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LEVELS OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOME ORGANS OF TILAPIA SPECIES FROM NEW CALABAR RIVER, NIGER DELTA, NIGERIA

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Abstract: -

The issues of haphazard discharge of polycyclic aromatic hydrocarbons (PAHS) into aquatic environment and its adverse impact on aquatic lives have attracted wide attentions in recent times. This study therefore examined the concentrations of PAHs in some organs (muscle, gill and brain) of Tilapia species (T.guineensis and T.zilli), which are the dominant fish consumed and marketed in Bille community Niger Delta, Nigeria. Samples of the fish were collected from the effluent impacted and control areas. The samples were prepared and levels of PAHs in the organs analyzed using gas chromatography and mass spectrophotometry (GC/MC) analytical procedures. The total PAHs levels determined from the muscle, gill and brain of T. guineensis were 0.13, 0.022 and 0.005 mg/kg, respectively. The control value were muscle (0.0005mg/kg), gill (0.0008mg/kg) and brain (0.0009 mg/kg). Similarly, the organs of T. Zilli had total PAHs values of 0.021, 0.077 and 0.008 mg/kg for the muscle, gill and brain in that order, while the values from the control samples were 0.0006, 0.0006 and 0.0007 mg/kg representing the muscle, gill and brain, respectively. All the values were above WHO limit of 0.001mg/kg Naphthalene with the highest concentrations of 0.064 mg/kg in the gill, and also posed the greatest danger to aquatic lives and humans.

Keywords: - *PAHs, SPDC, Tilapia species, Tilapia organs, GC/MC, WHO Limit, New Calabar River, Niger Delta.*

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INTRODUCTION

The spread of PAHs in the environment has continued to increase following increases in anthropogenic activities that generate them. PAHs are found in air, water, terrestrial and biological systems (Ceringlia, 1992; Haeseler et al., 1999; Gae and Zhou, 2004). The main sources of PAHs in water bodies are pollution of rivers and lakes by oil spills, industrial effluents and municipal waste water discharge (Dabestani and Ivanor, 1999; Latimer and Zheng, 2003). They are also commonly found in heavy oils, coal tar and creosotes (Chumgold Remediation Limited, 2013).

The New Calabar River receives PAHs from effluent discharged from an oil well head at Awoba Oil Field Flow Station owned and operated by Shell Petroleum Development Company (SPDC). The river is also polluted by precipitates of gas flaring at the flow station. The high interest being expressed about PAHs is because the compounds are toxic, mutagenic or are known suspected carcinogens (Armstrong et al., 2004; Alani et al., 2012). For example, a compound such as (a) pyrene which is mainly of pyrogenic source is a known carcinogen (Walker, 2009). Marine organism consume these pollutants in water and they bioaccumulate at higher trophic levels where the pollutants can be hazardous to man (Eljarrat and Barcelo, 2003).

The choice of Tilapia fish (T.guineensis and T.zilli) for this study was because they are the dominant fish species in the river, and also the most consumed and marketed in the study area and its environs. In addition, Agbozu (2007) reports that fishes are better specimens in the investigation of pollutant load than water samples because of their levels of accumulation. According to law and Hellou (1999); Vives et al., (2004), marine organisms like fish are able to accumulate several folds higher concentration of PAHs than the surrounding water. This study therefore attempted to determine the levels of PAHs in the muscle, gill and brain of tilapia species in the New Calabar River.

Materials And Method

The New Calabar River in Bille Community, Niger Delta, Nigeria is shown in figure 1, while figures 2 and 3 presents the fish species (T.guineensis and T.zilli), respectively.

Figure 1: The New Calabar River

Figure 2: T. guineensis samples

Figure 3: T. zilli samples

Fish Samples Collection

The fish samples were collected from parts of the river impacted with oil processing effluent and from un-impacted control area. The samples were caught by local fishermen using local nets. Thereafter, the collected samples were washed with distilled water, lebelled and transported in a chess box at freezing temperature to the laboratory. In the laboratory, the samples were stored in the freezer at -10^0c in order to prevent post mortem changes until analysis commenced.

Laboratory Analysis

The samples were cleaned, scaled and dissected with clean plastic knife to get the muscle, gill and brain tissues of the organisms. These organs were then transferred to labelled containers and ovendried at 100^0C. After the drying, the samples were milled with a high speed blender. The concentrations of PAHs in the samples were analyzed using gas chromatography and mass spectrophotometry (GC/MC) (Liang et al., 2007).

