ASSESMENT OF POLY CYCYLIC AROMATIC HYDROCARBON (PAH) DISTRIBUTION IN DRY SEASON OF AMBIENT AIR OF OIL PRODUCING COMMUNITIES OF EGBEMA, IMO STATE, NIGERIA

BY

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Abstract: -

Mosses plants (pleurozium schreberi) was used to trap Poly cyclic aromatic hydrocarbon in ambient air of oil producing areas of Egbema, where the distribution and assessment of pollution in ambient air from six locations where harvested for Six months (Dry Season). Gas chromatography was used to analyze the samples where the mean average of PAH recorded Pyrene with highest concentrations of 9.74(µg/kg) followed by Fluoranthane with 4.50(µg/kg). Lowest concentration was Indeno(123)perylene with 0.13(µg/kg) while locations that recorded highest were AQOWH, AQEOJ with 2.86(µg/kg) followed by AQEWH and AQEWFS with 1.73(µg/kg) and 1.87(µg/kg) respectively. AQEOJ and AQOWH have largest variation spread of PAH in all locations, while Fluorathene recorded highest variation spread in all Locations. This research is used to ascertain the level of concentration of Polycyclic Aromatic Hydrocarbon during the dry season in various locations of Oil producing communities using a Bio indicator (pleurozium schreberi), and to understand the variability of natural environmental conditions and, at the same time, a significant diversity of anthropogenic influences in air quality of Egbema Oil producing communities in Imo State.It is also noted that not only oil exploration generates PAH spread in Egbema, there are other vices that contribute to daily exposures of PAH which is associated with increased incidences of premature death, chronic asthma and as well as respiratory problems in children.

Keywords: *PAH, concentration, variability, exposure, toxicity*.

INTRODUCTION

PAHs are subset of a set of compounds known as poly cyclic organic matters (POM). They are, originally, organic compounds primarily that are formed from the incomplete combustion of organic materials or pyrolysis of organic material. These compounds are related to the use of oil, gas, coal and wood in energy production [7].

Polycyclic aromatic hydrocarbons (PAHs) are transported in the atmosphere in gas and/or particle phases and they are deposited by wet and dry deposition. Daily exposures to particulate matter associated with increased incidences of premature death, chronic asthma and increased hospital admissions as well as respiratory problems in children [2].

Several PAHs and their epoxides are highly toxic, mutagenic and/or carcinogenic to microorganisms as well as to higher systems including humans. The polycyclic aromatic hydrocarbons compounds (PAHs) require activation to electrophilic metabolites to exert their mutagenic or carcinogenic effects [5].

Exposure to PAHs always involves complex mixtures that may induce synergistic or antagonistic effects on the nontoxic properties that make risk assessment more difficult. Assessment of exposure to PAHs is important due to the widespread presence of PAHs in the environment and their toxicological relevance.

The biological impact in terms of the total PAHs intake into the body via respiratory, dermal, and gastrointestinal routes should be monitored precisely [3].

It was early discovered that terrestrial moss (*pleurozium sohreberi*) samples has the ability to be used for monitoring of atmospheric deposition of pollutants

Within the European network on monitoring of environmental pollutants it has been discussed that moss also can be utilized for sampling other types of contaminants such as e.g. persistent organic pollutants (POPs)and polycyclic aromatic hydrocarbons (PAHs) [1]. It has earlier been discovered that environmental samples (*pleurozium sohreberi)* may well serve as passive samplers of organic contaminants. Already in the early 1980 it was discovered that mosses (*pleurozium sohreberi)* and lichen successfully sampled chlorinated pesticides and PAH, [1].

