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CONCENTRATION OF POLYECYCLIC AROMATIC HYDROCARBONS IN WETLANDS OF OIL PRODUCING COMMUNITIES WARRI NORTH AND CAGE AQUACULTURE

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Abstract: **Oil exploitation in Nigeria leaves in its trail environmental degradation of varying degrees due to intended and unintended human actions. This study was an ex–post facto research whose general objective was to investigate the concentrations of polycyclic aromatic hydrocarbons in the wetlands in Ogidigben and environs. The specific objectives were to (i) determine the concentrations of Pyrene, Chrysene, benzo (a) pyrene, benzo (a) anthracene and benzo (b) fluorathene (ii) to ascertain if the concentrations of the PAHs were within the maximum permissible concentrations for PAHs in wetlands of 1.00ug/l stipulated by EU1881/2014 (iii) to asses the sustainability of the produce for human consumption (v) establish if the produce will be suitable as concentrate for animal feeds and (v) to evaluate the export potentials of the produce based on Codex 1963 commission conditions. Each wetland was mapped out into 5 sampling sites and samples were collected from 5 spots adopting grab sampling techniques, bulked, composites were drawn, fixed with nitric acid and stored in ice cooled flasks. The analytical standard adopted was EU1881/2014 and the instrument for determination was gas chromatography fixed with mass spectrometry, Agilent Tripple Quadrupole Model 7000. The mean results obtained were pyrene 1.05±0.01ug/l, Chrysene, 1.05±0.011ug/l BaP, 1.05±0.01ug/l, BaA, 1.05±0.00ug/l and BbF, 1.05±0.01ug/l. The mean results were subjected to test of significance with analysis of variance using SPSS IBM Model 29 at 0.05 level of Significance and the P value 0.048 thus rejecting Ho. The study concluded that the wetlands were polluted above EU 1881/2014 MPC for wetland water and thus are unsuitable for the deployment cage aquaculture as the produce will not be healthy for human and animal consumption and will equally not be exportable for failing Codex Alimentarius conditions for produce export. The study thus recommended that the oil companies operating in Ogidigben and environs should adopt the world best practices in their operations, environmental monitoring agencies NESREA and NOSDRA should step up the surveillance of the oil companies operations and the impacted wetlands should be remediated and restored forth with to allow for the adoption of cage aquaculture for hunger eradication in Nigeria.**

Keywords: **Oil exploitation, polycyclic aromatic hydrocarbons, pollution, Wetlands, Cage aquaculture, bioaccumulation and biomagnifications, health, remediation.**

1. INTRODUCTION

Wetlands are delicate, complex and valuable ecosystems that exist in varying degrees in different countries of the world. Wetlands are ecosystems that saturated flooded with water permanently or partially for decades or years (Sabastine 2021). They are areas of water mash, peatland or fen that may be natural or artificial permanent or temporary may be fresh water,

brackish or salt flowing or static. (Ramsar Conference of Parties 2023). Wetland can be marine, inland, estuarine, lucustrine and palustrine (Ogwu *et al.*, 2024). They can be fresh water brackish or saline, swamp, bog, fen or mash (Bamgboye 2022). Wetland ecosystem is the habitat for crabs, water fowl, periwinkles, snails (Ojogwu, 2020). They provide breeding grounds for numerous breeds of fish and wetland animals, recharge the aquifiers and rivers, cools the high ground, purifies runoff and provide exciting scene for tourism's (Ubeku 2019), provide varying fruits and nuts and also are good location for hunting, fishing and aquaculture (Ogwu *et al.*, 2024). Wetlands are good sites for cage aquaculture. Cage aquaculture is the art of raising fish in a cage anchonred in a natural body of water. (Ogwu *et al.*, 2024, Haruna & Babajide, 2020). Cage aquaculture reduces investment outlay in fish farming, offsetting the cost of water amenities (Loryem & Tsav 2020) Nigeria annual fish demand is 3.6 million metric tones while the local production is 1.2 million metric tones, the difference is bridged through importation (Ruwani 2023, National Bureau of statistics, 2023), thus causing unemployment and foreign exchange depletion (Ogwu *et al.*, 2023)