Statistical Procedure

The SPSS version 20.0 and MS Excel 2007 statistical packages were used in the analysis of the data. The data were further subjected to statistical models such as one-way ANOVA and post hoc Duncan multiple Range Test and plots.

Results and Discussion

Variations of PAHs in T.guineensis

The values of accumulated PAHs in the muscle, gill and brain of T. guineensis from the effluent impacted and un-impacted areas are shown in table 1, and figures 4-7. The total PAHs compounds were 0.013, 0.022 and 0.005 mg/kg for the muscle, gill and brain respectively.

Naphthalene with a concentration of 0.017mg/kg had the highest PAHs component in the gill (figure 4). DouAbul et al. (1997), Deb et al. (2000), and Dhananjayan and Muralidharam (2012) similarly reported from their studies that Naphthalene levels in fish were the highest when compared with other PAHs compounds.

Table 1: PAHs Concentration in the T.guineensis

Parameters (mg/kg)	Tilapia guineensis (Impacted Location)			Tilapia guineensis (Control Location)		
	Muscle	Gills	Brain	Muscle	Gills	Brain
Naphthalene	0.004	0.018	0.002	0.001	0.001	0.001
Acenaphthe	0001	0.001	0.001	0.001	0.001	0.001
Acenaphthylene	0.002	0.001	0.001	0.001	0.001	0.001
Chrysene	0.003	0.002	0.001	0.001	0.001	0.001
Fluroanthen	0.001	0.001	0.001	0.001	0.001	0.0009
Pyrene	0.004	0.001	0.002	0.0007	0.0007	0.001
Fluorine	0.0006	0.001	0.001	0.001	0.001	0.001
Benzo(k) Fluoranthene	0.0005	0.0007	0.001	0.0007	0.0007	0.008
Dibenz (a,h) Anthracene	0.001	0.001	0.0008	0.0007	0.0007	0.0007
Benz (a) Anthracene	0.0008	0.0009	0.001	0.001	0.001	0.0006
Indeno (1,2,3–cd) pyrene	0.01	0.001	0.0006	0.001	0.001	0.0009
Benzo(b) Fluoranthene	0.0008	0.001	0.0005	0.001	0.001	0.0008
Benzo(g,h,i) Perylene	0.0007	0.001	0.0009	0.0007	0.0007	0.0009
Total	**01013**	**0.022**	**0.005**	**0.0007**	**0.0007**	**0.009**

Benzo (k) fluroanthene and benzo (b) fluranthene with same value of 0.0005mg/kg had the lowest of PAHs compounds from the analysis and occurred in the muscle and brain. The variations in the levels of accumulation of the compounds may be attributed to the mobility, concentration, or metabolic processes in the organs. The total PAHs concentrations from the un-impacted (control) locations were generally below the ones from the effluent impacted sites. The values were muscle (0.0005mg/kg), gill (0.0007mg/kg) and brain (0.0009mg/kg) (Table 1).

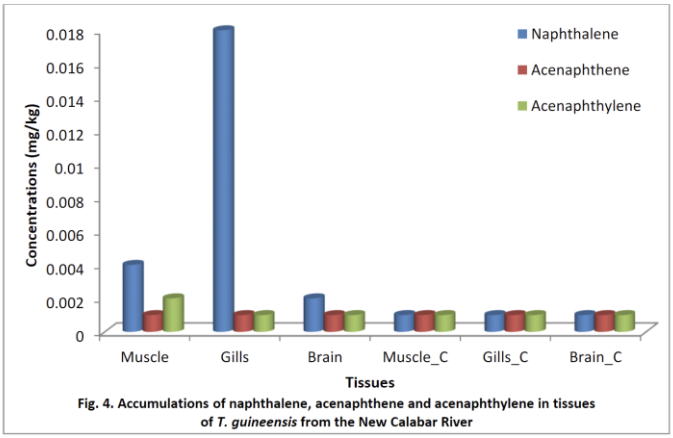

Fig. 4. Accumulations of naphthalene, acenaphthene and acenaphthylene in tissues of *T. guineensis* from the New Calabar River

