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Evaluation of Concentrations of Polycyclic Aromatic Hydrocarbons in Soil and Borehole Water in Abattoir Environs in Parts of Port Harcourt, Rivers State, Southern Nigeria

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Abstract

Water and soil contamination due to human activity is a natural phenomenon in all parts of the world. Water and soil samples were collected from three abattoirs in Port Harcourt, Rivers State. The water samples were collected from boreholes sited within the area, while soil samples were collected from the surface to a depth of 0-20 cm and were placed in well capped glass vials. Standard purification and extraction procedures were applied on the samples before analysis. Both water and soil extracts were analyzed using gas chromatography – mass spectrophotometry which enabled the fractionation of the polycyclic aromatic hydrocarbon (PAHs) components. ***.*** *Gas chromatographic analysis of water samples revealed the presence of six PAH compounds in Mile 3 station, none in Aker station and two in Egbelu station. Summation of PAH values showed 2.562, nil and 1.243 mg/L for Mile 3, Aker and Egbelu respectively. All the detected PAHs in the stations were above the USEPA value recommended for water use. Soil PAHs from the stations showed that naphthalene, anthracene and benzo(k)fluoranthene were not detected in any of the stations. Soil PAHs total content of the stations were 12.577, 12.397 and 7.802mg/Kg for Mile 3, Aker and Egbelu Stations. PAHs origin and sources favoured pyrogenic input sources in all the stations. Analysis of the ring sizes generally showed the predominance of HMW PAHs over LMW PAHs in Mile 3 borehole water and soil, but LMW PAHs was the only PAH detected in water samples of Egbelu*. *In case of individual groups, the group order for Mile 3 was 2-3 > 4>6>5, Aker was 4 > 5 > 1 > 6 and Egbelu was 5 >1 > 6 > 4. To reduce the occurrence and increase of PAHs in these locations, there is the need to stop the use of firewood and other incinerating substances to prepare the skin of meat.*

Keywords*: Soil, borehole water, polycyclic aromatic hydrocarbons, diagnostic ratio, pyrogenic, petrogenic*

Introduction

Polycyclic aromatic hydrocarbons (PAHs) as an environmental pollutant is presently of a major global concern. They are present in rural, urban and industrial settlement and also in natural environments. They have low comparative solubility in water, but are very soluble in lipids (Salman et al., 2014). The Solubility of polycyclic aromatic hydrocarbons in water usually drops as the molecular weight, but the boiling and melting point rises consistently (Prabhukumar and Pagilla, 2015). Four and five ring PAHs are almost insoluble in water. The Solubility of PAHs decreases correspondingly with increase in ring size. Their vapour pressure decreases equally with increase in size of the rings **(**Kailzadeh et al., 2011**).** When they are dissolved in water or adhered onto particulate material in the presence of ultraviolet light due to solar radiation undergo (Osu et al., 1999).

PAHs are known environmental toxins and consists of more than one fused benzene rings, even though some of them known to have substituents on the rings (Fetzer, 2000). They are a set of unique environmental nuisance that are formed majorly from partial burning of organic waste, petroleum products, coal, smoking of tobacco, production of asphalt for road surfacing, fumes from car exhaust. Natural sources of PAHs in the environment can result from volcanic explosions, forest fires and decay processes (Ogunfowokan et al., 2003).

PAHs are considered as persistent organic pollutants (POPs) of which some members are inclined to distribution on a universal measure. This is because they are not only environmentally persistent, but interchange between the different earth’s atmospheres repeatedly, due to temperature changes which drives the cycles of deposition and volatilization.

PAHs are broadly divided into two main groups which is purely based on their physical and biological properties which are high molecular weight (HMW) and low molecular weight (LMW) PAHs. The group of HMW PAHs are made up of 4–6 fused aromatic rings which are not easily bio-degradable by microbes, and therefore continue to remain in water and terrestrial environments and consequently bio-accumulate in organisms dwelling within the environment (Rocher et al., 2004). The LMW PAHs is made up of 2–3 membered fused aromatic rings which are less persistent in the environment due to volatility, but also pose lethal effects to organisms (Brown and Peake, 2006).

The origin of PAHs in the environment are either from pyrogenic (pyrolysis), formed as a result of incomplete incineration of wood, coal, oil, gas, compost, charring of roasting of fish and meat and other organic substances (Green et al., 2014) or petrogenic which is produced as a result of anthropogenic based sources due to accidental or deliberate discharges, legal permissible discharges and spills from old and worn out pipes conveying petroleum products and crude oil (Doong and Lin, 2004).

