Journal of Agriculture and Biological Sciences Vol.2(3) pp.065-070, June 2011.
Available online http://www.globalresearchjournals.org/journal/?a=journal&id=jabs

Full Length Research.

LEVELS OF TOTAL HYDROCARBON CONTENTS IN PLANTS ALONG SELECTED ROADSIDES IN PORT HARCOURT METROPOLIS, NIGERIA

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Accepted 15th May 2011

Hydrocarbon (HC) content in plants along selected roadsides and control sites in Port Harcourt were determined. Plant samples were collected at intervals of 0m and 50m from roads during the dry and rainy seasons. HC content in plants was determined using a 21D spectrophotometer. The mean HC contents in plants are (16,784.32mg/kg) for low density stations, (24,171.21mg/kg) for high density stations, (1,055.23mg/kg) for the rainy season, (19,695.49mg/kg) for dry season, (8,620.46mg/kg) for 50m and (12,130.26mg/kg) for 0m. Grass and orange leaves recorded the highest HC content with a mean value of 58,220.0mg/kg, while the least value (0.1424mg/kg) was recorded in Bitter leaf. The mean concentrations of HC in plants measured during the dry season were generally higher than the mean concentrations measured during the rainy season. The differences between the dry and rainy season values were significantly different at P≥0.05. HC measured at the high density areas were generally higher than those measured at low density areas. There was no significant difference in the mean concentrations of HC measured at 0m and those at 50m. The levels of HC in plants were influenced by traffic density, seasonal variations and distances from major roads, therefore farming activities and consumption of exposed foodstuffs are discouraged along busy roads in Port Harcourt.

Key words: Hydrocarbon, Plants, Traffic Density, Leaf samples, *Jeatropha curcas*, seasonal variation

INTRODUCTION

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). Transportation accounts from 40 to 50% of total emissions of HC/VOC. They can be emitted by incomplete combustion (70%), during refueling (10%) or by evaporation from storage units (20%), particularly gas tanks. For instance, a car parked overnight during summer emits approximately 4 grams of HC/VOC (Jean-Paul, 2009).

VOCs are also found in paints and solvents used to finish automotive bodies (Nesea, 2002). They evaporate and enter the air as vapour and as molecules resulting from the incomplete burning of fuels and wastes (www.wwfpak.org, 2009). VOCs react with NOx in the presence of sunlight to form low-level ozone. They also contribute to global warming. (Nesea, 2002).

VOCs are emitted from a variety of sources, including motor vehicles, chemical plants, factories, consumer and commercial products, and other industrial sources.VOCs

are also emitted by natural sources such as vegetation. (USEPA, 2001).

It has been reported that most fuel combustion processes results in the release of HCs to the environment.(EPA, 2001). Exposure to HCs can cause headaches or nausea, while some compounds may cause cancer. Some may also damage plants. (EPA , 2001).

The burning of HCs in motor vehicle engines gives rise to CO_2, CO, SO_2, NO_x (NO and NO_2 in varying proportions) and C_2H_4, as well as a variety of other HCs. Additional SO_2 originates from domestic and industrial burning of fossil fuels. Industrial plants, such as chemical works and metal-smelting plants, release SO_2, H_2S, NO_2, and HF into the atmosphere. (Eduardo, 2006).

Contaminants in the air can cause the stomata or pores of a plant leaf to close (Thomas, 1961). 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. (Thomas, 1961).

Agricultural crops can be injured when exposed to high concentrations of various air pollutants. Injury ranges from visible markings on the foliage, to reduced growth and yield, to premature death of the plant. The development and severity of the injury depends not only on the concentration of the particular pollutant, but also on a number of other factors. (Heather, 2009).

Hydrocarbons cause premature fall of leaves and flower buds, discolouration of sepals and curling of petals. (Papatoto, 2010).

The threats posed by high levels of HCs emissions to both flora and fauna in urban areas prompted this research which is aimed at determining the levels of HC in an urban area like Port Harcourt. The choice of Port Harcourt was ideal because it has among others the presence of industries near residential areas and high traffic densities (a typical source of HC emissions). We hypothesise that, HCs levels in plants that are 0 to 50 m away from industries and heavy traffic of vehicles in Port Harcourt do not contain/differ in their HCs contents

MATERIALS AND METHODS

STUDY AREA

Port-Harcourt, the study area, is a highly industrialized city in Nigeria, with large presence of multinational firms as well as, other industries, particularly those related to the oil and gas industry (a major source of HCs). 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 (Fig 1) with a mean annual rainfall of 2000mm and mean annual temperature of about 29^{0}C (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). (Alagoa and Derefaka, 2002).

