International Journal of Advanced Research in Chemical Science (IJARCS)
Volume 6, Issue 12, 2019, PP 16-23
ISSN No. (Online) 2349-0403
DOI: http://dx.doi.org/10.20431/2349-0403.0612003
www.arcjournals.org

Total Petroleum Hydrocarbons content of Taylor Creek, Rivers State, Niger Delta Nigeria

Edori, E. S*, Marcus, A. C.

Department of Chemistry, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Rumuolumeni, PMB 5047 Port Harcourt, Rivers State NIGERIA.

Corresponding Author:** ***Edori, E. S *Department of Chemistry, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education, Rumuolumeni, PMB 5047 Port Harcourt, Rivers State NIGERIA.*

Abstract: *Randomly collected samples from four stations in Tailor Creek sediment in Engenni axis, Ahoada West, Rivers State for a period of four months were analyzed to ascertain the level of pollution and contamination. Extraction of the sample was achieved by soxhlet and cleanup for column chromatography. Total petroleum hydrocarbons were then determined by gas chromatography- flame ionization detection (GC-FID). The results revealed a total petroleum hydrocarbon contamination range of 18.035±3.527-30.768±10.850 ml/Kg in the selected months and 16.192±6.828-34.790 ± 12.954 ml/Kg for the stations. The concentration levels of total petroleum hydrocarbon in sediment samples were well within acceptable limits of FMW and EGAPSIN. Findings from the study showed evidence of slight contamination and pollution. The Taylor Creek therefore needs remediation at this early stage to forestall adverse health effect on humans and other water dwelling organisms.*

Keywords: *Total petroleum hydrocarbon, sediment, Tailor Creek. Pollution, contamination, gas chromatography – flame ionization detector.*

1. INTRODUCTION

The aquatic environment is under threat due to pollution. As a result of the activities of man, water quality is now subject to question in Niger Delta communities which hosts multinational Oil Companies. It is a known fact that there are certain qualities of water that are used to establish the index or fitness for its consumption (Iyama and Edori, 2014). These qualities are used in assessing the status of any given river to ascertain its usefulness to humans. The presence of these parameters at certain levels affect the status of rivers/ other water bodies and their qualities. Any water quality to be properly assessed must be based on its chemical, biological and physical contents (Lindsey et al., 2005; Lawson, 2011; Iyama and Edori, 2014,).

The rivers or water bodies receive hydrocarbons through prospecting activities and pollution due to illegal refining activities, pipeline explosion, and vandalization, runoffs, leakages from tanks etc., which bring about the greater effect on the nutritional, domestic, economic, ecological and recreational services the rivers offer to the inhabitants of these communities (Isibor and Freeman, 2016, Inyang et al., 2018). The effect of pollution due to hydrocarbons in the rivers of the Niger Delta region of Nigeria is alarming; studies have revealed that petroleum hydrocarbons are potentially harmful and toxic to humans and other organisms that occupy the aquatic space (Barry 2007, Gay et al., 2010). Some human health implications and effects due to petroleum hydrocarbons include, defect at birth, skin rashes, skin irritation, miscarriages and possibly infertility in women, effect on respiratory system, cancer of the different organs of the body etc. (Hurtig and San Sebastian, 2002; Aguilera, 2010; Sudakin et al., 2011; Olawoyin et al., 2012; Ezekwe and Edoqhotu, 2015).

Total petroleum hydrocarbon is a mixture comprising different hydrocarbons in crude oil. The carbon chain of total petroleum hydrocarbons ranges between C_6 - C_{35} and do not occur in one single sample. Total petroleum hydrocarbon compounds are known common pollutants or contaminants of the environment where oil production and exploitation take place (Dibofori- Orji *et al*., 2018; Alagoa *et al*., 2018). The presence of total petroleum hydrocarbon even at low concentration of 0.1ppm has acute toxic effect on marine larvae (USEPA, 1986), and also little quantity of crude oil when in

contact with sea-water can hinder the actual fish life in the water by affecting its feeding habits (Connell and Miller, 1980). The presence of hydrocarbon fractions such as polycyclic and aromatic hydrocarbons when dissolved in water can be absorbed by some water dwelling creatures due to the fact that they have high level of lipid solubility and can be bio-accumulated in fish and shellfish (Variance and Malins, 1977; Vandermeulen *et al*., 1985; Al-shwafi, 2008).