Materials and Method

Six sampling sites distributed in the Oil producing areas were used. The sampling sites were selected taking into account the areas where mosses (*Pleurozium sohreberi*) plants were abundant. The sites with the highest percentage of tree cover and the location of the site with respect to air currents and sources of pollution in an area was considered. Material from selected sites was collected in order to test the feasibility of using mosses as indicators for PAHs. The research was done in six locations of oil producing areas of Egbema, Imo State. In each of the six locations, samples of (*Pleurozium sohreberi*) moss were collected. All sites were within areas with different human created activities, such as oil exploration and heavy vehicular movements, construction and building activities etc. (*Pleurozium sohreberi)* materials were collected in the field for six months. Samples were placed in sealed polythene bags and labeled against their locations of collection and were transported in a portable cooler to the laboratory where they were kept frozen until used for analysis, [2]. After removal of the nylon bag, one half of each sample was extracted for 24hrs with 200ml of acetonitrile in a Soxhlet extractor. The dry weight of the other half was recorded by exhaustive drying at 50°C. The acetonitrile extract was mixed with 600 ml of distilled water and 100 ml of pentane. The pentane fraction was separated, dried with anhydrous sodium sulphate and concentrated to 0.5 ml in a Kuderna-Danish apparatus. The concentrate was fractionated over a silica column, and eluted with 4 ml of hexane and 15 ml of dichloromethane/pentane. The latter eluate was concentrated, and taken up in 1 ml of acetonitrile. An aliquot of the concentrate was injected into a liquid chromatograph (Hewlett-Packard 1090M). Identification and quantification of the PAHs was carried out by GC/LRMS on an Agilent 6890N gas chromatograph coupled to an Agilent 5973 mass spectrometer in an electron impact mode, [4]. The PAHs were identified by their retention times, and, whenever the diode array signal allowed, by their relative peak heights at different absorbance wavelengths. The PAHs were quantified by their respective peak areas.

Results and Discussion

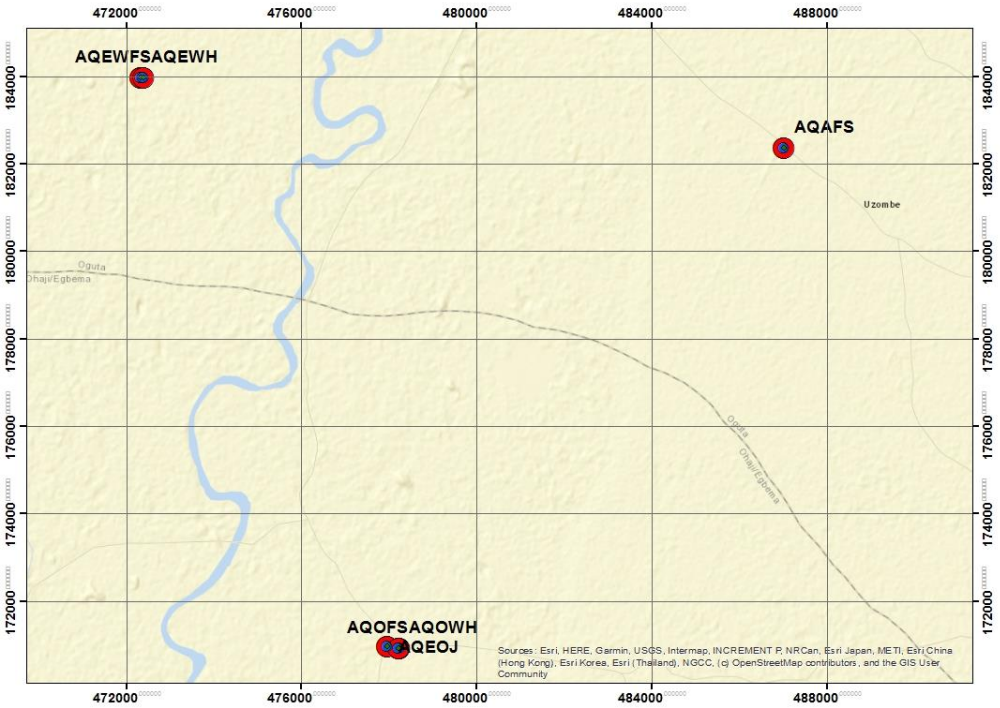

Plate 1: Map of sample Locations in Egbema Oil producing area of Imo State

Results on poly cyclic aromatic hydrocarbon (PAH) in Egbema

Table 1: MEAN PAH CONCENTRATION DISTRIBUTION IN OIL PRODUCDING COMMUNITIES OF EGBEMA.