The composition of PAHs in any medium (water, soil and sediment) can provide vital facts with regard to the way they were derived and their sources. High concentrations of LMW PAHs are most likely found in sample mediums that are contaminated by naturally occurring PAHs which resulted from petrogenic and biogenic sources**.** However, PAHs formed from combustion (pyrolytic) sources in most cases hold more of HMW and less of LMW PAHs (Yan et al., 2004).

PAHs are known to be mutagenic to experimental animals and man (Martinez et al., 2004). They are carcinogenic, immunotoxic and teratogenic (Effenga and Aramandia, 2009; Pratt et al, 2009). PAHs are known to interfere with cellular membrane functions and enzymatic activities that are linked with the membrane, which then lead to their carcinogenic and mutagenic tendencies and immune suppression (Nwineewii and Marcus, 2015).

Intentional pyrolytic processes leads to PAHs formation. This occur when substances of organic origin are exposed to elevated temperatures in the presence of little oxygen or complete absence of oxygen. In similar situations, which may be not deliberate such as fuel combustion in vehicles, burning of coal, wood, forest fires, and burning of oil also lead to incomplete combustion that releases PAHs into the environment.

Abattoir is a place where animals are slaughtered and the meat prepared for consumption. However, different human activities in addition burning of the skin, roasting of the meat for native delicacies, burning of the bones and hones of animals and other activities are carried out there. Therefore, this study investigated the concentration of PAHs in soil and borehole water from the immediate vicinity of the abattoirs from selected abattoirs within Port Harcourt metropolis.

Materials and Methods

Study Area

Collection of Water Samples from Boreholes

Samples of water were collected from boreholes sited within abattoirs. The abattoirs are situated at Mile 3, Aker Junction and Egbelu. The water samples were collected from the well-head of the different boreholes in the early hours of the morning with previously washed and dried glass bottles. They were transferred into ice packs and immediately transported to the laboratory.

Collection of Soil Samples

Surface soil samples from three abattoirs located at Mile 3, Aker Junction and Egbelu were collected with soil auger within a depth range of 0-20 cm. The soil samples were collected randomly from five points within the abattoirs and mixed together to form representative samples. The samples were placed in glass container, which were immediately covered. The samples were immediately taken to the laboratory for analysis.

Preparation and Extraction of PAHs from Water Samples

PAHs extraction and purification in samples of water was done thrice. To one litre of water sample was added 100 cm3 of dichloromethane as the extractant solvent. Two separate layers were formed. The layer above contains the extractant solvent being dichloromethane and the extracts being PAHs. The upper mixed layer was to drain into into a funnel containing anhydrous sodium sulphate. The content of extractant/extract mixture was reduced to 2-3 cm^3 using rotatory evaporator. The extract was further purified in a chromatographic column implanted with silica gel/potassium silicate and 2 g of anhydrous sodium sulphate. The column was at first rinsed with 30 cm^3 of n-hexane**.** Thereafter, 50 cm^3 1:1 mixture of n-hexane and dicloromethane were added. The ultimate extract that was eluted from the chromatographic column was more concentrated to 2.0 cm^3 with the aid of rotary vacuum evaporator. Finally, gas chromatography-mass spectrometer

(GC-MS) analysis was performed on the extract to separate the individual PAHs (Prycek et al., 2007).

Preparation and Extraction of PAHs from Soil Samples

Before the extraction of PAHs from the soil, the soil samples were even out to powdery form. The powdered soil sample was sieved with a 0.2mm net. Then, a mass of 2.5g of the homogenized soil sample was brought into an extractor which contains 10ml of methanol and 25ml of dichloromethane. The extractor was refluxed constantly for 24 hours at 80^{o}C**.** The extract was discharged into a 250ml and further purified by the use of dichloromethane solvent. The purified extract was put into a rotary evaporator and concentrated to a volume of 5ml. At this point, all the other processes were conducted as in the case of water sample.

Analysis, Determination and Quantification of PAHs in water and Soil

The examination of the extracts for polycyclic aromatic hydrocarbons (PAHs) achieved by gas chromatographic analysis using Agilent model 6890N (Agilent technologies Avondale, USA). The identification and quantification of the PAHs was matched with those gotten from ready standards provided by the producers of the instrument. The distinctiveness and magnitude of ion peaks were obtained from the probe mode which differentiated the unlike PAHs compounds in the sample.