Although petroleum hydrocarbon may occur naturally in the environment such as the marine sediment at very low concentrations, large volumes come from the activities of man. The sediment (bottom) of any river is the habitat of many water dwelling or aquatic creatures and it is the reservoir of petroleum hydrocarbons where the high risk of bioaccumulation and concentration on the organisms is high (Filho *et al*., 2013). Bottom sediment dwelling creatures are greatly affected by petroleum fractions when it is settled at the bottom of the river or creek. These creatures are killed when they cannot swim away, due to the reduction of oxygen which characterizes the presence of petroleum hydrocarbons. Bottom dwelling creatures also accumulate petroleum hydrocarbons through feeding at the bottom of the river, and this results in reduction and loss of important water living organism especially those living at the bottom (Wanat *et al*., 2007; Ogeleka *et al*., 2016). This study therefore on the sediment of Taylor Creek in the Niger Delta is predicated upon the above facts in order to ascertain the level of contamination due to the prevalence of oil prospects and other illegal activities.

This study therefore, investigated the concentration of total petroleum hydrocarbons in the sediment of Taylor Creek, an important creek in the Niger Delta.

2. MATERIALS AND METHODS

2.1. Study Area and Description of Sample Location

The Tailor Creek is a fresh water that is subject to flooding annually. The Creek flows from its course, the Orashi River through Biseni clan in Bayelsa State to Edagberi axis in Engenni, Ahoada West, Rivers State, Zarama and Okordia villages in Yenagoa Local Government Area of Bayelsa State and finally empties itself into River Nun. The inhabitants occupying the area covered by the Creek are mostly fisherman and peasant farmers.

The study sites were located around $6^{o}29'$ 18.7" E and $6^{o}30'$ 20.5 E and $5^{o}10'$ 35.8" N and $5^{o}11'1.2$"N. Four sampling points (stations) were chosen along the creek for the collection of sediment samples. A distance of 1-2 Km was used as gap separating one station from the other at the Edagberi – Better land axis of the creek. The various communities along the shore of the creek play host to the Shell Petroleum Development Company (SPDC). Other activities peculiar to the area include road construction or repair at intervals, illegal oil business/ activities, petty trading etc.

2.2. Sample Collection

With the use of a core sediment grab sampler, sediments samples were collected between 5cm to 10cm. Five sediment samples were collected at each sampling location and pooled together to form composite of 400g. the samples were kept in a plain clear glass bottle previously washed to avoid contamination, and kept at $4^{o}C$, in an ice pack for total petroleum hydrocarbon analysis. The procedure was repeated for each sample station/location. The sediment was then transported to the laboratory for analysis within two (2) weeks of collection.

2.3. Extraction And Clean Up Procedure of Sediment Sample

The composite sample was air dried and 120g was weighed. The sample were filtered after being properly sieved and homogenized; was then loaded to a soxhlet extractor with the aid of a thimble. Dichloromethane is used as the solvent for extraction. After a period of 24hours the extract was collected and then concentrated using a rotary evaporator at $40^{o}C$. Previously weighed bottles were used to collect the extract and then evaporated to dryness for column chromatography clean-up (Saari *et al*, 2007).

The clean-up was achieved by putting the extract into a 10mm ID by 30cm column that is packed with gel (silica) and slurred with anhydrous sulphate layer of 2cm at the top. To obtain the total hydrocarbon fractions, the column was eluted with 30ml of n-hexane. A rotary evaporator at $40^{o}c$ was used to evaporate the sample to dryness and the eluates concentrated to 3ml. The sediment samples were treated by the method of Maioli *et al*., (2011).