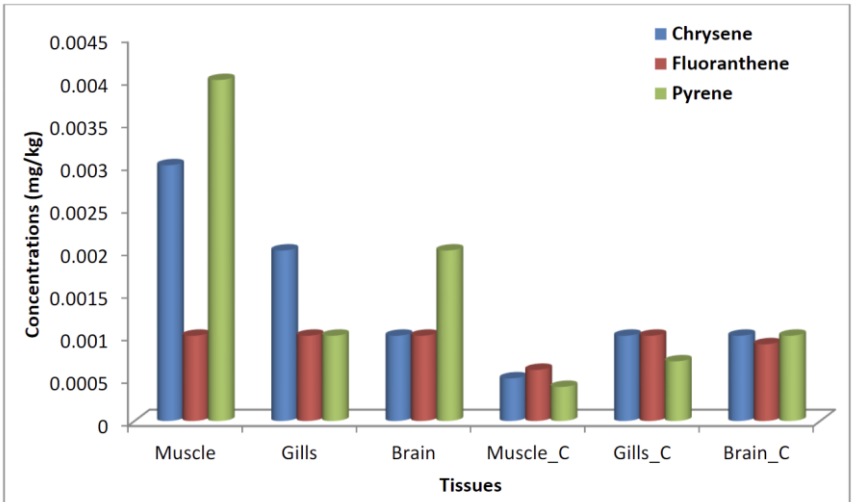

Fig. 5. Accumulations of chrysene, fluoranthene and pyrene in tissues of *T. guineensis* from the New Calabar River

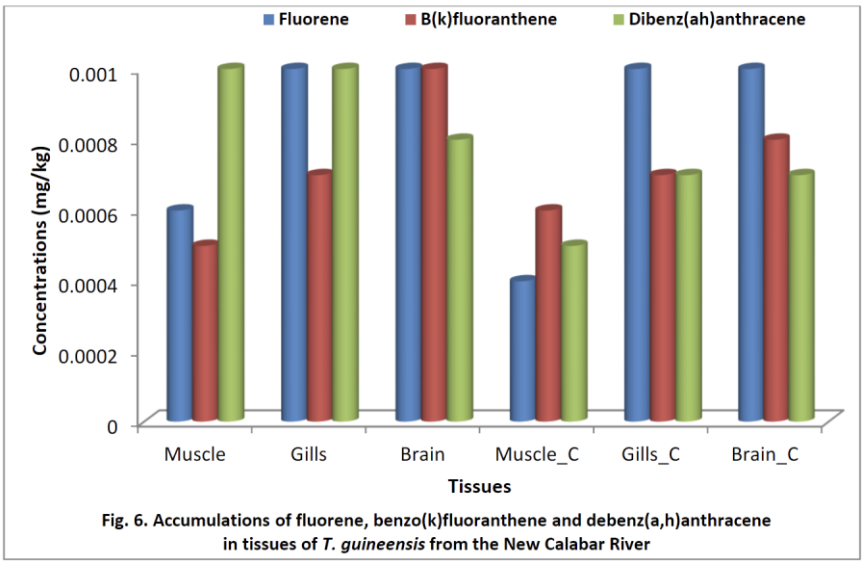

Fig. 6. Accumulations of fluorene, benzo(k)fluoranthene and debenz(a,h)anthracene in tissues of *T. guineensis* from the New Calabar River

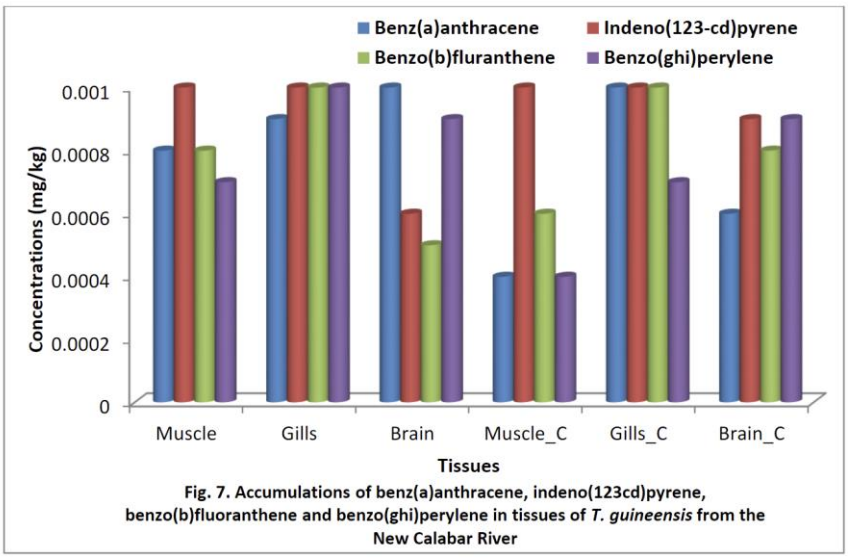

Fig. 7. Accumulations of benz(a)anthracene, indeno(123cd)pyrene, benzo(b)fluoranthene and benzo(ghi)perylene in tissues of *T. guineensis* from the New Calabar River