Wetlands Pollution is however a major obstacle in utilizing wetland ecosystem for cage aquaculture. Contaminants of wetlands includes microplastics, polychlorinated, biphenyls, (PCBs) pesticides, heavy metals, polycyclic aromatic hydrocarbons (PAHs). PAHs are group of hydrocarbons containing multiple aromatic benzene rings (United State Environmental protection Agency, 2018) Bioavailability of PAHs in wetland environment will result in bioaccumulation and biomagnifications of PAHs in aquatic organisms. Bioaccumulation is the propensity of a toxicant within ecosystem to penetrate the tissues of organism while biomagnifications is the tendency of the toxicant to multiply in geometry in the organism's tissue (Ogwu *et al.*, 2025) Polycyclic hydrocarbons in food have been implicated in cancer of the lungs, Castro intestinal track and bone marrow (Ogwu *et al.*, 2024) Oesteoporosis, teratogenic effect and mutation (Ojiako 2024) and sources of PAHs in the environment include coal, gasoline and crude Oil (Osatuyi 2022). Crude oil contamination occurs in oil exploitation through pipes rapture, equipment failure, ballast water, tank wash, well head blow out and sabotage (Nam *et al.*, 2015). Nigeria recorded 70,000 oil operational spills in Niger Delta in 2023 (NBS 2024). Oil Spillage in Bateren Warri North in 2023 resulted in contamination of wetlands and ponds resulting in food insecurity (Omashola 2024), while the oil well head blow out in Kolokolo wetlands in Warri North in 2022 that resulted bush fire that destroyed mangroves nets and contaminated ponds (Onatuyi 2024). The focus of this study is the analysis of water in the wetlands in Ogidigben Madogho, Aja-Edad, Ubaoke and Ugbegugu for the concentrations of PAHs for cage aquaculture deployment for job and wealth creation for poverty eradication in Nigeria.

Objective: The main purpose of the study was to assess the contents of polycyclic aromatic hydrocarbons in the wetlands in Ogidigben and environs.

The specific objectives of the study were:

i. to determine the concentrations of pyrene, chysene, benzo (a) pyrene (BaP) and benzo (a) anthrocene (b) fluorathane (BbF)

ii. to ascertain if the concentration of the PAHs measured are within EU1881/2014 maximum permissible concentrations (MPC) for PAHs in wetlands 0f 1.00ug/l

iii. to assess the suitability of the produce from the wetland for human consumption.

iv. to establish if the produce will be suitable as concentrate for animal feeds production.

v. to evaluate the export potentials of the produce considering Codex 1963 commission conditions for produce export.

The study was guided by research question as;

i. what are the concentrations of pyrene, chysene BaP, BaA and BbF in the wetlands in Ogidigben and environs?

ii. are the concentrations of PAHs within EU 1881 2014 MPC for wetland of 1.00ug/l?

iii. are the produce suitable for human consumption?

iv. are the produce suitable for animal consumption?

v. what is the export potential of the produce?

The study was guided by a null hypothesis as;

Ho: there is no significant difference between the concentrations of pyrene, chysene BaP, BaA and BbF and EU2014/ MPC for PAHs in Wetlands water.

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Design of the study

This study adopted ex post facto research design. Ex post facto research "after the fact" is a research design that studies the interactions between dependent and independent variables (Betrand 2020).

Area of the Study

Ogidigben, Madogho, Aja-Edad, Ubaoke and Ugbegugu are wetland oil bearing settlements in Warri North local Governmenty Area, Delta State Nigeria. They lie within geographical positioning coordinates of $5^0$882243N and longitude 5^0.27687E. The people of Ogidigben and environs are predominantly farmers and fishermen. Some are artisans and petty traders while few work in oil companies mainly as janitors and security guards. The wetlands are the cesspools of the effluents and spillages resulting from oil extraction activities in the area.