2.4. Sample Analysis Using Gas Chromatography

The sample extracts were analyzed using Agilent 5890 Gas Chromatography with flame Ionization Detector (GC – FID). 3ml of the concentrated extract was used to determine the concentration of total petroleum hydrocarbon in the sediment samples. The temperature of the detector was kept at 400^{o}C and the aliphatic and the aromatic hydrocarbon in the samples are measured by the GC-FID, to give the total petroleum hydrocarbon concentration.

2.5. Statiscal Analysis

The resultsobtained were reported as mean ± standard deviation and were subjected to student's t – test in order to compare between means. The obtained data were replicated in triplicates, and analysis of variance (ANOVA) was then used to test more than two means to see whether there is a significant difference between the sample stations and months.

3. Results and Discussion

The level of contamination by total petroleum hydrocarbon in the sediment of Taylor Creek are shown in Tables 1 to 4. Most river pollutants found themselves at the bottom part of the river and therefore the bottom (sediment) is the residue or sink for pollutants in the rivers of the Niger Delta region of Nigeria and elsewhere in the world (Inyang *et al*., 2018). Table 1 showed the levels of contamination for the month of December, Table 2, for February, Table 3 for April and Table 4 for June. The concentration levels of pollution in Table 1 are: station 1; 11.45118ml/Kg, station 2; 36.06666ml/Kg, station 3; 8.33891ml/Kg and station 4; 22.97539ml/Kg, in February, the level of total petroleum hydrocarbon contamination in the stations are 23.05472ml/Kg, 13.45606ml/Kg. 16.4935ml/Kg and 19.13457ml/Kg respectively for station 1,2,3 and 4. In April the result showed contamination level of 7.5571544ml/Kg, 42.23962ml/Kg, 24.27905ml/Kg and 20.49308ml/Kg, for station 1 to 4 and in June, the level of hydrocarbon recorded in 1 is 22.69754ml/Kg, station 2; 47.39567ml/Kg, station 3; 33.29445ml/Kg and station 4; 19.682ml/kg. The concentration levels of the various stations do not follow any special pattern. This is because there is no activity in any particular station that is completely different from the others.

Table1. *Total Petroleum Hydrocarbon concentrations in Sediments of Taylor Creek in December.*

Carbon Length (ml/L)	Stations			
	1	2	3	4
C8	-	-	-	0.68179
C9	-	-	-	-
C10	-	-	-	-
C11	-	-	-	-
C12	-	-	-	-
C13	-	-	-	0.42192
C14	-	-	0.85751	2.24375
C15	-	-	2.09457	3.35482
C16	1.90596	1.59649	0.84269	-
C17	2.88204	-	1.51575	0.68339
C18	-	0.84386	1.51575	0.96286
C19	-	0.96028	0.68167	0.46042
C20	1.80313	1.03125	2.20175	2.48963
C21	-	-	-	-
C22	3.57061	0.47890	0.32078	0.17433
C23	-	-	-	-
C24	4.31379	1.50851	1.00659	2.48305
C25	-	-	-	-
C26	0.56147	-2.66966	0.94532	0.01370
C27	-	-	-	-
C28	0.52271	0.05474	2.59422	1.99679
C29	-	-	-	-
C30	0.27017	2.49588	1.91691	0.01121
C31	-	-	-	-
C32	4.60086	1.81649	-	2.68096
C33	-	-	-	-
C34	2.62398	-	-	0.47595
C35	-	-	-	-
C36	1.28727	-	-	-

C37	-	-	-	-
C38	-	-	-	-
C39	-	-	-	-
C40	-	-	-	-
Total	23.05472	13.45606	16.49351	19.13457

Table2. *Total Petroleum Hydrocarbon concentrations in Sediments of Taylor Creek in February.*

