Characteristic, Sources and Risk Assessment of PAHs in Surface Soil from Five Wastes Dumpsites in Yenagoa Metropolis, Bayelsa State, Nigeria

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Abstract
The reawakened interests beamed on the prevalence of polycyclic aromatic hydrocarbons (PAHs) concentrations in urban soils remains a serious embodiment to developing countries like Nigeria despite their noxious effects, carcinogenic, mutagenic, teratogenic and endocrine perturbation. The goal of this research is to determine the level of PAHs in soil surface of five dumpsites in Yenagoa Metropolis, Bayelsa State, Nigeria. Concentrations of individual PAHs were analyzed using Gas Chromatography Techniques (ASTM) FID Model SN 6890N (America Society for Testing Materials 20th Edition). The total concentrations of PAHs gotten between the depth of 0-10cm was 38.3151 mg/kg for Amarata, 55.3406 mg/kg for Ede-pie, 84.8949 mg/kg for Ekeki, 25.0972 mg/kg for Okaka and 57.0769 mg/kg for Onopa wastes dumpsites respectively. Most of these concentrations were far much higher than the Dutch guideline maximum limits of 40 mg/kg. The results showed that the highest concentration of a single PAHs compound was at Ekeki estate waste dumpsite with chrysene value of 22.095 mg/kg and 12.888 mg/kg as the second highest for fluoranthene at a depth of 0-10cm respectively. The Diagnostic ratios of PAHs account for about 5.078-44.151% of the total PAHs detected in the dumpsite raising concerns of human exposure through the food web.

Keywords: *PAHs, Waste dumpsites, Invasive, Yenagoa Metropolis*

Introduction

The term polycyclic aromatic hydrocarbons (PAHs) are a group of organic compounds consisting of two or more fused aromatic rings. They are bioaccumulative and noxious compounds to all living organisms (Edori & Iyama 2019). PAHs emanate mainly from anthropogenic processes like incomplete combustion of organic fuels and industrial emissions. PAHs are distributed widely in the atmosphere. While Natural processes, such as volcanic eruptions and forest fires, equally contribute to an ambient existence of PAHs. PAHs can be present in both particulate and gaseous phases, depending upon their volatility. Light molecular weight PAHs (LMW PAHs) that have

two or three aromatic rings are emitted in the gaseous phase, while high molecular weight PAHs (HMW PAHs), with five or more rings, are emitted in the particulate phase (Wickliffe et al., 2014). Atmospherically, PAHs can undergo photo-degradation and react with other pollutants, such as sulfur dioxide, nitrogen oxides, and ozone. Due to widespread sources and persistent characteristics, PAHs disperse through atmospheric transport and exist almost everywhere. Human beings are continually exposed to PAH mixtures in gaseous or particulate phases in ambient air. Long-term exposure to high concentrations of PAHs is associated with invasive health problems. Since some PAHs are considered carcinogens, mutagenic and teratogenic, inhalation of PAHs in particulates is potentially a serious health risk associated with increased risk of lung cancer (Zheng et al., 2018). The carcinogenicity of most PAHs has been confirmed by series of laboratory animals' studies. Researchers have reported increased incidences of skin, lung, bladder, liver, and stomach cancers, as well as injection-site sarcomas, in animals. Animal studies show that some PAHs also can affect the hematopoietic and immune systems and can produce reproductive, neurologic, and developmental effects (Malmgren et al., 1952; Hahon and Booth, 1986; Yoshikawa et al., 1987; Blanton et al., 1988; Philips et al., 1991; Dasgupta and Lahiri, 1992; Yanysheva et al., 1993; Szczeklik et al., 1994; Zhao et al., 2010). It is difficult to ascribe observed health effects in epidemiological studies to specific PAH because most exposures are to PAH mixtures. The renewed search light beamed on monitoring the behaviour, distribution and toxicity of PAHs in soils is imperative for ameliorating risk factor posed on human survival. Since PAHs is hydrophobic, low water solubility and vapour pressure, the chemicals tend to adsorb on the soil organic matter and accumulate and persist in soil for long periods (Sverdrup et al., 2002; Kwon & Choi, 2014). Hence, soil is termed the major reservoir for such hydrophobic organic pollution. It is an established fact that the PAH contaminants would be readily present in the top layer of the soil (Peng et al., 2016). Niger Delta Region being the hub of most oil exploration activities in Nigeria is immeasurably contaminated by emissions of noxious PAHs. The emitted PAHs basically emanate from the combustion of fossil fuels and biomass (Farid et al., 2016). The determination of the characterization, sources and risk of PAHs in atmosphere, water, soils, and sediments have been huge in the Niger Delta States. Investigation have shown elevated presence of PAHs in terrestrial ecosystem soils of Nigeria. Mostly in the mangrove forests where oil is explored.