2. MATERIAL AND METHODS

This study was conducted between February and July, 2024. Five research assistants assisted in samples collection. The wetlands in each settlement was mapped into sampling grids and sample were collected from 5 spots in each grid adopting grab samplings techniques as described in (Cheng *et al.*, 2013) Samples collected in each spot were bulked and composites were drawn fixed with nitric acid (HNO_3) to forestall oxidation and stored in ice cooled flasks for analysis. They were 125 samples

3. ANALYSIS OF SAMPLES

The analytical method adopted was EU 1881/2014 as in (Deila Rosa *et al.*, 2016). The PAHs in water samples from the wetlands in Ogidigben and environs were determined with gas chromatography fixed with mass spectametry (Coronnal 2016) 10ml of water were measured out into beakers into these 2g of anhydrous sodium sulphate were introduced and the mixture were vigorously agitated and allowed to settle for 1 hour. The supernatant was transferred into extraction beakers and decafluorobiphyl (20g) were added and also sodium hydrosulphate and beakers were agitated vigorously again to the point where slurry began to flow freely. The eluents were then fed into gas chromatography coupled with, mass spectrometry Agilent Quadrupole 7000 models for the determination of the PAHs of the interest.

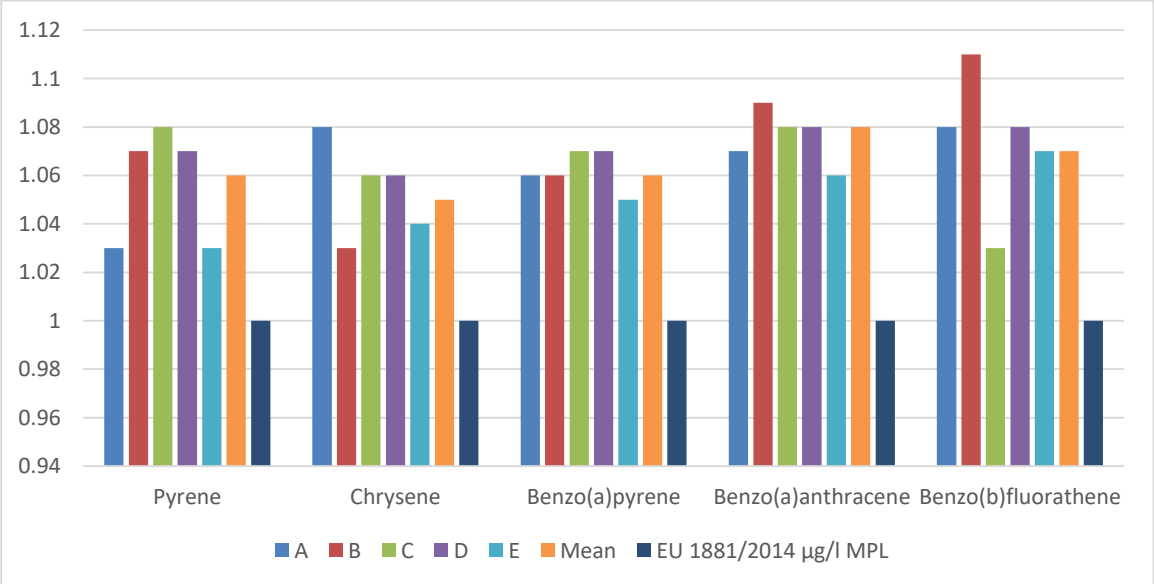
4. RESULTS

The results of the analysis of the PAHs in wetlands in Ogidigben and environs were presented in Figures 1 to 5 and the comparative mean results of the PAHs in the wetlands in Figure 6.

Results of the PAHs in the wetlands in the Ogidigben were as in Figure1.

Figure 1: The results of the PAHs in the wetland in Ogidigben and EU1881/2014 MPC for PAHs in wetlands in ug/l.