Concentrations of PAHs in the organs of T.zilli

Presented in table 2 and figures 7 – 11 are the levels of PAHs in some organs of T.zilli. The total PAHs in the muscle, gill and brain were 0.021, 0.077 and 0.0008 mg/kg, respectively. Naphthalen was the dominant chemical compound in all the organs while Benzo (b) flouranthene and Benzo (g.h.i) pyrene were the least fig 8 and 11. The low detection of Benzo-related PAHs compounds in both fish species may be associated to their rapid depuration or biotransformation (Deb et al.,

2000). The total concentrations of PAHs in the control samples were 0.006, 0.006 and 0.007mg/kg for the muscle, gill and brain in that order. These values were lower than those obtained from the effluent impacted areas. The control values were however higher than WHO stipulated limits (0.001mg/kg) of total hydrocarbon in sea food (Olaifa and Ayodele, 2004). The higher control values over WHO limit may be attributed to the input from gas flaring activity and the ubiquitous nature of PAHs in the environment.

T.zilli generally accumulated more PAHs than T.guineensis. These differences can be linked to various factors such as route and duration of exposure, environmental factors, and differences in species, age, sex and exposure to other exnobiotics (Varnasi et al., 1987).

Table 2: PAHs Levels in T.zilli

Parameters (mg/kg)	Tilapia zilli (Impacted Location)			Tilapia zilli (Control Location)		
	Muscle	Gills	Brain	Muscle	Gills	Brain
Naphthalene	0.012	0.064	0.003	0.0008	0.001	0.001
Acenaphthe	0.0008	0.001	0.001	0.0009	0.0008	0.001
Acenaphthylene	0.004	0.009	0.002	0.0009	0.0008	0.0008
Chrysene	0.001	0.001	0.001	0.001	0..0009	0.001
Fluroanthen	0.001	0.001	0.001	0.001	0.0008	0.001
Pyrene	0.004	0.003	0.002	0.0007	0.001	0.0009
Fluorine	0.001	0.001	0.001	0.0008	0.0009	0.001
Benzo(k)Fluoranthene	0.001	0.001	0.001	0.0005	0.0006	0.0008
Dibenz (a,h) Anthracene	0.0009	0.001	0.002	0.0004	0.0005	0.0007
Benz (a) Anthracene	0.0008	0.002	0.001	0.0006	0.00005	0.0006
Indeno (1,2,3–cd) pyrene	0.001	0.001	0.001	0.0006	0.0006	0.0007
Benzo(b) Fluoranthene	0.001	0.0009	0.001	0.0007	0.0008	0.0008
Benzo(g,h,i)Perylene	0.0006	0.0009	0.0009	0.0006	0.0007	0.0007
Total	**0.021**	**0.077**	**0.008**	**0.0006**	**0.0006**	**0.0007**