Source Evaluation and Origin of PAHs

Diverse methods were used to determine the different sources of PAHs in water and soil. The values gotten were used to assume a situation whether the origin was petrogenic or pyrogenic. Five separate parametric methods were used and their related interpretations applied.

i) Low Molecular Weight (LMW-PAHs)/High Molecular Weight (HMW-PAHs)

The sum of all the concentrations obtained from 2-3 rings PAHs were divided by the sum of all concentrations observed in 4-6 rings. When the value is greater than unity 1, the source is identified to be of petrogenic origins, but when the values is less than unity, then it is considered as coming from pyrogenic source (Vrana et al., 2001).

ii) Anthracene/Anthracene + Phenanthrene. An/(An+Phe)

When the calculated value of An/(An+Phe) ratio is lower than 0.1, the source of the PAHs is probably of petrogenic origin, while ratio that is higher than 0.1 proposes pyrogenic sources (Edori et al., 2020).

iii) Fluoranthene/fluoranthene +pyrene (Fl/Fl + Py).

For this category, when the calculated values is greater than unity (1), then pyrogenic sources and origin is inferred, but when the values are below 1, then petrogenic origin or sources is suggested (Qiu, 2009).

iv) Benzo(a)Anthracene/(Benzo(a)Anthracene + Chrysene). BaA/ (BaA+Chr).

In this group, the value observed from dividing BaA/(BaA+Chr) is taken to be petrogenic in origin if it is found to be greater than 0.2. When the values calculated falls between 0.2-0.35, it is an informed decision of varied origin, but when the calculated value surpasses 0.35, then it is classified as being originated from pyrogenic sources (Guo et al., 2007).

v) Indeno (1, 2, 3-cd) pyrene/(Indeno (1, 2, 3-cd) Pyrene + Benzo (ghi) Perylene). IP/ (IP+ BgP).

In this category, source determination was established on the ground that values less than 0.2 are proposed to come from petrogenic origin, while values with a range of 0.2-0.5 implies origin arisen from mixed sources, that is a combination of both petrogenic and pyrogenic origin and values exceeding > 0.5 are judged to have emanated from pyrogenic (Tolosa et al., 2004).

Results and Discussion

Polycyclic aromatic hydrocarbons in borehole water within the abattoir

The results of the concentrations of polycyclic aromatic hydrocarbons in water from boreholes within the selected abattoirs sites are given in Table 1. The result showed the presence of acenaphthylene, fluorine, fluoranthene, benz(a)anthracene, benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene at the Mile 3 station, none of the PAHs was detected at the Aker Junction station, but naphthalene and acenaphthylene were the only PAHs detected at the Egbelu station. The total sum of PAHs in the stations showed values of 2.562, undetected and 1.243 mg/L at Mile 3, Aker Junction and Egbelu stations respectively. The values of PAHs observed in the various stations in the present work are lower than the values observed in groundwater at a coal tar Site (Mackay and Gschwend, 2001) and also the values of Wang et al. (2021) in groundwater from southern China, and in hand dug well water and borehole water from Betem, Ogoni, Rivers State, Nigeria (Ideriah and Nwinaa-ie, 2015).

According to Srogi (2007) polycyclic aromatic hydrocarbons have many organic ring structures ranging from 2-6 and some are carcinogenic. These chemicals are primarily freed into the environment by way of incomplete sweltering of living matter (Papageorgopoulou et al., 1999). Besides places that are industrially polluted, the levels of single PAHs in superficial and ground water is usually very low in value (Ideriah and Nwinaa-ie, 2015). The view by Ideriah and Nwinaa-ie (2015) may also be one of the reasons that is responsible for the low content of PAHs in the borehole water. The location of the abattoir site is free from heavy industrial activities that can release PAHs into the environment. When PAHs are released to soil, they are adsorbed to soil particles and more especially if the soil contains high content of organic matter. This coupled with the fact that soil is a natural sink and in the process of leaching, PAHs are sorbet unto soil particle and thus may no leach to the groundwater. Notwithstanding, its presence in some groundwater samples point toward the fact that some mechanisms of transport may have occurred to take them down to groundwater. Concentrations of PAHs beyond a value range of 0.01mg/l indicate a contamination source from industrial input.