PAHs content in Wetland in Ogidigben



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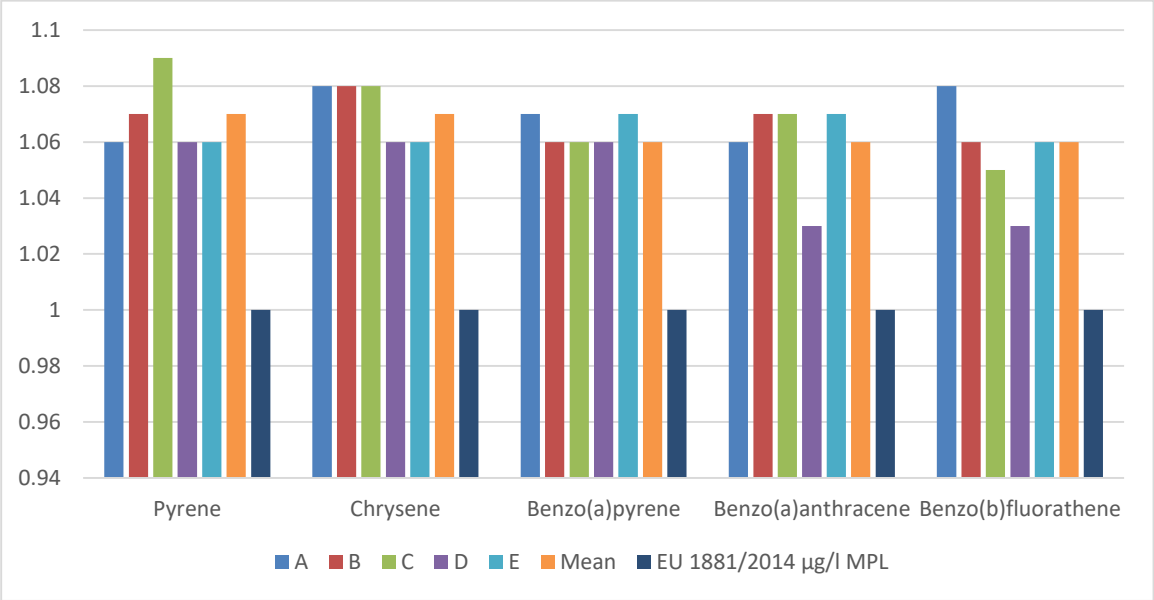
The analysis of the water in the wetland in Ogidigben as presented in the graph in figure 1 showed that the mean concentration of pyrene in Ogidigben was 1.06ug/l, Chrysene mean concentration was 1.05ug/l, the mean concentration of BaA was 1.081ug/l while the mean concentration of BbF was 1.07ug/l.

The result of the PAHs content in the wetlands in Madogho were as in figure 2

Figure 2: the results of the PAHs in the wetlands in Madogho and EU 1881/2014 MPC for PAHs in Wetlands in ug/l

