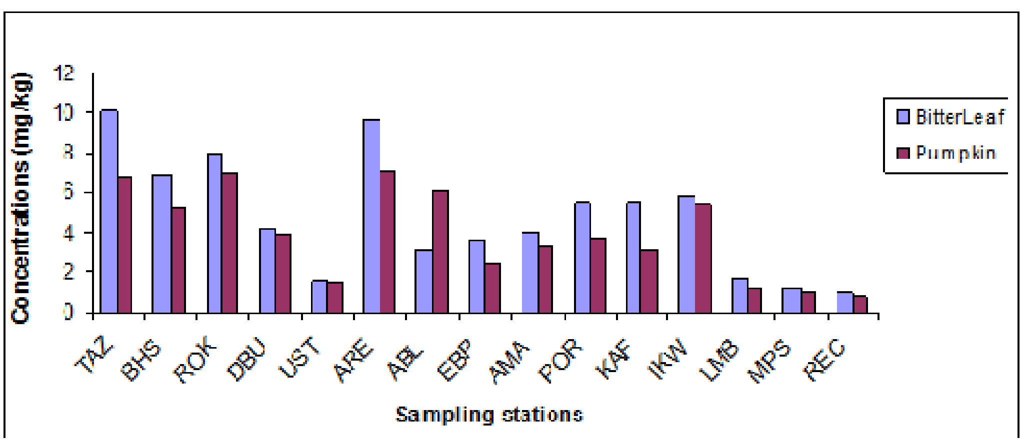

Figure 5. Variation in concentration of Pb in Bitter leaf and Pumpkin at sampling station (Rainy season)

at Rumuokoro with a mean of 7,039mg/kg±2035.34 in the dry season and between 419mg/kg at Reclamation and 20,950mg/kg at Rumuokoro junction with a mean of 5,469mgkg±1702.36 in the rainy season.

The concentrations of Pb in bitter leaf ranged from 1.86mg/kg at Reclamation road to 12.56mg/kg at Aba road/Eleme junction with a mean of 6.23mg/kg±0.73 in the dry season and 0.94mg/kg at Reclamation road to 10.05mg/kg at Trans Amadi/Zoo junction with a mean of 4.77mg/kg±0.71 in the rainy season.

The concentrations of THC in pumpkin ranged from 409mg/kg at Reclamation road to 15,784mg/kg at Rumuokoro junction with a mean of 4,618mg/kg±1273.62 in the dry season and 362mg/kg at Reclamation road to 13,768mg/kg at Rumuokoro junction with a mean of 3,802mg/kg±1043 in the rainy season.

The concentrations of Pb in pumpkin varied between 1.50mg/kg at Reclamation road and 8.28mg/kg at Aba road/Eleme junction with a mean of 4.86mg/kg±0.60 in the dry season and between 0.77mg/kg at Reclamation road and 7.08mg/kg at Aba road/Eleme junction with a mean of 3.90mg/kg±0.58 in the rainy season.

The concentrations of both THC and Pb in the dry season were higher than the concentrations in the rainy season. Also the concentrations of both parameters were higher in Bitter leaf than in pumpkin.

The highest concentrations of THC in both bitter leaf (25,114mg/kg, dry season and 20,950mg/kg, rainy season) and pumpkin (15,784mg/kg, dry season and 13,768mg/kg, rainy season) were measured at Rumuokoro junction. The least concentrations of both THC and Pb were measured at Reclamation road in both seasons.

The highest concentrations of Pb in both bitter leaf (12.56mg/kg) and pumpkin (8.28mg/kg) were measured at Aba road/Eleme junction in the dry season. However in the rainy season, the Pb concentrations were (10.05mg/kg) in bitter leaf at Trans Amadi and (7.08mg/kg) in pumpkin at Aba road/Eleme junction.

The dry season concentrations of THC and Pb were higher than the concentrations in the rainy season.

The concentrations of Pb in bitter leaf and pumpkin in all the stations except Aba road/Eleme junction in the dry season were below the recommended limit of 12-20mg/kg (Ideriah *et al* 2006). The variations in the concentrations of Pb and THC indicate the differences in the activities in the sampling areas. The concentration range of Pb in pumpkin (1.50-8.28mg/kg in dry season) measured in this study agrees with the concentration range of 2.4mg/kg-8.6µg/g in pumpkin reported by Hart *et al* (2005).

The concentration range of Pb in bitter leaf 1.86mg/kg-12.56mg/kg in the dry season measured in this study is higher than the highest concentration of 0.41µg/g Pb in bitter leaf reported by Gbaruko and Friday (2007).

The concentrations of Pb in both bitter leaf and pumpkin exceeded tolerable limit, 0.001µg/g and natural limit of 0.05 – 3ppm but are below threshold limit of 12-20ppm. The levels of the pollutants measured in this study are of serious health concern.