PAH	AQAFS	AQEWFS	AQEWH	AQEOJ	AQOFS	AQOWH	Mean AV	MEAN AV (µg/kg)
naphthlene	0.008	0.006	0.004	0.004	0.007	0.007	0.006	0.54
acenaphthalene	0.006	0.015	0.010	0.010	0.021	0.017	0.013	1.7
acenaphthene	0.021	0.004	0.007	0.008	0.002	0.000	0.007	1.53
florene	0.017	0.017	0.008	0.006	0.015	0.015	0.013	2.4
phenathrene	0.004	0.004	0.001	0.005	0.001	0.006	0.004	3.9
anthracene	0.007	0.006	0.003	0.005	0.078	0.006	0.018	3.7
fluoranthene	0.031	0.006	0.021	0.146	0.006	0.096	0.051	4.5
pyrene	0.165	0.164	0.100	0.103	0.172	0.172	0.146	9.74
Benzo(a)anthracene	0.004	0.010	0.090	0.090	0.021	0.052	0.045	3.13
chrysene	0.030	0.018	0.004	0.034	0.020	0.022	0.021	1.78
Benzo(b)fluoranthren	0.004	0.010	0.004	0.002	0.013	0.007	0.006	0.43
Benzo(a)pyrene	0.001	0.012	0.002	0.002	0.009	0.011	0.006	4.0
Benzo(k)fluoranthene	0.007	0.008	0.010	0.013	0.013	0.011	0.010	0.62
Indeno(123)perylene	0.003	0.004	0.002	0.001	0.002	0.001	0.002	0.13
Benzo(g,h,i)Perylene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00

Table 2: TOTAL PAH CONCENTRATION DISTRIBUTION IN URBAN AND OIL PRODUCDING COMMUNITIES OF EGBEMA. (DRY SEASON)

PAH	AQAFS	AQEWFS	AQEWH	AQEOJ	AQOFS	AQOWH
naphthlene	0.008	0.006	0.004	0.004	0.007	0.007
acenaphthalene	0.006	0.015	0.010	0.010	0.021	0.017
acenaphthene	0.021	0.004	0.007	0.008	0.002	0.000
florene	0.017	0.017	0.008	0.006	0.015	0.015
phenathrene	0.004	0.004	0.001	0.005	0.001	0.006
anthracene	0.007	0.006	0.003	0.005	0.078	0.006
fluoranthene	0.031	0.006	0.021	0.146	0.006	0.096
pyrene	0.165	0.164	0.100	0.103	0.172	0.172
Benzo(a)anthracene	0.004	0.010	0.090	0.090	0.021	0.052
chrysene	0.030	0.018	0.004	0.034	0.020	0.022
Benzo(b)fluoranthren	0.004	0.010	0.004	0.002	0.013	0.007
Benzo(a)pyrene	0.001	0.012	0.002	0.002	0.009	0.011
Benzo(k)fluoranthene	0.007	0.008	0.010	0.013	0.013	0.011
Indeno(123)perylene	0.003	0.004	0.002	0.001	0.002	0.001
Benzo(g,h,i)Perylene	0.000	0.000	0.000	0.000	0.000	0.000
TOTAL PAH	**30.8**	**28.0**	**26.6**	**42.9**	**38.0**	**42.9**
TOTAL AV PAH	**2.05**	**1.87**	**1.73**	**2.86**	**2.53**	**2.86**

From Table 1, Pyrene recorded 0.146(µg/kg) as highest mean average concentration followed by Fluoranthene with 0.051 (µg/kg) concentrations. Also Benzo(g,h,i),Perylene and Indeno(1,2,3) Perylene recorded lowest concentration of PAH, with 0.002(µg/kg) and 0.000(µg/kg) respectively. This indicates that the latter has little or no pollution presence in oil producing communities of Egbema.

Also from Table 2, AQEOJ and AQOWH locations recorded an average PAH as 42.9(µg/kg) and 2.86(µg/kg) respectively, while AQEWFS location recorded 28.0(µg/kg) and 1.87(µg/kg) concentration of PAH respectively. This can tell the type or volume of pollution caused by oil exploration and its activities which are carried out within such locations. These explanations suggested that natural gas/oil exploration activities may be contributing significantly to PAHs in air at levels that are relevant to human health. [4].