The level of PAHs in unpolluted ground water are ordinarily in the range of 0-5ng/l. Leaching of PAHs from soil into ground water is negligible, as the compounds tend to absorb strongly to the soil organic matter (Stuermer et al., 1982). It is only in heavily contaminated locations that PAHs concentrations in groundwater may be above 10µg/l (Environment Canada, 1994).

Since the total PAHs in the ground water samples were lower than permissible limits they do not pose grave environmental and health concerns in the area. Consequently the managers of the water used to prepare the meat before selling to the populace do not constitute source of PAHs contamination to the meat and thus cannot cause harm to the consumers of the meat and others that may be using the water for domestic purposes.

Table 1: Polycyclic Aromatic hydrocarbons in boreholes sited within abattoirs vicinity

PAHs (mg/L)	Location			USEPA
	Mile 3	Aker Junction	Egbelu	(2013)
Naphthalene	ND	ND	0.209±0.011	0.04
Acenaphthylene	0.292±0.001	ND	1.033±0.101	0.2
Acenaphthene	ND	ND	ND	0.2
Fluorene	0.321±0.100	ND	ND	0.2
Phenanthrene	ND	ND	ND	0.2
Anthracene	ND	ND	ND	0.2
Fluoranthene	0.406±0.021	ND	ND	0.2
Pyrene	ND	ND	ND	0.2
Benz(a)anthracene	0.510±0.021	ND	ND	0.0004
Chrysene	ND	ND	ND	0.0002
Benzo(b)fluoranthene	ND	ND	ND	0.0002
Benzo(k)fluoranthene	ND	ND	ND	0.0002
Benzo(a)pyrene	ND	ND	ND	0.0004
Benzo(g,h,i)perylene	0.531±0.132	ND	ND	0.04
Dibenz(a,h)anthracene	ND	ND	ND	0.0003
Indeno(1,2,3-cd)pyrene	0.503±0.041	ND	ND	0.0004
Total	2.562	-	1.243	

Polycyclic aromatic hydrocarbons in soil within the abattoirs

The results of the concentrations of polycyclic aromatic hydrocarbons from surface soil within the abattoirs are given in Table 2. The result showed that naphthalene, acenaphthene, anthracene and, benzo(k)fluoranthene were not detected in any of the examined location. All the other members were detected in at least two stations. The observed total values of PAHs in the stations were in the order; Mile 3 > Aker > Egbelu.

The values of PAHS reported in soil from Mile 3 and Aker stations were greater than 10 mg/Kg value required by Italian legislation for soils to be used for recreational purposes (Guarino et al., 2019), while the value at Egbelu station was lower than the above stipulated value. The observed concentrations of PAHs in soils in this study are lower than the values observed in dumpsites (Ekpete et al., 2019), asphalt plant sites (Simon and Sobieraj, 2006; Chukwuogene et al., 2021), Soils collected from power plant vicinities within three universities in Port Harcourt, Rivers State, Niger Delta, Nigeria (Edori et al., 2022), but are higher than total PAHs values reported in soils in the vicinity of fuel stations in Abraka, Nigeria (Emoyan et al., 2011) and in soil at Akala-olu Ahoada West, Rivers State, Nigeria (Ideriah et al., 2017).

The trend and concentrations of PAHs observed from the different stations showed that Mile 3 was the highest, which was followed Aker and lastly Egbelu. The abundance of PAHs in the stations examined may be associated to the time (age) and nature of activities within the area, notwithstanding the abattoir practice (Edori et al., 2022) and the equilibrium between contributing and discharge sources (Holoubek et al., 2009). However, the major contributor may be the result of abattoir practice that is accompanied with roasting of the skin with fire for human consumption. This leads to continuous flare of incomplete combusted gases which are later precipitated back to the soil within the area. This observation is in consonance with the observation of Nam et al. (2008), Chukwuogene et al. (2021) and Edori et al. (2022), who observed that the amount of PAHs in any soil environment has a link with the type of emissions, atmospheric transference and land cover.