The soil is an essential constituent that alongside other elements such as atmosphere, water and plant partake in the elimination of PAHs contaminants from the environment (Vácha et al., 2010; Wang et al., 2015). The soil acts as a major repository of PAH compounds (Orecchio, 2010; Huet al., 2015). Apparently the function of soil detachment in PAHs must be considered intensively. Nevertheless, this study on the characteristic sources and risk of PAHs in surface soils is imperative in assessing soil segregation and managing the risks associated with soil exposure to these chemicals. The pollution of surface soils should be of high priority to humans most especially in urban areas where modern factory are built to measure up with the rising need of industrialization, urban population growth, increasing motor vehicle ownership and the like that generate numerous wastes. The loop holes caused by poor waste management has negative consequences on public health systems being the cardinal host and propagator of infectious diseases outside water.

Globally, urban cities are typified and faced with daunting task of wastes management arising from population growth, unemployment, crime and complex environmental degradation. Apparently,

most urban dwellers residing in the cities often complain about large volume of waste being generated causing inconvenience for town planners, developers and local authorities concerned (United Nations Habitant Assembly 2023). Waste simply put is an inevitable aspect of human life revolving round domestic, commercial, industrial, municipal, healthcare and agriculture generated wastes that poses invasive public health menace to the surrounding. In 2022 and 2023 the average waste generated per capita in Organisation for Economic Co-operation and Development (OECD) countries was over 530kg. Of this waste, 37% was recycled, composted or recovered; 43% was buried in landfills, and 20% was incinerated and energy recovered from the process. The United States comes first in the list of countries with the highest amount of daily per capita MSW with 2.58 kg, followed by Canada (2.33 kg/per capita) and Australia (2.23 kg/per capita). The other two biggest landfills are: Bordo Poniente located in Mexico City, Mexico with an area extending to 927 acres or 375 hectares. Laogang, found in Shanghai, China covers a total area of 830 acres or 35 hectares. 4:00 PM. Yenagoa Metropolis (Nigeria) waste generation is about 68.985 kg per capita quantity per year. Nigeria beign a developing country is plague with limited options for safe waste disposal, thus compounding series of noxious health hazards and other epidemic from indiscriminately waste disposal. Open dumpsites are characteristics of most Nigerian cities and lower-income individual disproportionately reside around these sites where they are exposed to chemicals that are present in amounts far much above the minimum limits required for humans safe haven and wildlife. Municipal solid wastes are commonly burnt in the open dumpsites/incinerators and these discharges pollutants into the air, water and soil thereafter depleting the biosphere with toxic chemicals such as thick smoke that contains carbon monoxide, soot and nitrogen oxides, all of which are hazardous to human health and degrade urban air quality (Olufunmilayo et al., 2015).

Material and Methods

Study Area

Yenagoa is the capital of Bayelsa State. It extends between latitude 455 36.30 N and longitude 6163.50 E. Bayelsa State is located in the South South Geopolitical Zone of Nigeria, in the core Niger Delta Region, the only homogeneous Ijaw speaking State situated between Delta State and Rivers State. The choice of carrying out this research work within five government approved wastes dumpsites situated around Yenagoa Metropolis was informed by numerous complain made by the inhabitants due to depleting wastes littered at various wastes dumpsites for more than the required days to decay without recourse to human health. Hence, the following wastes dumpsites where chosen namely; Amarata, Ede-pie, Ekeki, Okaka and Onopa.