Statistical analysis of PAH in oil producing communities of Egbema

Table: 3 Descriptive Statistics: AQAFS, AQEWFS, AQEWH, AQEOJ, AQOFS, AQOWH,, ...

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
AQAFS	14	0	0.0289	0.0147	0.0549	0.0030	0.0040	0.0105	0.0278
AQEWFS	14	0	0.0266	0.0144	0.0540	0.0040	0.0055	0.0135	0.0187
AQEWH	14	0	0.0412	0.0183	0.0684	0.0020	0.0040	0.0095	0.0572
AQEOJ	14	0	0.0417	0.0188	0.0702	0.0010	0.0037	0.0075	0.0592
AQOFS	14	0	0.0335	0.0145	0.0544	0.0010	0.0088	0.0160	0.0260
AQOWH	14	0	0.0378	0.0150	0.0562	0.0020	0.0087	0.0140	0.0393

It is good to note that AQEOJ and AQOWH locations has the largest variation (spread) of PAH element while AQEWFS location has the lowest spread of PAH in Egbema oil producing communities in Imo State. Hence, the location AQEOJ is most volatile area with PAH element and this is evident in the Maximum value of the variables.

Table: 4 Descriptive Statistics: NAPH, ACHTHA, ACTHE, FLORE, PHENA, ANTHR, FLUORA, ...

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
NAPH	10	0	0.00740	0.00107	0.00337	0.00400	0.00400	0.00650	0.01100
ACHTHA	10	0	0.02500	0.00702	0.02220	0.00600	0.00775	0.01750	0.03550
ACTHE	10	0	0.01900	0.00518	0.01637	0.00200	0.00700	0.01050	0.03450
FLORE	10	0	0.03030	0.00930	0.02941	0.00600	0.01425	0.01850	0.03850
PHENA	10	0	0.0559	0.0234	0.0740	0.0010	0.0040	0.0085	0.1588
ANTHR	10	0	0.0677	0.0236	0.0747	0.0040	0.0060	0.0445	0.1180
FLUORA	10	0	0.0861	0.0282	0.0890	0.0080	0.0245	0.0515	0.1553
PYRENE	10	0	0.1172	0.0265	0.0837	0.0130	0.0352	0.1100	0.2077
BENZOa	10	0	0.0400	0.0142	0.0448	0.0000	0.0030	0.0210	0.0762
CHRYSE	10	0	0.02120	0.00495	0.01564	0.00200	0.00550	0.02200	0.03700

It is observable that FLUORANTHENE has the largest variation (spread) of PAH element while NAPHTHALENE has the lowest spread of PAH in Egbema oil producing communities in Imo State. Hence, the location FLUORANTHENE is most volatile PAH element and this is evident in the Maximum value of the variables.