The concentration of the PAHs in wetland in Madogho

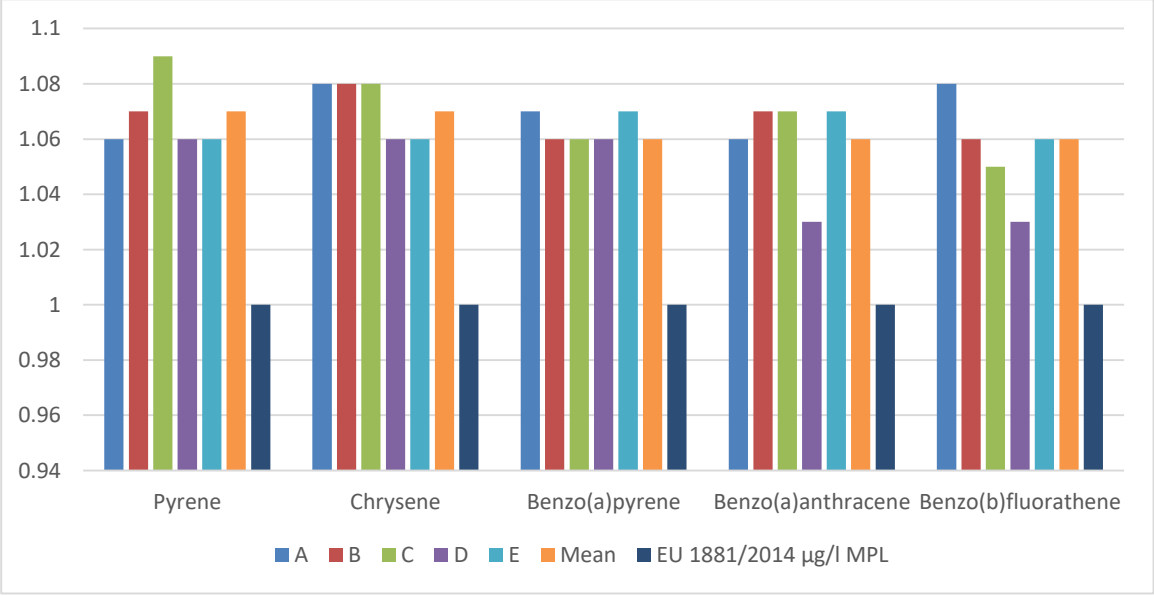


The graph above represents the contents of PAHs measured in the wetlands in Madogho. Pyrene mean content in Madogho was 1.07ug/l, Chrysene was 1.07ug/l, BaP, mean content was 1.06mgll BaA mean concentration was 1.06 and BbF mean concentration n Madogho was 1.06ug/l.

The results of the PAHs concentration in Aja-Edad were as in figure 3

Figure 3; results of the PAHs content in the wetlands in Aja-Edad and EU 1881/2014 MPC for PAHs in Wetlands in ug/l.

Contents of PAHs in Wetland in Aja-Edad

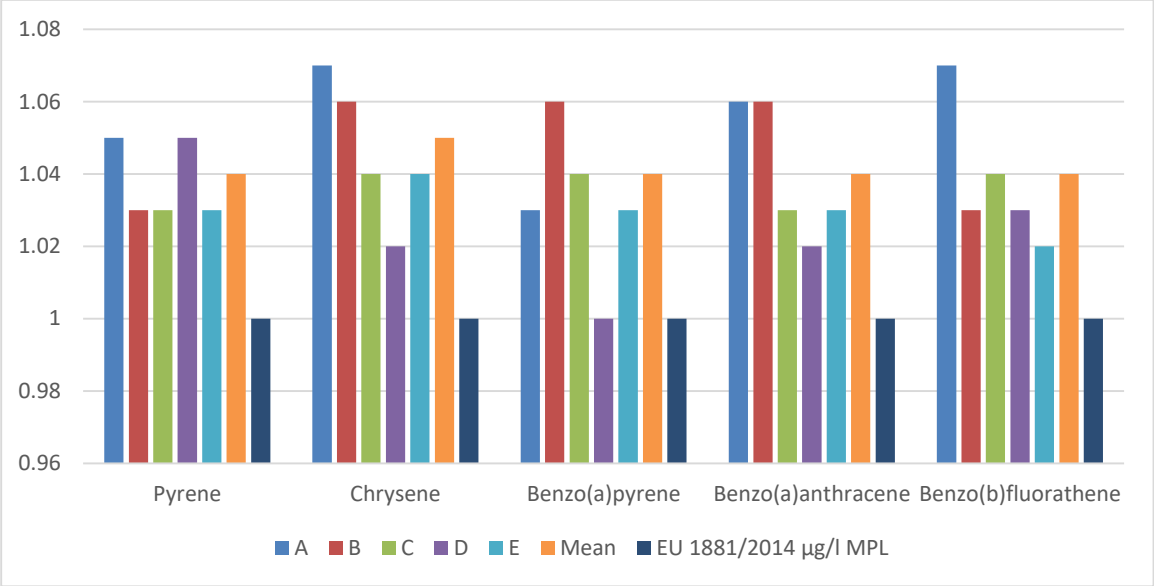


The graph above presents the concentrations of PAHs in the wetlands in Aja-Edad. The pyrene mean content was 1.05ug/l, Chysene content in wetlands in Aja-tdad was 1.04ug/l, BaA mean content was 1.04ug/l and BbF mean concentration in Aja-Edad was 1.04ug/l.