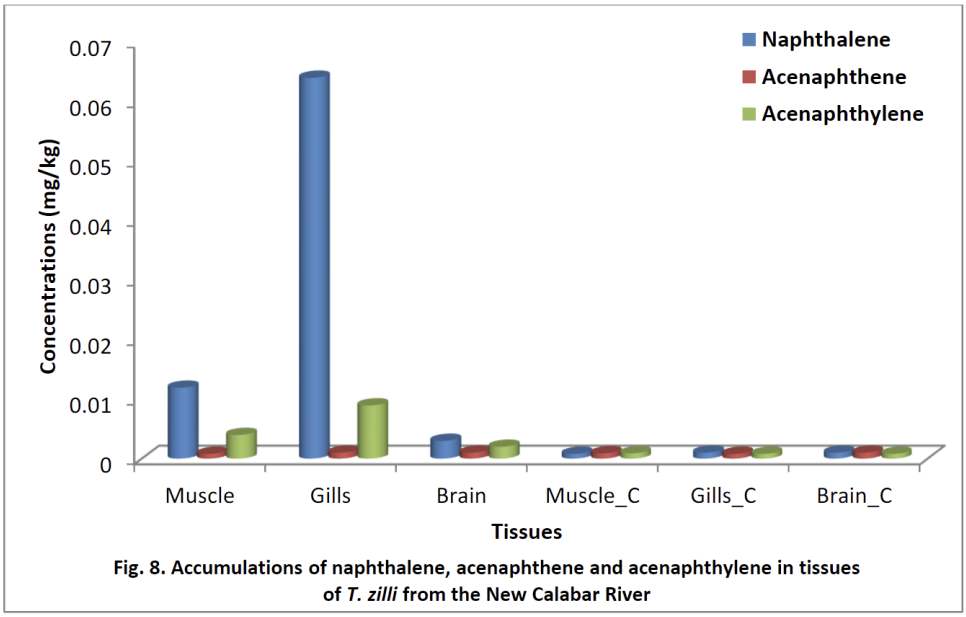

Fig. 8. Accumulations of naphthalene, acenaphthene and acenaphthylene in tissues of *T. zilli* from the New Calabar River

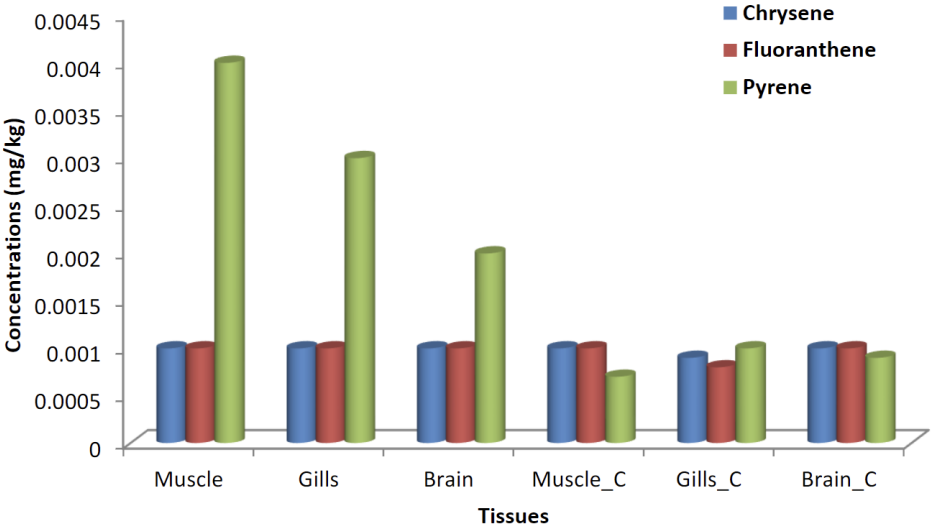

Fig. 9. Accumulations of chrysene, fluoranthene and pyrene in tissues of *T. zilli* from the New Calabar River

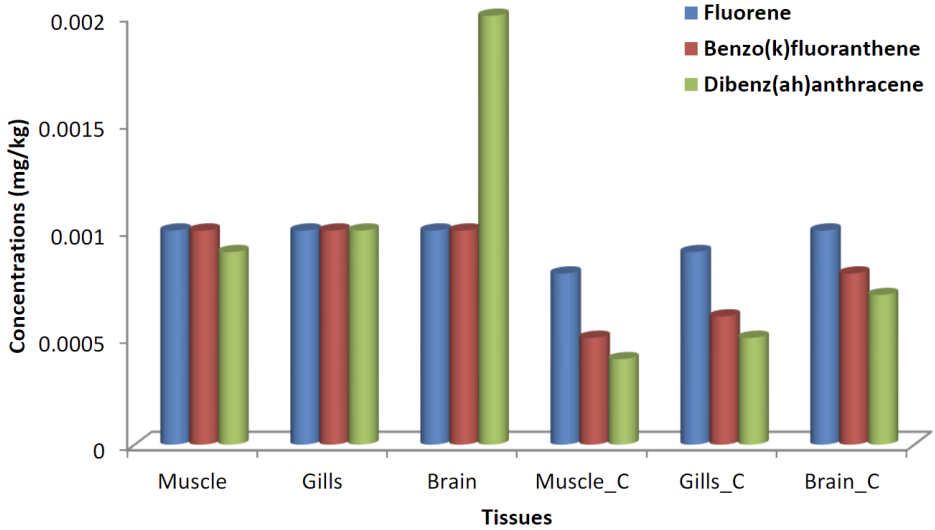

Fig. 10. Accumulations of fluorene, benzo(k)fluoranthene and dibenz(ah)anthracene in tissues of *T. zilli* from the New Calabar River