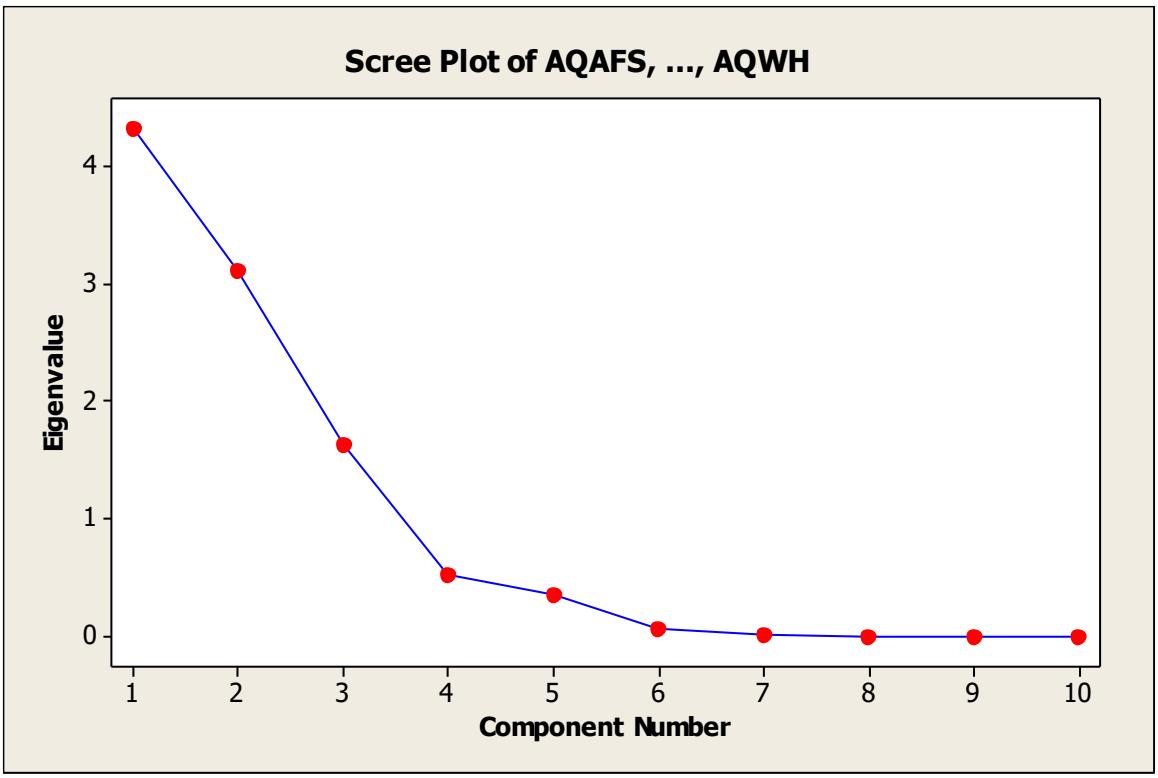

Plate 1. Screen Plot of AQAFS, AQEWFS, AQEWH, AQEOJ, AQOFS, AQOWH

From plate 1, the first two and the first three **principal components** represents from 74.2% to 90.5% of the total variability in the location of PAH. Thus, most of the data structure can be captured in two or three underlying dimensions. The remaining **principal components** account for a very small proportion of the variability and are probably unimportant. The Screen plot provides this information visually.