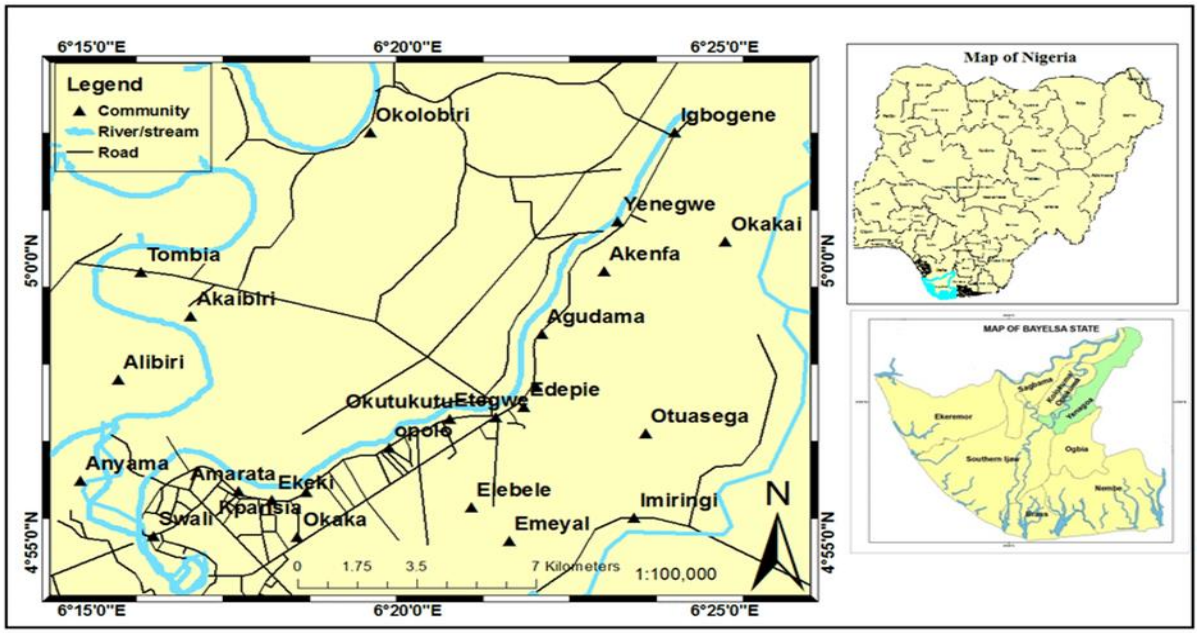

Figure 1 Location of selected wastes dumpsites in Yenagoa Metropolis

Sample Collection

This study analysed sixteen different PAHs (Naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoreanthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, benzo(g,h,i)perylene and indeno(1,2,3-cd)(pyrene) which were obtained from five Government Approved wastes dumpsite soils situated at different parts of Yenagoa metropolis using soil auger after removing the covering wastes. Soil samples was randomly collected at five spot in each wastes dumpsites and mixed together to form a true representative sample of the bulk. The samples were collected at a depth of 0-10cm and immediately place in glass container with cover. The samples were subsequently taken to the laboratory for the analysis of polycyclic aromatic hydrocarbons.

Sample preparation and extraction of PAHs

Prior to the extraction, soil samples were homogenized to powder and sieved with a 0.2mm mesh. Then, 2.5g of the sieved sample were introduced into a soxhlet extractor and extraction was completed with 10ml of methanol and 25ml of dichloromethane for 24 hours at 800°C by refluxing vigorously. The extract was transfered into a 250ml flask and purified using dichloromethane solvent. Thereafter a rotary evaporator were used to concentrate the extract to 5ml. Subsequently, purification was carried out in a 50ml flat bottom flask with addition of 15ml pentane, which was volatilized with rotary extractor to 2ml. The pentane extract was further concentrated by evaporation to 0.5ml using a constant flow of uncontaminated nitrogen gas. This was permitted to pass over slurry packed column of activated silica gel for 8 hours at a controlled temperature of

200°C. All other hydrocarbon constituents were eluted from PAHs using a pentane solvent first and then dichloromethane which separated the PAHs.

Sample Analysis

The extraction of the surface soil samples extracts for polycyclic aromatic hydrocarbons (PAHs) was completed using Gas Chromatography Techniques (ASTM). FID Model SN 6890N (America Society for Testing Materials, 20th Edition). The characteristics of the individual PAHs components were compared with those gotten from already prepared standards as provided by the manufacturers of the instrument. The identity and quantity ion peaks was obtained from the scan mode and were used to differentiate the various PAHs components in the sample.