The results of the analysis of PAHs in the wetlands in Ubaoke were as in Figure 4

Figure 4: results of the analysis of the PAHs in the wetlands in Ubaoke and EU1881/2014 MPC for the PAHs in the wetlands in ug/l.

The concentration of PAHs in Wetlands in Ubaoke

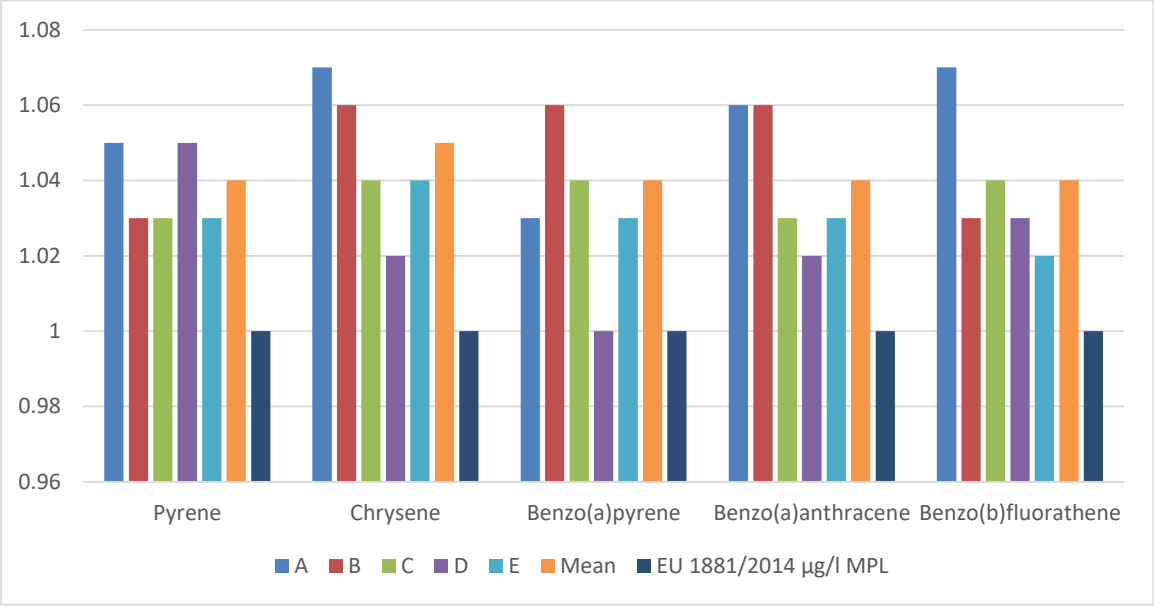


The graph above presents the concentrations of PAHs in Ubaoke. The mean content of pyrene was 1.04ug/l, Chrysene mean content was 1.05ug/l, Bap had a mean concentration of 1.04ug/l, BaA mean content was 1.04ug/l and BbF content was 1.04ug/l

The results of the analysis of the PAHs contents in the wetlands in Ugbegugu were as Figure 5

Figure 5: results of the PAHs content in the wetlands in Ugbegugu and EU1881/2018 MPC for PAHs in Wetlands in ug/l.

The concentrations of PAHs in the wetlands in Ugbegugu.