Carbon Length (ml/L)	Stations			
	1	2	3	4
C8	-	-	-	-
C9	-	8.98843		-
C10	-	6.82417	-	-
C11	-	4.76341	-	-
C12	-	-	-	-
C13	-	8.23466	-	-
C14	-	7.25599	-	-
C15	-	-	-	-
C16	-	-	-	-
C17	-	-	-	-
C18	-	-	2.65205	-
C19	2.26369	-	3.18332	0.89696
C20	0.83269	-	-	1.88716
C21	-	-	-	-
C22	0.02004	-	-	
C23	-	-	-	-
C24	2.07098	-	-	
C25	-	-	-	-
C26	2.37404	-	0.14786	20.19127
C27	-	-	-	-
C28	1.76548	-	2.27664	
C29	-	-	-	-
C30	0.41673		0.07904	
C31	-	-	-	-
C32	1.75753		-	-
C33	-	-	-	-
C34	-		-	-
C35	-	-	-	-
C36	-		-	-
C37	-	-	-	-
C38	-	-	-	-
C39	-	-	-	-
C40	-	-	-	-
Total	11.45118	36.06666	8.33891	22.97539

Table3. *Total Petroleum Hydrocarbon concentrations in Sediments of Taylor Creek in April.*

Carbon Length (ml/L)	Stations			
	1	2	3	4
C8	0.83414	-	-	10.81285
C9	1.19628	-	-	1.11381
C10	1.24472	-	-	1.10252
C11	0.46615	-	-	0.21970
C12	0.00458	-	-	3.77484
C13	3.49602	-	-	0.28450
C14	0.17873	-	2.91768	2.16040
C15	0.053307	-	1.75378	0.040049
C16	-	-	0.94128	-
C17	-	-	1.62440	-
C18	-	-	0.70540	-
C19	-	0.95387	4.23102	-
C20	-	3.44019	3.95617	-
C21	-	-	-	-
C22	-	-	1.92770	-
C23	-	-	-	-
C24	-	-	2.62502	0.0082283

C25	-	-	-	-
C26	0.0209087	37.84556	-	0.0713792
C27	-	-	-	0.0277949
C28	-	-	-	0.0442824
C29	-	-	-	-
C30	0.0623183	-	3.59668	0.0620886
C31	-	-	-	0.0750028
C32	-	-	-	0.0816718
C33	-	-	-	-
C34	-	-	-	0.0290676
C35	-	-	-	0.105238
C36	-	-	-	0.0289019
C37	-	-	-	0.113339
C38	-	-	-	-
C39	-	-	-	0.190881
C40	-	-	-	-
Total	7.5571544	42.23962	24.27905	20.4939308

Table4. *Total Petroleum Hydrocarbon concentrations in Sediments of Taylor Creek in June.*

Carbon Length (ml/L)	Stations			
	1	2	3	4
C8	-	1.48533	-	-
C9	-	2.34464	-	-
C10	-	3.40226	-	-
C11	-	2.81943	-	-
C12	-	1.60829	-	-
C13	-	-	-	-
C14	-	5.15724	-	-
C15	3.22017	1.79875	-	-
C16	0.72638	5.50333	-	-
C17	0.41828	-	-	-
C18	0.97050	1.96170	21.21699	-
C19	0.32856	15.70324	7.20371	-
C20	0.03276	-	2.15885	-
C21	-	-	-	-
C22	2.13401	2.14022	-	-
C23	-	-	-	-
C24	3.79484	1.73562	2.71490	13.35548
C25	-	-	-	-
C26	4.45071	1.73562	-	3.36848
C27	-	-	-	-
C28	0.87481	-	-	-
C29	-	-	-	-
C30	0.05274	-	-	2.95805
C31	-	-	-	-
C32	0.96429	-	-	-
C33	-	-	-	-
C34	4.72949	-	-	-
C35	-	-	-	-
C36	-	-	-	-
C37	-	-	-	-
C38	-	-	-	-
C39	-	-	-	-
C40	-	-	-	-
Total	22.69754	47.39567	33.29445	19.682