Quality assurance/quality control (QA/QC)

The following quality control measures were adequately ensure to minimize errors from potential sources:

• Sample collection technique, preservation and sample transfer conformed to international standard.
• Analytical grade reagents were used for the analysis.
• The cooling system of the laboratory was maximized so as to leverage the integrity of reagents and chemicals used for analysis.
• All laboratory equipment was properly calibrated prior to use, to ascertain the reproducibility of the analytical results.
• Sequence analysis were employed for all parameters accompanied with GC measures (such as blanks, duplicates and standards) to check interferences and validation of analytical procedures used.

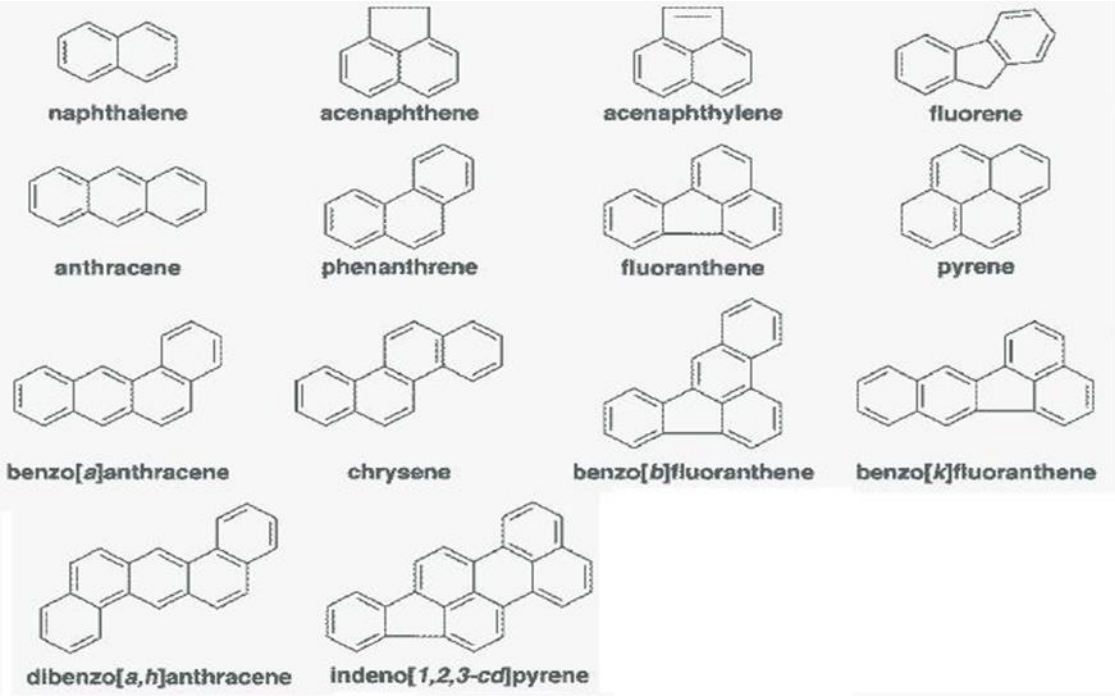

Figure 2 Structures of 14 identified PAHs in soil

Results and discussion

The concentration of the 16 priority PAHs was determined in five waste dumpsites soil namely Amarata, Ede-pie, Ekeki, Okaka and Onopa at a depth of 0-10cm within Yenagoa Metropolis. The analytical result of the soil samples is presented in Tables 1 and Figure 3. The minimum detection limit for GC/FID used in the analysis was 0.001 mg/kg. The mean levels and standard deviation were also calculated for individual and total PAHs for each location. The computation was done using Microsoft excels page and to minimize errors in the table, the values <0.001 mg/kg was expressed as 0 (zero).