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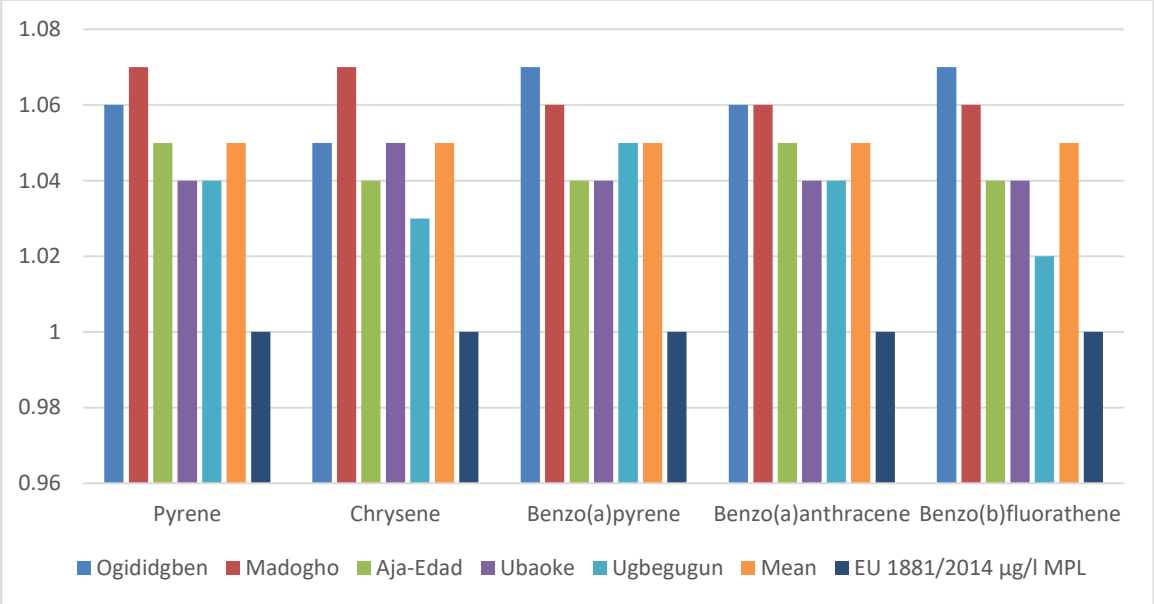
The graph in Figure 5 presents the concentrations of the PAHs in the wetlands in Ugbegugu. The mean content of pyrene, the graph revealed was 1,04ug/l, Chrysene 1.03ug/l, BaP mean content was 1.03ug/l, BaA mean content was 1.04 while BbF had a mean concentration of 1.02ug/l.

The comparative means of the contents of PAHs in the wetlands in Ogidigben and environs were as in figure 6.

Figure 6: results of the group mean contents of PAHs in the wetlands in in Ogidigben and environs and EU 1881/2014 MPC in ug/l.

The comparative mean results of the PAHs in the wetland in ogidigben and environs.



The above graph presents the group mean results of PAHs in the Wetlands in Ogidigben and environs. The group mean concentration of the pyrene in the wetlands in Ogidigben and environs was 1.05ug/l, Chrysene mean content was 1.05ug/l, BaP mean content was 1-05ug/l, BaA mean was 1.05ug/l and BbF mean concentration was 1.05ug/l.

Statistical Analysis: the mean results of the PAHs content in the wetlands in Ogidigben and environs were subjected to test of significance with special package for Social Sciences (SPSS) Model 29 IBM at 0.05 level of significance and the P value was 0.048 thus rejecting Ho.

5. DISCUSSION

The analysis of the wetlands in Ogidigben and environs showed varying concentrations of the parameters measured. The content of the pyrene the analysis revealed range from 1.04ug/l in Ubaoke and Ugbegugu to 1.07 in Madogho with general mean of 1.05ugl. The EU 1881/2014 MPC for pyrene in wetland water is 1.00ug/l. The result is similar to the results recorded by Ofodile and Nwaokike (2021) in Omambala River in Anambra State Nigeria but at variance with Ochu (2021) who reported low content of Pyrene in Katsina Ala River in Benue State. Adebayo (2018) revealed that high content of pyrene in Ogun River discouraged the adoption of cage aquaculture in Abeokuta and environs Effects of human exposure to pyrene include DNA Mutation lung cancer (Hu *et al.*, 2014).