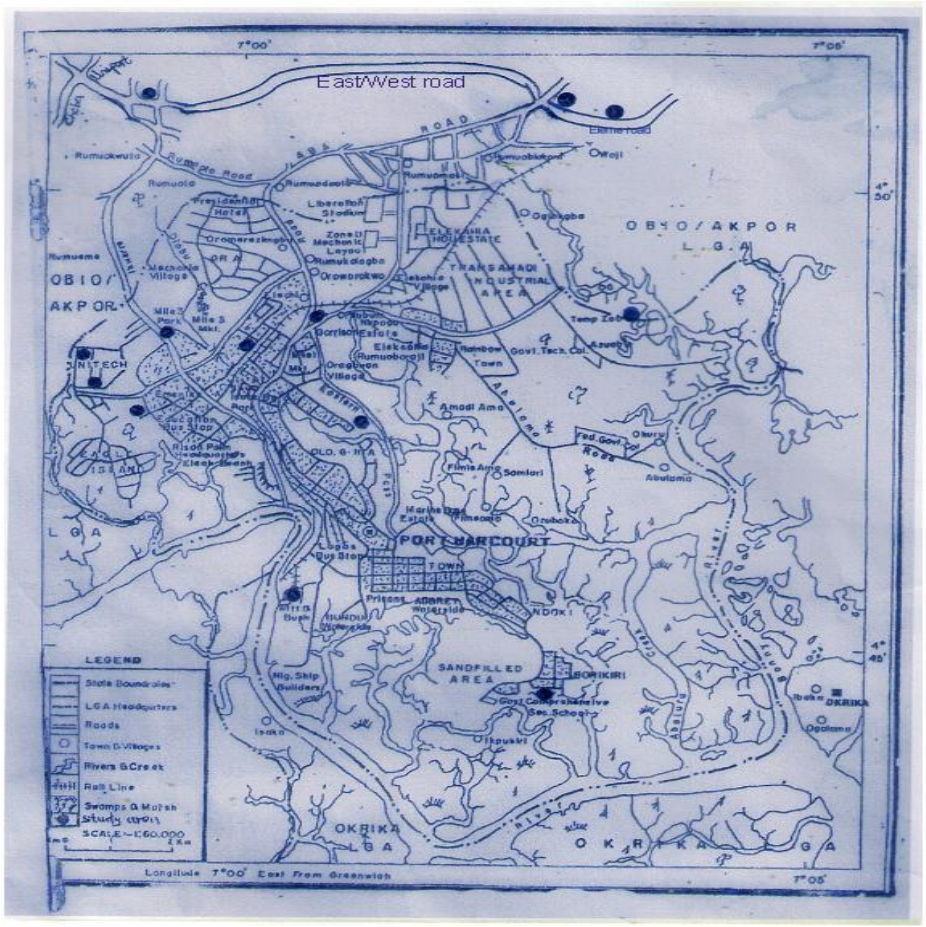

FIG 1: Map Of Port Harcourt Showing Study Areas

SAMPLING SITES AND SAMPLE COLLECTION.

The criteria used in selecting the sampling stations include: traffic densities which were characterized thus; high density (> 400,000 vehicles per day), Low density (< 400,000 vehicles per day) and control (approximately 20 vehicles per day). Geographical references were also used (see Table 1). The vehicles at the stations include cars, trucks, tractors, trailers, tankers and motor cycles. The other criterion used was the availability of plants at the stations. On the whole, six high density stations, five low density stations and two control stations were selected (Fig 1).

Leaf samples from selected stations were collected during the rainy season (September 2009) and during the dry season (January 2010) to determine the effect of seasonal variation on the concentrations of THC in plants. The local and scientific names of the plant samples are presented in Table 2. Samples were taken at intervals of 0 and 50m along a transect away from the road at each station. Leaf samples (collected once at each season and location) were collected using knives and carefully placed in labeled polyethylene bags which were later taken to the laboratory for analysis.