PAH concentrations

Ideally, PAHs coexist in groups and did not exist as a separate entity within the surrounding. They occurred in mixture and this numerical strength is used to characterize their sources and distribution. The 16 priority PAHs determination in soil was done at a depth of 0-10cm around five Government approved waste dumpsites in Yenagoa metropolis.
The analytical results obtained for polycyclic aromatic hydrocarbons (PAHs) in the soil samples from the five waste dumpsites are shown in Table 1, whereas the total concentration of PAHs in each waste dumpsites is shown in Figure 3. The concentrations of the different PAHs compounds observed in the various stations indicated that the first four PAHs compounds (naphthalene, acenapthylene, acenaphthene, fluorene anthracene and Benzo(a)fluoranthene) were not detected

but all the others were detected at various concentrations. Fluoranthene was observed to have the highest concentration across this dumpsite with a value of 8.784mg/Kg. Others such as Benzo(g,h,i)pyrene, chrysene, phenanthrene, Benzo(a)pyrene and Benzo(a) anthracene were observed to be as high as 7.641, 6.894, 4.723, 4.626 and 2.714 mg/Kg respectively. The total value of PAHs in Amarata station was observed to be 38.3151 mg/Kg. At Ede-pie waste dumpsite, naphthalene and acenaphthene were not detected. The PAHs compound with acenaphthylene the highest value observed was fluorene, whose value was 9.228mg/Kg, which was accompanied by the values observed for chrysene 7.834mg/Kg and benzo(a)anthracene 7.811mg/Kg. The total concentration of PAHs in Ede-pie waste dumpsite were observed to be 55.3406 mg/Kg. At Ekeki estate waste dumpsite, naphthalene, acenaphthylene, acenaphthene, anthracene and benzo (k) fluoranthene were not detected. Whereas, chrysene got the highest value of 22.095 mg/kg been the highest concentration across each waste dumpsites, followed by fluoranthene, pyrene Benzo(a) anthracene, fluorene and phenanthrene with concentration values as high as 12.888, 11.045, 11.011, 9.831, 8.613 mg/Kg respectively. The total concentration of PAHs in Ekeki waste dumpsite were observed to be 84.8949 mg/Kg. At Okaka waste dumpsite naphthalene, acenaphthene, fluorene, phenanthrene, anthracene, pyrene, chrysene and indeno(1,2,3-cd) pyrene were not detected, but all the others were detected at various concentrations. Benzo(g,h,i) pyrene was observed to have the highest concentration across this dumpsite with a value of 6.332mg/Kg. Others such as Benzo(a) anthracene, fluoranthene, Benzo(b) fluoranthene and acenaphthylene were observed to be as high as 5.862, 4.503, 3.271 and 2.997 mg/kg respectively. The total value of PAHs Okaka station was observed to be 25.0972 mg/Kg. At Onopa waste dumpsite, it was only benzo(b)fluoranthene that was detected across the 16 priority PAHs with phenanthrene having the highest value of 9.349 mg/kg. Others such as acenaphthylene, dibenzo(a,h) anthracene, Benzo(a) pyrene, Benzo(k) fluoranthene, indeno(1,2,3-cd) pyrene and benzo(a) anthracene were observed to be as high as 8.095, 6.736, 5.697, 5.632, 4.289 and 3.269 mg/kg respectively. The total value of PAHs in Onopa waste dumpsite was observed to be 57.0769 mg/Kg.

Table 1: Mean and Standard Deviation Concentration of studied PAHs in surface soil (mg/kg) from five wastes dumpsites

PAHS (mg/kg)	Wastes dumpsites				
	Amarata	Ede-pie	Ekeki	Okaka	Onopa
Naphthalene	ND	ND	ND	ND	2.565
Acenaphthylene	ND	9.228	ND	2.997	8.095
Acenaphthene	ND	ND	ND	ND	1.669
Fluorene	ND	6.676	9.831	ND	1.294
Phananthrene	4.723	2.192	8.613	ND	9.349
Anthracene	ND	2.824	ND	ND	1.294
Fluoranthene	8.784	0.242	12.888	4.503	1.722
Pyrene	0.142	5.793	11.045	ND	0.999
Benzo(a) Anthracene	2.714	7.811	11.011	5.862	3.269
Chrysene	6.894	7.834	22.095	ND	2.269
Benzo(b) Fluoranthrene	ND	2.170	3.008	3.271	ND