The analysis of the water in the wetlands in Ogidigben and environs presented the content of Chysene to be between 1.03ugl in Ugbegugu to 1.05ug/l in Ogidigben with a mean of 1.05ug/l. This result of elevated content of Chrysene in the wetlands is in agreement with the reports of Olayemi and Babatunde (2020) in Asa River Kwara State. According to Adeola (2020) high concentration of Chysene reported in River Ose was a reason for low adoption of Cage aquaculture in Ogbese and environs in Ondo State Ogwu *et al.*, (2024) revealed that the ingestion of chrysene contaminated food results in health complications of Cancer of gastro intestinal tract and Oesteoporosis.

Wetland water analysis for the content of BaP Showed the concentration to range from 1.04ug/l in Ubaoke to 1.07ug/l in Ogidigben with a mean of 1.05ugl. This high content of Bap is associated to oil production activities in the wetlands. This

report is a coroboration of the reports by Ogwu *et al.*, (2024) who reported high content of BaP in Ase creek Kwale as a concomitant effect of oil activities. Ogagaoghene and Ifowodu (2022) reported that the non adoption of Cage aquaculture in Kokori oil producing communities in Delta State was because of contamination of the rivers and streams with heavy metals and PAHs arising from oil exploitation. Epidemiological studies have implicated BaP in obstructive lung problems and burning sensation (Adeleye 2020).

The analysis of the wetlands in Ogidigben and environs presented the concentration of BaA of 1.04ug/l in Ugbegugu and Ugbaoke to 1.06ug/l in Ogidigben and Madogho with a mean of of 1.05ug/l. This high content of BaA is human activities induced. A similar report of high content of BaA was reported in Osakwe (2022) in Ukpoba River benin City. Eromosele and Asuelimen (2021) attributed the low rate of adoption of cage aquaculture in Gelegele wetlands to the high content of BaA reported. Human exposure to BaA is associated with lung cancer in man (Net *et al.*, 2014).

The wetland water analysis Ogidigben and environs for the content of BbF presented concentrations ranging from 1.02ug/l in Ugbegugu to 1.07ug/l in Ogidigben with a mean concentration of 1.05ug/l. This high content of BbF is anthropogenic. A similar report of high content of BbF in wetland water of oil bearing communities was r in Osamuta and Osugo (2021) who reported high content of BbF in Iyiatu River in Utagba Ogbe Delta State. Ogwu *et al.*, (2023) opined that the low rate of cage aquaculture implementation in Okpai oil bearing communities and environs was due to water contamination reported in the distributor of River at Okpai. Health complications arising from human exposure to BbF include tetratogenic effects, Cancer of the skin, intestinal tract and liver (Coirotea *et al.*, 2014).

6. CONCLUSIONS

Wetlands degradation arising from oil exploitation is a recurring decimal in the annals of oil activities in Nigeria and this study has just affirmed an existing norm. The analysis have revealed that the concentrations of the PAHs investigated in Ogidigben and environs wetlands are above acceptable MPC by EU 1881/2014, which means that the wetlands are contaminated and thus the adoption and deployment of cage aquaculture will not be feasible in their present states as the produce will neither be fit for human consumption nor for the production of animal feeds. Also the produce will not scale Codex Alimentarius Commission conditions for produce export.

7. RECOMMENDATIONS

Against this backdrop of the results of the analysis of the PAHs contents of the wetlands in Ogidigben and environs, the study recommended that

(1) oil companies operating in Ogidingben and environs should be made to adopt the world best practices in their operations.

(2) The monitoring agencies National Environmental Standards Regulation and Enforcement Agency (NESREA) and National Oil Spills Detection and Response Agency (NOSDRA) should step up their surveillance of the oil companies operations in Ogidigben and environs

(3) The impacted wetlands should be remediated and restored for the adoption of cage aquaculture for hunger eradication in Nigeria.

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