Table 2: Polycyclic Aromatic hydrocarbons in soils within abattoirs vicinity

PAHs (mg/Kg)	Location		
	Mile 3	Aker	Egbelu
Naphthalene	ND	ND	ND
Acenaphthylene	1.128±0.122	ND	1.769±0.163
Acenaphthene	ND	ND	ND
Fluorene	2.064±1.002	0.983±0.086	ND
Phenanthrene	1.969±0.041	0.861±0.341	ND
Anthracene	ND	ND	ND
Fluoreanthene	0.951±0.217	0.888±0.032	ND
Pyrene	0.164±0.000	1.045±0.008	ND
Benz (a)anthracene	0.150±0.011	1.012±0.311	ND
Chrysene	2.922±0.135	2.095±0.300	0.305±0.041
Benzo(b)fluoranthene	0.677±0.221	0.301±0.021	1.921±0.215
Benzo(k)fluoranthene	ND	ND	ND
Benzo(a)pyrene	0.091±0.031	0.207±0.003	0.109±0.000
Benzo(g,h,i)perylene	2.762±0.035	ND	0.653±0.000
Dibenz(a,h)anthracene	0.827±0.361	2.637±0.124	2.580±0.134
Indeno(1,2,3-cd)pyrene	ND	0.370±0.002	0.465±0.201
Total	12.577	12.397	7.802

The diagnostic ratios of PAHs from borehole water within the abattoir is given in Table 3. At the At the Mile 3 station, the ratio for LMW/HMW was 0.694, Flu/Flu+Py was 1, Ant/Ant+Phe was not established due to either the numerator was not detected or both were undetected, BaA/BaA+Chr ratio gave 0.510. Aker station, PAH components were not detected, therefore no diagnosis could be made. At the Egbelu station, the components for diagnostic ratio evaluation were not detected in the water samples.

The observed value of LMW/HMW at Mile 3 location was found to be less than 1, which presupposes that the source originated from pyrogenic (combustion) origin (Jiao et al., 2017; Edori et al., 2022). Flu/Flu+Py analysis showed a value of 1, of which it can be inferred that the source could have originated from pyrogenic sources. The value of BaA/BaA+Chr was observed to be 0.510, which suggests pyrogenic sources. The value of IP/ (IP+ BgP) indicated 1, which infers pyrogenic sources.

Different molecular ratio of the same ring size groupings have been used to identify sources of PAHs in diverse environmental media (Azza, 2006; Emoyan et al, 2008; Edori and Iyama, 2019; Edori et al., 2022). Having applied the different diagnostic tools to examine the origin and sources of PAHs in the borehole water from the different abattoirs, it can be concluded that their presence is a function of pyrogenic origin or pyrolysis.

Table 3: Diagnostic ratio of PAHs in borehole water samples from Abattoirs vicinity

Stations	LMW	HMW	LMW/HMW	Flu/Flu+Py	Ant/Ant+Phe	BaA/BaA+Chr	IP/ (IP+ BgP)
Mile 3	1.071	1.543	0.694	1	-	0.510	1
Aker	-	-	-	-	-	-	-
Egbelu	1.243	-	-	-	-	-	

The diagnostic ratios of PAHs from the soil within the named abattoirs is given in Table 4. Diagnostic ratios for LMW/HMW showed 0.846, 0.571 and 0.293 values for Mile 3, Aker and Egbelu locations respectively. All the location values were established to be less than 1, which presumes that the source originated from pyrogenic (combustion) origin (Jiao et al., 2017; Edori et al., 2022). This observation is in agreement with the observation of Jiao et al. (2017) and Edori et al. (2022) but at variance with the observation of Ekpete et al. (2019), who all worked on different soil environments associated with different human interferences. Flu/Flu+Py diagnostic ratio showed 0.853 and 0.460 for Mile 3 and Aker stations, while Egbelu station value could not be ascertained. The values obtained for the two stations were above 0.5, indicating pyrogenic sources. According to Yan et al. (2010) values of Flu/Flu+Py ratios < 0.4 results from unburned petroleum, 0.4-0.5 originated from liquid fossil fuels, and values >0.5 come from coal and wood burning.