Benzo(k) Fluoranthrene	1.133	1.192	ND	0.662	5.632
Benzo(a) pyrene	4.626	5.611	2.070	1.214	5.697
Benzo(g,h,i) Pyrene	7.461	1.351	ND	6.332	2.199
Dibenzo (a,h) Anthrancene	1.191	1.542	0.637	0.257	6.736
Indeno (1,2,3-cd) pyrene	0.559	0.875	3.698	ND	4.289
Mean	3.133	3.890	8.489	3.137	3.654
Standard Deviation (SD)	2.962	3.063	6.399	2.319	2.691

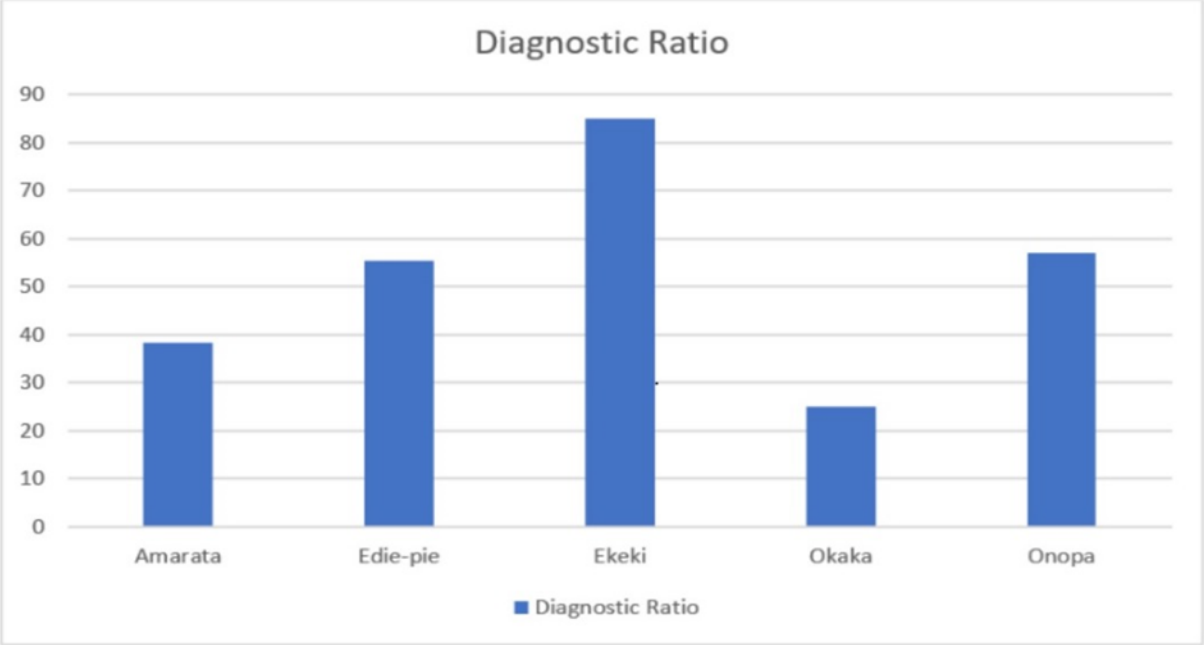

Figure 3: Total PAHs Concentrations at five waste Dumpsites

Ekeki waste dumpsite had the highest concentrations of PAHs, immediately followed by Onopa dumpsite and then Ede-pie waste dumpsite. The occurrence of high level PAHs in the environment has depleting health consequences on humans living within the affected sampling stations. The cause of extremely high PAHs values could have originated from incomplete combustion of waste materials frequently dumped at these stations. The continue occurrence of PAHs in soil has the potentials of contaminating ground and surface water by way of leaching through the soil profile and runoffs to nearby creek or stagnant water bodies. The adverse consequences of PAHs detected in the surface soil is hazardous to man and other animals and if not check can posed noxious effects. Giving the fact that their toxic effects direct or indirect parculate into the food web and destroy the aquatic biomes. Statistically, the total USEPA 16 PAHs concentrations being analyzed