Table 1: Locations of study stations within Port Harcourt city with geographical references and their Traffic Density categories

STATION NO	STATION NAME	STATION CODE	GPS coordinates	TRAFFIC DENSITY
1	Aba road by Garrison junction	AR/GJ	N 04º 48.413' E 007º 00.567'	High
2	Trans-Amadi / Port Harcourt Zoo	TA/PZ	N 04º 48. 758' E 007º 02.673'	High
3	Aba road by Eleme Junction	AR/EJ	N 04º 51.427' E007º 04.120'	High
4	East-West road by Eleme junction	EW/EJ	N 04º 51.418' E 007º 04.170'	High
5	Eastwest road by Rumuokoro	EW/RU	N 04º 52.052' E 006º 59.780'	High
6	Ikwere road by Mile 3 junction	IR/M3	N 04º 48.308' E 006º 59.351'	High
7	University of Sci. &Tech. School Farm	UST/F	N 04º 48.233' E 006º 58.622'	Control
8	University of Sci. &Tech. Road E	UST/E	N 04º 47.308' E 006º 58.807'	Control
9	Reclammation Road by Emmanuel close	RR/EC	N 04º 45.745' E 007º 00.700'	Low
10	Lumumba Street Diobu	LS/DB	N 04º 47.516' E 006º 59.346'	Low
11	Manilla-pepple Street D/Line	MP/DL	N 04º 47.990' E 006º 59.902'	Low
12	Government Comprehensive Sec. Sch. By Borikiri	GCSS/B	N 04º 44.535' E 007º 02.101'	Low
13	Eastern by Pass LNG round about	EB/RA	N 04º 47.516' E 007º 00.984'	Low

Table 2: Local and scientific names of leaf samples collected from the study stations

STATION NO	STATION CODE	DISTANCE (m)	COMMON NAME	SCIENTIFIC NAMES
1	AR/GJ	0	Exotic spp	*Greeenwayodenron suaveolens*
		50	Umbrella tree	*Terminalia catappa*
2	TA/PZ	0	Guinea grass	*Panicum maximum*
		50	Avocado pear	*Persea gratissima americana*
3	AR/EJ	0	Paw-paw	*Carica papaya*
		50	Mango	*Mangifera indica*

Table 2 continues

4	EW/EJ	0	Mango	*Mangifera indica*
		50	Mango	*Mangifera indica*
5	EW/RU	0	Orange	*Citrus sinensis*
		50	Mango	*Mangifera indica*
6	IR/M3	0	Mango	*Mangifera indica*
		50	Mango	*Mangifera indica*
7	UST/F	0	Lemon	*Citrus limon*
		50	Plantain	*Musa sapientum*
8	UST/E	0	Bitter leaf	*Vernonia amaygdalina*
		50	Almond fruit	*Terminalia catappa*
9	RR/EC	0	Paw-paw	*Carica papaya*
		50	Bitter leaf	*Vernonia amaygdalina*
10	LS/DB	0	Grape	*Citrus paradise*
10	LS/DB	50	Avocado pear	*Persea gratissima*
11	MP/DL	0	Jeatropha	*Jeatropha curcas*
		50	Bitter leaf	*Vernonia amaygdalina*
12	B/GCSS	0	Paw-paw	*Carica papaya*
		50	Bitter leaf	*Vernonia amaygdalina*
13	EB/RA	0	Plantain	*Musa sapientum*
		50	Guava	*Psidium guajava*

SAMPLE PREPARATION AND ANALYSES

Leaf samples were oven- dried at 90$^{\circ C}$ (using GallenKamb Hotbox oven size 1), pulverized to uniform size with a laboratory mill and ~1g of this extracted with 10ml of toluene. The THC was thereafter determined with a 21D spectrophotometer at 410nm using toluene as a blank.

RESULTS AND DISCUSSIONS

The results for the mean total hydrocarbons (THCs) in plants are shown on Table 3. The THC content in plants during the dry season was highest in *Panicum maximum* collected at station 2 and in *Citrus sinensis* collected at station 5, both having a THC content of 58,220.0mg/kg (Table 3), while the highest THC content of plants collected during the rainy season was 8,844.71mg/kg in *Carica papaya* leaves from station 3 (Table 3). The lowest THC content in both dry and rainy seasons was recorded in Bitter leaf at station 12. Statistical analysis using DMRT at P≤0.05 (Table 4), showed that the mean THC content in plants collected during the dry season are significantly higher than those collected during the rainy season.

The mean THC content in plants from the high traffic density stations was higher, having

a mean THC value of 24,171.21mg/kg as compared to the mean THC content (16,784.32mg/kg) in plants from the low traffic density stations also the mean THC content (12,130.26mg/kg) in plants at 0m was higher than the mean THC content (8,620.46mg/kg) in plants at 50m.

Table 3 shows the mean THC contents in plants from sampled stations. The mean THC (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 and agrees with the report of Ideriah *et al*., (2001).

Although no significant difference was observed in the mean total hydrocarbon contents in plants between the high and low traffic density stations and also in plants collected at 0m and 50m away from roadsides, the increase from 16.784.32mg/kg (low traffic density) stations to 24,171.21mg/kg (high traffic density) stations and 8,620.46mg/kg (50m) to 12,130.26mg/kg (0m), imply that automobiles are the major sources of total hydrocarbons emission. This observation is in agreement with the report by Jean-Paul (2009), which stated that transportation accounts from 40 to 50 % of HC/VOC emissions.