The ratios of BaA/BaA+Chr in the locations indicated 0.049 and 0.326 for Mile 3 and Aker respectively. No value was recorded for Egbelu station. The values obtained indicated non-combustion sources for both locations, thus petrogenic origin might be the source. When a ratio of this nature is considered, values > 0.35 typifies combustion sources and values < 0.2 show petrogenic sources (Yan et al., 2010). This might have resulted from fuel discharge or spill that are meant for generating set used to power electrical installations in the area. The stations ratio for IP/ (IP+ BgP) showed 1 and 0.416 at Aker and Egbelu stations respectively. The obtained result showed that in Aker location, the source originated from biomass and burning of coal, while Egbelu station values showed that PAHs originated from gas, petrol, paraffin, diesel or crude oil combustion. This conclusion is reached based on the classification of Guarino et al. (2019), who proposed that Ip/(Ip+Bgp) ratio greater than 0.50 resulted from biomass and coal ignition and that pyrolytic products whose origin emanated from gas, petrol, paraffin, diesel and crude oil gives ratios below 0.50 and automobiles sources are in the range of 0.24 and 0.40.

Table 4: Diagnostic ratio of PAHs in soil samples from Abattoirs vicinity

Stations	LMW	HMW	LMW/HMW	Flu/Flu+Py	Ant/Ant+Phe	BaA/BaA+Chr	IP/ (IP+ BgP)
Mile 3	6.284	7.430	0.846	0.853	-	0.049	-
Aker	3.777	6.620	0.571	0.460	-	0.326	1
Egbelu	1.770	6.032	0.293	-	-	-	0.416

The compositional pattern of the different PAHs ring size (ring categories) for borehole water and soil are given in Tables 5 and 6. At the Mile 3 station, the 5-membered rings were not detected in the borehole water, but values of 0.613, 0.915 and 1.034 mg/L were observed for 2-3, 4 and 6-membered rings respectively. None of the ring type was detected in borehole water from Aker station and only 2-3 ring type of a value 1.243 mg/L was detected at the Egbelu station.
For the soil, there were pronounced values of all the PAHs groups in all the stations. Mile three values showed 5.162, 4.188, 1.595 and 2.762 mg/Kg for 2-3, 4, 5, 6 ring types respectively. Aker values showed 1.844, 5.039, 3.145 and 0.370 mg/Kg for 2-3, 4, 5, 6 ring types respectively and Egbelu values showed 1.769, 0.305, 4.610 and 1.117mg/Kg for 2-3, 4, 5, 6 ring types respectively. The LMW PAHs are easily volatilized and are easily leached when compared to HMW PAHs. Therefore, it is expected that in any environment they should form the lower part of PAHs content. This assertion could be seen in the total values of 2-3 ringed PAHs in water at the Mile 3 station. However, at the presence of only LMW PAHs at the Egbelu location can be attributed to recent input sources (Edori et al., 2022). Furthermore, their solubility in water surrounding is also a reason for low values.
Generally, the total values of LMW PAHs are lower than the combined values of HMW PAHs in all the locations that the soils were examined, but considering individual groups, the 2-3 membered rings were appreciable in value. This observation is in agreement with the observation of Edori et al. (2022) in soil contaminated with wastes from generating sets. The Appreciable content of LMW PAHs originated from steady use of firewood to roast the skin of animals while preparing them for sale. Any soil where there is high presence of LMW PAHs contamination indicates current deposition, which has not been interacted with environmental factors (Wu et al. 2019, Edori et al. 2020). For the HMW PAHs, their formation in the soils examined probably arose from combination of LMW PAHs at elevated temperatures. They have the tendency for accumulation in the environment because they cannot be degraded easily and are neither non-volatile, so the fairly high quantities of higher membered rings in the soils might indicates deposition or accumulation that has taken place gradually over time.

Table 5: Compositional pattern of PAHs (mg/L) by ring size in borehole water samples from Abattoirs vicinity

Stations	Ring Size			
	2-3	4	5	6
Mile 3	0.613	0.915	-	1.034
Aker	-	-	-	-
Egbelu	1.243	-	-	-

Table 6: Compositional pattern of PAHs (mg/Kg) by ring size in soil samples from Abattoirs vicinity

Stations	Rings Size			
	2-3	4	5	6
Mile 3	5.162	4.188	1.595	2.762
Aker	1.844	5.039	3.145	0.370
Egbelu	1.769	0.305	4.610	1.117

Conclusion

The study has proven that PAHs were present in both borehole water and soil from abattoir vicinity. The observed individual PAHs in the water in some stations even though were few, yet were more than the required value for domestic water use. The occurrence of almost all the PAHs classified as priority PAHs in the soil at the abattoir is a pointer to the possibility of near future bloom of PAHs in these stations if proper management is not enforced. Moreover, human life especially those butchers are at risk. This is because the value of PAHs in the soil samples were greater than 10mg/Kg limit for soil.

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