in this study is far much higher than the values gotten in urban and rural areas of Southern Italian soils, 0.01- 13.05 mg/kg in Eket automobile repair workshop by Akanimo et al. (2019) and Predrag et al. (2021) with 0428-0.898 mg/kg in industrial zone and evaluation of pollution sources Banja Luka. But in agreement with the values gotten by Ekpete et al. (2015) in concentrations of polycyclic aromatic hydrocarbons from selected dumpsites within Port Harcourt metropolis, Rivers State, Niger Delta, Nigeria, with a mean values spanning between 0.146±0.364 to 9.575±2.013 mg/kg. Recalling Kaszubkiewicz et al (2010), the Dutch postulate the maximum acceptable limits for intervention in PAHs pollutions for any given soil as 40mg/Kg. Notwithstanding, the figures gotten at three waste dumpsites in this research proved beyond reasonable doubt that Ekeki, Onopa and Ede-pie waste dumpsites are polluted above the maximum permissible limits. Whereas, Amarata and Okaka were closed to the intervention limits and falls within the danger zone. The values of PAHs obtained from the dumpsites may be linked to overpopulation growth, which is a major collaborating factor in waste generation. Urbanization, globalization and modern technological industries majorly depict the waste dumpsites size at Ekeki, seconded by Onopa then others following suit, as replicated in the analyzed PAHs results gotten from the waste dumpsites. Given the fact that most of the observed values were pretty higher than the maximum guidelines for growing Cities and Towns along the study area, they are obviously more prone to PAHs disease outbreak, hence precautionary measure must be taken to advert severe health challenges and risk of being inhaled or transmitted to closely by water bodies.

Sources of PAHs in dumpsite soils

In order to vividly outline the sources of PAHs in soils, several studies had been carried out precisely to inundate an effective diagnostic or isomeric ratios of individual PAHs. Isomeric ratios anthracene/(anthracene+phenanthrene){Anth/Phe}, Benzo (a) anthracene/chrysene {BaA/(BaA+Chry}, and fluoranthene/(fluor+pyrene) {FLu/(Flu+PYR} has being used to ascertain the sources of PAHs. Fluoranthene/pyrene ratio (FLu/PYR) is used basically to expatiate the difference between pyrolytic and petrogenic sources. Preferentially Fluoranthene is less thermodynamically stable than pyrene and a predominance of FL over PYR is characteristic of pyrogenic source. Experimentally in this study the ratios of FLu/PYR were basically determined for surface soil at a depth of 0-10cm in almost all the dumpsites except Okaka were it was below detectable limit. The FLu/PYR for the surface soil at Amarata was 8.784, Ede-pie 0.242, Ekeki 12.888, Okaka 4.503 and 1.722 mg/kg for Onopa waste dumpsite. It is an established fact that fluoranthene/pyrene less than one indicates petrogenic source of pollution while a ratio of more than one indicates pyrogenic sources. Furthermore, the ratio of fluoranthene to fluoranthene + pyrene {Flu/ Flu +Pyr} was used to confirm whether the dominant source of PAHs in the dumpsite soils originated from the pyrogenic processes. The Flu/ Flu +Pyr ratio for the surface soil at Amarata dumpsite was 0.728 which was corroborated by other studies. Yunker and Macdonald had earlier suggested that the ratio of fluoranthene to fluoranthene + pyrene greater than 0.5 indicates pyrogenic sources, particularly the burning of fossil fuel. Pyrogenic sources according to include high-temperature combustion products such as incomplete combustion of organic materials (combustion of fossil fuel, vehicular engine combustion, smelting, and waste

incinerators). Pyrogenically produced PAHs are primarily compounds with unsubstituted aromatic rings and these PAHs are often called parent PAH structures. Although the pyrogenic source seems to dominate, petrogenic sources could have made minor contributions due to the location of the dumpsites along major transport routes.

Table 2 The diagnostic ratios calculated for all sampling area

PAHs Rings Number	Amarata	Ede-pie	Ekeki	Okaka	Onopa
2-3	13.507	21.162	31.332	7.5	25.988
4	9.75	21.438	44.151	5.862	6.537
5	5.759	8.973	5.078	5.147	11.329
6	9.211	3.768	4.335	6.589	13.224

PAHs diagnostic ratios

PAHs diagnostic ratios was calculated from the obtained results and are expressed in Table 2. The analytical results from the diagnostic ratios of the UNEPA 16 PAHs was showed as (0.9841) for Ant/(Ant+Phe) in sediment sample gotten at Amarata ebis road waste dumpsite been the highest value and (0.1216) were the lowest ratio for Onopa primary school junction waste dumpsite. This imply that Amarata ebis road got the highest PAHs concentrations across all the study dumpsites with a proof of combustion origin (ratios > 0.1).