The dry season levels of THC and Pb were higher than the rainy season levels in all the stations. This is attributed to the cleansing effect of the rain. Statistical analysis showed significant difference ($P<0.05$) between the dry and rainy seasons concentrations of THC in bitter leaf ($r = 0.9962$) and pumpkin ($r = 0.9898$) and Pb in bitter leaf ($r = 0.9958$) and pumpkin ($r = 0.9950$).

The concentrations of THC and Pb in bitter leaf were higher than their concentrations in pumpkin. This implies that bitter leaf is a better accumulator of atmospheric pollutants.

Bitter leaf is usually chewed raw or cooked by humans and animals in the study area; thus the likely hood of negative impact on humans due to the elevated levels of these pollutants.

There was low correlation ($P<0.05$) between the concentrations of THC and Pb in bitter leaf ($r = 0.0660$) and pumpkin ($r = 0.4302$).

The differences in THC concentrations, between bitter leaf and pumpkin showed high positive correlation ($r = 0.9867$) in the dry season and ($r = 0.9802$) in the rainy season with no significant difference ($P<0.05$) between them. Alternatively, the differences in Pb concentrations between bitter leaf and pumpkin showed low correlation ($r = 0.3368$) in the dry season and ($r = 0.2840$) in the rainy season with significant difference ($P>0.05$).

The concentrations of lead measured in pumpkin are attributed to the extent of accumulation of Pb in the environment resulting from automobile emissions. This observation is in agreement with the report of Salami *et al*. (2002) who found that water lettuce accumulate Pb than did water lily. There are differences in the Pb concentrations at the stations. These differences in concentrations are attributed to the source of the pumpkin, fertilizers and variations in vehicular traffic that discharge dust particles into the environment. A study done in Akwa Ibom on pumpkin leaf grown in soil within the vicinity of a paint industry showed lead concentrations of 34mg/kg and 86mg/kg (Udosen, 1994). The results exceeded the recommended threshold limit range of 12 – 20mg/kg (Ideriah, 2006). Furthermore, the variations in the concentrations of lead in the various plants could be because plants differ in their uptake of and sensitivity of lead – a factor which depends on certain soil conditions and roots morphology (Hemphill, 1997 and Hart *et al*., 2005).

Concentrations in bitter leaf throughout the stations were within the recommended threshold limits (12 – 20mg/g) reported by Ideriah (2006). Similarly, considering a dietary intake of 1.5 µg/day as WHO safe standard, may not cause any health hazard to the populace.

The mean Total hydrocarbon content (19,695.45mg/kg) in plants collected during the dry season were significantly higher than the total hydrocarbon content in plants collected during the rainy season. This observation is attributed to the fact that air pollutant emissions and concentrations are higher during the dry season owing to meteorological factors such as high temperature, scavenging of the atmosphere by heavy rainfall.

The highest total hydrocarbon content (25,114.0mg/kg) was obtained in bitter leaf at Rumuokoro followed by 18,619 at Aba road/Eleme junction and 15,340 at Trans Amadi/Zoo. The high total hydrocarbon contents recorded at the stations are attributed to activities at major junctions linking different parts of the city with a mix of commercial and medium to small scale industries. Hydrocarbon is reported to be a major component of smoke (http://www.epa.vic.gov.au/air/aq4kids/main_pollutants.asp#top). Total hydrocarbons and volatile organic carbons are emitted from a variety of sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products and other industrial sources. (http://www.mde.state.md.us/Programs/AirPrograms/Mobile).

The variations of the THC in bitter leaf at the sampling stations were similar to the variations reported by Ideriah et al (2011) which showed high traffic density stations and dry season having higher values than low traffic density stations and rainy season.

The highest THC value (25,114mg/kg) in bitter leaf measured in this study is similar to the highest value (25,164mg/kg) reported by Ideriah et al. (2011). However, it was observed that while the highest value in the previous study was at Reclamation road, the highest value in the present study was at Rumuokoro. At the time of sampling young bitter leaf plants were sampled as a result of road maintenance and construction of drainages at Reclamation road. Similar observation was made at Manilla Pepple street where the present values (561mg/kg) were lower than the previous values (11,644mg/kg).

These observations show that the levels of HC and indeed the levels of pollutants in plants depend on the ages of the plant in addition to the traffic density. Therefore automobile activities contributed immensely to the levels of THC in bitter leaf in the area in agreement with Jean –Paul (2009) and Ideriah et al (2011).

The order of variations in concentrations of THC in bitter leaf and pumpkin were similar throughout the sampling station.

The similarity in the variations of THC in bitter leaf and pumpkin at the sampling stations indicate same source of the pollutant. The order of variations in concentrations of Pb in bitter leaf and pumpkin were similar only at three stations (ARE, TAZ and ROK) reported as high traffic density areas (Ideriah *et al*., 2011) but were not similar at the other stations. This observation implies that automobile is the major source of the pollutant at the stations.

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