Tables 5 and 6 showed the total and mean concentration of total petroleum hydrocarbon for the months of December, February, April and June. The result in December showed 94.5689044ml/Kg as total and 23.6422261ml/Kg, in February, 78.83214ml/Kg and 19.708035ml/Kg as total and mean values respectively. Total and mean concentration values for April were 72.13886ml/kg and

18.034715ml/kg, in June, the concentration values for total and mean hydrocarbons in sediment were 123.06986ml/kg and 30.767465ml/kg respectively. The total and mean concentrations of total petroleum hydrocarbons for the stations were64.7605944ml/Kg and 16.1901486ml/Kg for station 1, 139.15801ml/Kg and 34.7895.25ml/Kg for station 2, 82.40592ml/kg and 20.60148ml/kg for station 3 and 82.28504ml/Kg and 20.57126ml/Kg for station 4.

The values obtained for mean total petroleum hydrocarbons for the sediment samples in the months and stations are below or equal to the allowable (accepted) value by Federal Ministry Environment (FME) (1991) OF 30mg/kg and EGASPIN (Environmental Guidelines and Standard for the petroleum industry in Nigeria (2002) for sediment samples for (50mg/Kg) and except station 2, which is slightly above the permissible limit of FME with mean value of 34.7895025mg/Kg. The mean total petroleum hydrocarbon concentration in the study fall far below what was reported by Adewuyi *et al*., (2011) of 1602.4 ± 8.9mg/Kg; that obtained from from Ubeji River in Warri, Nigeria, by Samuel and Ayodele, (2014), which recorded high value of 41900mg/Kg from Benin river which is close to an oil factory. Inyang*et al*., (2018) also had a mean sediment value of 606.83± 229.48mg/Kg in Qua-Iboe River, which is higher than the ones obtained in this study. The average value of total hydrocarbon content also is lower than those elsewhere in other parts of the world, such as in the sediment of the Victoria harbor, Hong Kong of 60 – 646mg/g (Hong et al, 1995) in the Bapco oil coastline that is highly contaminated around the refinery in Bahrain which is 779mg/g (Tolose *et al*., 2005).

The results from the creek though when compared to other rivers of the Niger Delta region of Nigeria and other parts of the world seem low, but may pose danger to benthic organisms (Monazami Tehrani *et al*., 2014), if proper measures are not taken into account. The behaviour of freshwater is different from that of brackish or tidal water. The flow is unidirectional, and when contamination is with total petroleum hydrocarbons as a result of spills or otherwise, the system has purifying measures that does not support accumulation. The rapid flowing mechanism help the petroleum fractions that is spilled into the creek to dissolve and thereby restricting much evaporation of the volatile fractions (Aremu, 1998; Adewuyi *et al*., 2011; Marcus *etal*., 2013). During months of flood, the creek over-flow its bank thereby depositing the petroleum hydrocarbons in the adjoining farmland, tree tops, and any other point the flood can take it to. The process does not allow sedimentation of hydrocarbon fraction, but re-suspends them from the sediment and drifts them away to the point where it finally flows into.

The pollution and contamination make the water source and the adjoining farmlands less useful to the inhabitants of such environments. Fishing and farming which is the main stay of the inhabitant becomes a difficult task due to the negative impact the contamination has posed on the people (Ite et al., 2016). The development of illegal oil activities has also increasingly impacted negatively on the health status of the dwellers since, the adjoining creek is used for domestic works, recreation, fishing etc. the presence of total petroleum hydrocarbon in the sediment of the creek may also pose danger to the ecosystem within the region of study.