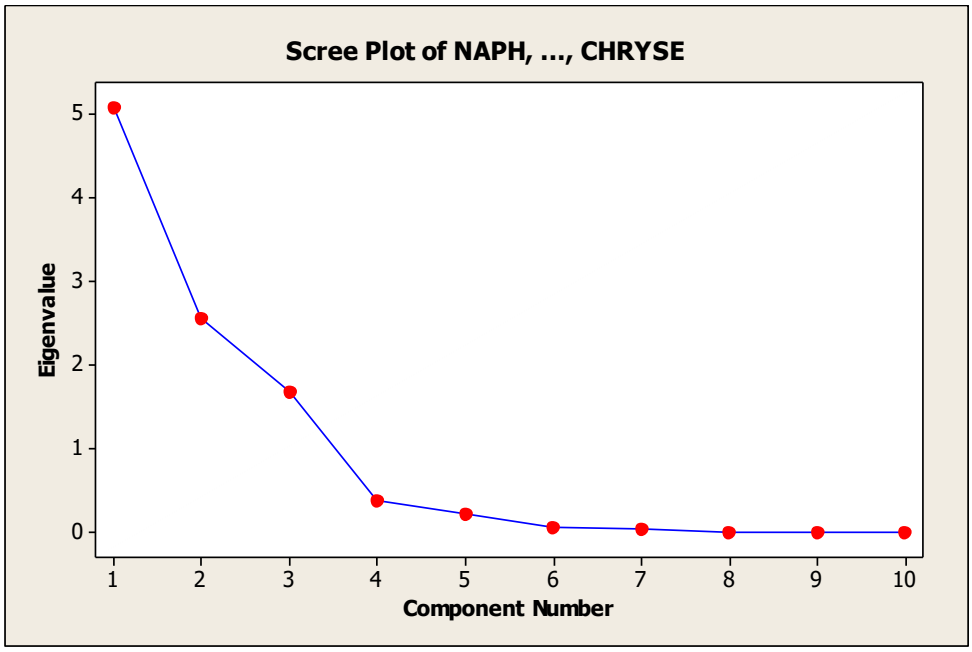

Plate 2: Screen Plot of NAPH, ACHTHA, ACTHE, FLORE, PHENA, ANTHR, FLUORA,

From plate 2, the first two and the first three **principal components** represent 76.3% and 93.1%, respectively, of the total variability in PAH. Thus, most of the data structure can be captured in two or three underlying dimensions. The remaining **principal components** account for a very small proportion of the variability and are probably unimportant. The Screen plot provides this information visually.

CONCLUSION

Generally, the PAH level determined in moss (*pleurozium schreberi*) collected around Oil exploration sites were considerably higher for the heavier PAHs than the PAH level found in moss (*pleurozium schreberi*) collected at background sites. This applies in particular to the mosses (*pleurozium schreberi*) collected in AQOWH and AQEOJ especially for the heavier PAHs such as fluoranthene and pyrene, while in AQEWH location recorded lower PAH such as Indeno(123)perylene and Phenathrene.

It is likely that the elevated levels determined in moss (*pleurozium schreberi*) are related to emissions from industries and exploration activities within these locations. However, the ratio of selected congeners indicate that combustion of organic material other than fossil fuel may contribute to the PAH level at several locations.

The highest levels within the individual locations were found in PAH deployed closest to the exploration/ industrial sites in the prevailing wind direction. Still there is no clear indication that the industries and oil exploration activities is the only source to the levels of PAHs concentration. The most dominating PAHs within all the locations was the lighter PAHs such as 2-4 ring PAHs, whereas 4-7 ring PAHs where dominating in the moss samples. Hence, results from this study, illustrates that moss (*pleurozium sohreberi*) samples together provides more comprehensive information regarding the spatial distribution of PAH around the oil exploration locations of Egbema communities. That said, information regarding local parameters such as wind direction and topography is important to consider in order performing an adequate sampling technique.

Polycyclic aromatic hydrocarbons (PAHs) are transported in the atmosphere in gas and/or particle phases and they are deposited by wet and dry deposition. Daily exposures to particulate matter is associated with increased incidences of premature death, chronic asthma and increased hospital admissions as well as respiratory problems in children [1]. Though there is very low concentration of PAH in oil producing communities of Egbema, Imo State, the biological impact in terms of the total PAHs intake into the body via respiratory, dermal, and gastrointestinal routes should be monitored precisely and continuously in order to build up a consistent and more comparable body of data on the compostion and trend of PAH on ambient air across oil producing communities of Egbema in Imo State.

REFERENCES

[1] Agency for Toxic Substances and Disease Registry, (2009) Toxicological Profile for Polycyclic aromatic hydrocarbon (PAHs). Accessed 12.09.95

[2] D.Piraga, G.Tabors, O. Nikodemus, Z. Zigure and G. Brumelis (2017), Current content of selected pollutants in mosses, humus soil and plants bark and long-term radial growth of pine trees in the Mezaparks forest in Riga. Environ. Sci. Pollution. Res, **24**, 11964–11977.

[3] K.Becker (2002). Environmental pollutants in the blood of the German population. *International Journal of Hygiene and Environmental Health*, **205**: 297–308.

[4] M.S. El-shaharwa, and A. Harmza (2010) an overview on the accumulation, distribution, transformations, toxicity and analytical methods for monitoring of POP. **80**: 1587-1597.

[5] M.B Paoliello,and E.M. De Capitani (2005). Environmental contamination and human exposure to lead in Brazil. *Reviews of Environmental Contamination and Toxicology*, **184**:59–96.

[6] M.Ikeda (2000). Urban population exposure to lead and cadmium in east and Southeast Asia. *Science of the Total Environment*, **249**:373–384.

[7] M.Jones (2019),*"Gas Chromatography-Mass Spectrometry"*, American Chemical Society, *Retrieved 19 Nov 2019*.