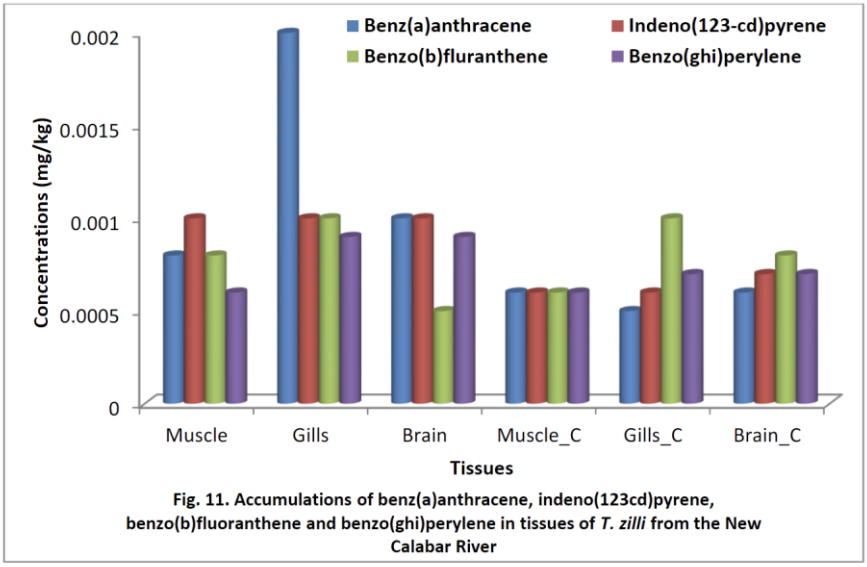

Fig. 11. Accumulations of benz(a)anthracene, indeno(123cd)pyrene, benzo(b)fluoranthene and benzo(ghi)perylene in tissues of *T. zilli* from the New Calabar River

From table 3, the one-way analysis of variance (ANOVA) indicates that the levels of fluorene, and Benzo (g,h,i) perylene differed significantly in the tissues of the fish species at P<0.05. A post-hoc Ducan Multiple Range Test (Table 3) shows that the accumulation levels of several of the PAHs detected did not differ significantly in the tissues sampled except for fluroene and Benzo (g,h,i) perylene which differed Significantly between the muscle and gill but not between the gill and brain. The differences in the concentrations of PAHs in the various organs of the fish species are probably due to the physiological functions of the organs.

Table 3: Mean Separation of Accumulation of the PAHs using the Duncan Multiple Range Test (P<0.05).

PAHs	Muscle	Gills	Brain
Naphthalene	0.004450[a]	0.021000[a]	0.001750[a]
Acenaphthene	0.000925[a]	0.000950[a]	0.0001000[a]
Acenaphthylene	0.001975[a]	0.002950[a]	0.001200[a]
Chrysene	0.001375[a]	0.001225[a]	0.001000[a]
Fluoranthene	0.000900[a]	0.000950[a]	0.000975[a]
Pyrene	0.002275[a]	0.001425[a]	0.001475[a]
Fluorene	0.000700[b]	0.000975[a]	0.001000[a]
Benzo (k) fluoranthene	0.000650[a]	0.000750[a]	0.000900[a]
Dibenz (a,h) anthracene	0.000700[a]	0.000800[a]	0.001050[a]
Benz (a) anthracene	0.000650[a]	0.000800[a]	0.001100[a]
Indeno (1,2,3 – cd) pyrene	0.000800	0.000900	0.000900
Benzo (b) fluoranthene	0.000775[a]	0.000775[a]	0.000925[a]
Benzo (g,h,i) perylene	0.000575[b]	0.000825[a]	0.000856[a]

Conclusion

This study revealed that tilapia species found in the New Calabar River accumulated PAHs in their muscle, gill and brain to levels that can be detrimental to higher tropic levels including human. Fish samples harvested from areas that receive effluent discharged from Awoba Flow Station of SPDC Well Head had higher concentrations of PAHs than those of the control. Naphthalene compounds accumulated the most in the selected organs. Bille Community should therefore suspend further consumption of the tilapia species from the New Calabar River. In addition, SPDC should stop the discharge of effluent into the river and also control gas flaring activity in the area.

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