The highest THC content (58,220.0mg/kg) was obtained in Panicum maxima at station 2 (Trans/Amadi by Port Harcourt zoo) and orange leaves at station 5 (East/West road by Rumuokoro). The observation at station 2 is in agreement with the report by Harrison and Laxen, (1981) which states that grass (Panicum maxima) is an efficient aerosol collector. The high THC contents recorded at these two stations are attributed to activities of major

junctions linking different parts of the city with a mix of commercial, medium to small scale industries and abattoir noted specifically for the preparation of barbeque, an act that generates large quantity of smoke. HC is reported to be a major component of smoke (EPA, 2001). THCs and VOCs are emitted from a variety of sources, including motor vehicles, chemical plants, refineries, factories, consumer and commercial products and other industrial sources. (USEPA, 2001).

Table 3: Mean Total Hydrocarbon content (mg/kg) in plants collected around Port Harcourt

STATION NO	STATION CODE	DISTANCE (m)	COMMON NAMES OF PLANTS	SCIENTIFIC NAMES	RAINY (mg/kg)	DRY (mg/kg)
1	AR/GJ	0	Exotic spp	*Greeenwayodenron suaveolens*	150.0	7,450.0
		50	Almond fruit	*Terminalia catappa*	577.06	32,779.0
2	TA/PZ	0	Guinea grass	*Panicum maximum*	1213.52	58,220.0
		50	Avocado pear	*Persea gratissima*	8.82	8,468.0
3	AR/EJ	0	Paw-paw	*Carica papaya*	8,844.71	4,138.0
		50	Mango	*Mangifera indica*	1,026.0	7,480.0
4	EW/EJ	0	Mango	*Mangifera indica*	9,315,29	10,6610
		50	Mango	*Mangifera indica*	1,026.0	7,480.0
5	ER/RU	0	Orange	*Citrus sinensis*	28.82	58,220.0
		50	Mango	*Mangifera indica*	18.59	32,480.0
6	IR/M3	0	Mango	*Mangifera indica*	460.59	11,644.0
		50	Mango	*Mangifera indica*	284.70	9,428.0
7	UST/F	0	Lemon	*Citrus limon*	531.18	15,632.0
		50	Plantain	*Musa sapientum*	95.60	21,632.0
8	UST/E	0	Bitter leaf	*Vernonia amygdalina*	5.29	23,288.0
		50	Almond fruit	*Terminalia catappa*	422.94	22,817.0
9	RR/EC	0	Paw-paw	*Carica papaya*	145.29	23,511.0
		50	Bitter leaf	*Vernonia amygdalina*	61.76	25,164.0
10	LS/DB	0	Grape	*Citrus paradise*	153.53	10,044.0
		50	Avocardo pear	*Persea gratissima*	91.81	2,328.0
11	MP/DL	0	Jeatropha	*Jeatropha curcas*	3068.82	29,691.0
		50	Bitter leaf	*Vernonia amygdalina*	44.80	11,644.0
12	GCSS/B	0	Paw-paw	*Carica papaya*	80.86	16,399.0
		50	Bitter leaf	*Vernonia amygdalina*	0.1424	0.6716
13	EB/RA	0	Plantain	*Musa sapientum*	102.34	21,876.0
		50	Guova	*Psidium guajava*	148.80	23,288.0

Table 4: Mean Total Hydrocarbon Content in Plant leaves collected from the Study stations around Port Harcourt City Nigeria

	Mean THC Content
Dry Season	19695.49[a]
Wet Season	1055.23[b]
High Density	24171.21[c]
Low Density	16784.32[c]
Distance (0m)	12130.26[e]
Distance (50m)	8620.46[e]

Means with different superscript within columns are significantly different at P≤0.05 using DMRT

CONCLUSION

The findings from this study have provided evidence of the distribution of total hydrocarbon content in plants around Port Harcourt metropolis. Seasonal variations, traffic density and distance from road influenced the concentrations of THC and VOCs in plants.

The findings showed that guinea grass (*Panicum maximum*) and orange (*Citrus sinensis*) leaves are good indicators of hydrocarbon pollution in the environment.

Since the results have shown that the levels of total hydrocarbon content in plants around Port Harcourt could be influenced by traffic density and distance from roadsides, farming activities and consumption of exposed

foodstuff along the roadsides should be discouraged because of their levels of THC and VOC.

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