Table 5. *Mean Bimonthly Concentrations (ml/L) of Total Petroleum Hydrocarbons in Sediments at the different Stations*

Stations	Months			
	December	February	April	June
1	7.557	11.451	23.055	22.698
2	42.240	36.067	13.456	47.396
3	24.279	8.339	16.494	33.294
4	20.493	22.975	19.135	19.682
Total	94.569	78.832	72.140	123.070
Mean	23.642±12.399	19.708±10.905	18.035±3.527	30.768± 10.850

Table6. *Mean Spatial (Station) Variation of Total Petroleum Concentrations (ml/L) in Sediments within the examined Months*

Stations	Months			
	1	2	3	4
December	7.557	42.240	24.279	20.493
February	11.451	36.067	8.339	22.975
April	23.055	13.456	16.494	19.135
June	22.698	47.396	33.294	19.682
Total	64.761	139.158	82.406	82.285
Mean	16.192±6.828	34.790± 12.954	20.602±9.245	20.571±1.470

4. CONCLUSION

The study showed that there is a degree of contamination of the Taylor Creek, though not yet at an alarming stage. The conclusion was reached based on the fact that certain level of total petroleum hydrocarbon concentration was found in the sediment of the Creek. There should be effective monitoring of the Creek by the relevant government agencies to forestall any further increase of total petroleum hydrocarbon in the Creek. Human dweller should be discouraged from pouring petroleum product to the Creek directly. The water in the Creek should not be used for drinking, bathing and other purpose that may affect human health.

REFERENCES

[1] Adewuyi, G. O., Etchie, O. T. and Ademoyegun, O. T. (2011). Determination of total petroleum hydrocarbons and heavy metals in surface water and sediment of Ubeji River, Warri, Nigeria. *Bioremediation, Biodiversity, andbioavailability*, 5(1): 46-51.

[2] Alagoa, K. J., Godwin, J., Daworiye, P. S. and Ipiteikumoh, B. (2018). Evaluation of total petroleum hydrocarbon (TPH) in sediments and aquatic macrophytes in the River Nun, Amasoma Axises, Niger Delta, Nigeria. *International Journal of Environmental and Agriculture Research*, 4(2): 63-67.

[3] Al-Shwafi, N. A. A. (2008). Total petroleum hydrocarbon carcinogens in commercial fish in the Red Sea and Gulf of Aden-Yemen. *MarineScience*, 19: 15-28.

[4] Aqilera, F., Mendez, J., Pasaro, E. and Laffon, B. (2010). Review on the effects of exposure to spilled oils on human health. *Journal of Applied Toxicology*, 30(5): 1021-1027.

[5] Aremu, D. A. (1998). Impact of petroleum industry operations in groundwater quality in Warri. PhD thesis, EMSEH, Public Health. University of Ibadan, 210pp.

[6] Barry, C. (2007). Slick death: Oil-spill treatment kills coral. *ScienceNews*, 171: 67.

[7] Connell, D. W. and Miller, D. J. (1980). Petroleum hydrocarbons in aquatic ecosystem-behaviour and effect of sublethal concentrations. Part 2, CRC Critical Review and Environmental Control, 12: 405-409.

[8] Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) (2002). Revised edition, Department of Petroleum Resources (DPR), 314.

[9] Ezekwe, C. I. and Edoghotu, M. I. (2015). Water quality and environmental health indicators in the Andoni River estuary, Eastern Niger Delta of Nigeria. *Environmental Earth Sciences*, 74(7): 6123-6136.

[10] Federal Ministy of Environment (FME) (1991). Guidelines and Standards for environmental pollution and control in Nigeria. Nigerian ambient air quality standard.

[11] Filho, S., Luz, J. P., Betemps, G. R., Silva, G and Caramao, B. E. (2013). Studies of n-alkanes in the sediments of colony Z3 (Pelotas-RS-Brazil). *Brazil Journal of Aquatic Science and Technology*, 17(1): 27-33.

[12] Gay, J., Shepherd, O., Thyden, M. and Whitman, M. (2010). The health effects of oil contamination: A compilation of research, Worcester Polytechnic Institute, Worcester, MA, USA.

[13] He, A, E., Ufot, U. F., Ite, M. U. Isaac I. O. and Ibok, U. J. (2016). Petroleum industry in Nigeria, environmental issues, national environmental legislation and implementation of international law. *American Journal of Environmental Protection*, 491): 21-37.

[14] Hong, H., Xu, L., Zhang, L., Chen, J., Wong, Y. and Wan, T. (1995). Special guest paper: Environmental fate and Chemistry of organic pollutants in the sediment of Xiamen and Victoria Harbours. *Marine pollution Bulletin*, 31(4-12); 229-2366.