Table 3 Diagnostic ratios of PAHs

Sampling site name's	ANT/(ANT+ PHE)	FLA/(FLA+ PYR)	BaA/(BaA+ CHR)	IP/(IP+ BgP)	HMW/LMW
Amarata	0.0000	0.9841	0.2825	0.0697	1.8302
Ede-pie	0.5629	0.0401	0.4993	0.3931	1.6151
Ekeki	0.0000	0.5385	0.3326	0.0000	1.7096
Okaka	0.0000	0.0000	0.0000	0.0000	2.3464
Onopa	0.1216	0.6329	0.5903	0.6611	1.1963

Flu/(Flu + Pyr) values were as follows; Amarata ebis road waste dumpsite (0.9841)), Onopa dumpsite (0.6329), Ekeki estate dumpsite (0.5385) and Ede-pie dumpsite (0.0401) respectively. This imply that Ede-pie dumpsite with a ratio of 0.0401 is of liquid fossil fuel combustion origin (range of ≥ 0.4 and ≤ 0.5), whereas Amarata dumpsite, Onopa, and Ekeki estate dumpsite are of petroleum source (ratios <0.4), and for Tombia (0.59) was likely of grass, wood and coal combustion sources (ratios > 0.5). These findings are in agreement with those. The BaA/(BaA+Chry) ratio as follows: Swali market (0.40) had the least ratio, Government House (0.79) had the highest ratio, this indicates that all the sampling locations were of combustion origin

(> 0.35). The results of PAH diagnostic ratio revealed that the soils of the Yenagoa city were of petroleum (petrogenic), combustion (pyrogenic), and grass/wood/straw combustion sources, the pyrogenic combustion sources had the dominant ratio indicates that PAHs in Yenagoa city soil samples were mostly of pyrogenic origin. The EPA has classified the following seven PAH compounds: benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(ah)anthracene, and indeno(1,2,3-cd)pyrene as probable human carcinogens. These were detected at high concentrations for each soil sample which may be detrimental to human health. The total observed PAHs concentration 32.981 mg/kg in the soil samples was above the critical level of 4.00 mg/kg recommended by WHO for soils at Government House area. Swali and flyover locations were moderate, while Tombia, Opolo roundabout and Opolo market were also above the acceptable minimal level of 0.1 mg/kg as recommended by the US EPA for each sample site. When these harmful compounds are inhaled or ingested by man, they could be harmful. [8] reported that there may be potential synergy between PAH compounds with different biological targets.

Conclusions

The ultimate goal of this investigation is to highlight the degree of degradation ongoing within five Government approved waste dumpsites chosen for this study. The analytical results indicating that there was more detectable amount of the USEPA 16 PAHs pollutants than the non-detectable variable in the soils around five waste dumpsites at Amarata, Ede-pie, Ekeki, Okaka and Onopa in Yenagoa Metropolis. Ekeki estate waste dumpsite got the highest value of PAHs seconded by Onopa. The surge in the analyzed soil samples gotten from Ekeki estate and Onopa dumpsites was majorly contaminated by Chrysene pollutants followed by fluoranthene, with an individual mean value (surface soil and subsoil) of 22.095 mg/kg and 12.888 mg/kg respectively. This revealed different sources of emission between the studied areas and affirmed the ugly negative trend of urbanization on the PAH characteristic in five waste dumpsites soils in Yenagoa Metropolis. The diagnostic ratios of PAHs indicate that PAHs from five wastes dumpsites soils in Yenagoa Metropolis emanate majorly from waste dumpsites or either open gas flare, industrial emissions and traffic mixed sources and grass/wood/coal combustion in Ekeki, Onopa, Ede-pie Amarata and Okaka waste dumpsites. The soils in this study stations were highly contaminated by various rings sizes of PAHs. The soil PAH risk assessment showed that the surface soils of these five wastes dumpsites in Yenagoa Metropolis poses noxious carcinogenic ecological risk if not attended to. Hence, these five wastes dumpsites soils should be routinely monitored owing to the fact that PAHs poses catastrophic consequences on soil ecosystems and organisms.

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