[15] Hurtig, A. K. and San Sebastian, M. (2002). Geographical differences in cancer incidence in the Amazon basin of Ecuador in relation to residence near oil fields. *International Journal of Epidemiology*, 31(5): 1021-1027.

[16] Isibor, P, O. and Freeman, O. E. (2016). Evaluation of some heavy metal and total petroleum hydrocarbon in water and palaemonid shrimps (*Macrobrachium vollenhovenni*) of Egboko River, Warri, Delta State, Nigeria.*Journal of Applied Life Sciences International*, 6(4): 1-12.

[17] Iyama, W. A. and Edori, O. S. (2014). Analysis of the water quality of Imonite Creek in Ndoni,Rivers State, Nigeria. *IOSR Journal of Applied Chemistry*, 7(1): 6-9.

[18] Inyang, S. E., Aliyu, A. B. and Oyewale, A. O. (2018). Total petroleum hydrocarbon content in sirface water and sediment of Qua-Iboe River, Ibeno, Akwa-Ibom State, Nigeria. *Journal of Applied Science and Environmental Management*, 22(12): 1953-1959.

[19] Lawson, E. O. (2011). Physico-chemical parameters and heavy metal content of water from the mangrove swamps of Lagos, Lagoon, Lagos, Nigeria. *Advances in Biological Research*, 5(1): 20-26.

[20] Lindsey, H. D. M. James, M. M. and Hector, M. (2005). An assessment of metal contamination in mangrove sediments and leaves from Paurita Mala Bay, Pacific Panama. *PollutionBulletin*, 50:547-552.

[21] Maioli, O. L., Rodrigues, C. K., Knoppers, B. A. and Azevedo, D. (2011). Distribution and sources of aliphatic and polycyclic aromatic hydrocarbons in suspended particulate matter in water from two Brazilian estuarine systems. *Cont. Shelf.* Res., 31(10): 1116-1127.

[22] Marcus, A. C., Okoye, C. O. B. and Ibeto, C. N. (2018). Environmental pollution quality assessment of the water of Bonny River and Creeks around Okrika in Rivers State, Nigeria. *International Journal of Applied Environmental Science*, 8(1): 1-11.

[23] Monazami Tehrani, G. H., Rosli, H., Sulaiman, A. H., Tavakoly sany, B., Salleh, A., Owfi, F., Savari, A., Khan Jazani, R. and Monazami Tehrani, Z. H. (2014). Petroleum hydrocarbon assessment in the wastewaters of petrochemical special economic zone and sediment benchmark calculation of the coastal area-northwest of the Persian Gulf. *Iranian Journal of Fisheries Sciences*, 13(1): 119-135.

[24] Ogeleka, D. F., Edjere, O., Nwudu, A. and Okieimen, F. E. (2016). Ecological effects of oil spill on pelagic and bottom dwelling organisms in the riverine areas of Odidi and Egwa in Warri, Delta State. *Journal of Ecology and the Natural Environment*, 8(12): 201-211.

[25] Olawoyin,R., Larry Grayson, R. and Okareh, O. T. (2012). Ecological and epidemiological assessment of human exposure to polycyclic aromatic hydrocarbons in the Niger Delta, Nigeria. *Toxicology and Environmental Health Sciences*, 4(3): 173- 185.

[26] Sudakin, D. L., Stone, D. L. and Power, L. (2011). Naphthalene mothballs: Emerging and recurring issues and their relevance to Environmental health. Current topics in toxicology, 7: 13-19.

[27] Saari, E, Peramaki, P. and Jalonen, J. (2007). A comparative study 0f solvent extraction of total petroleum hydrocarbons in soil. *Microchim. Acta*., 158(3-4): 261-268.

[28] Samuel, O. A. and Ayodele, R. I. (2014). An assessment of the oil and toxic heavy metal profiles of sediments of the Benin River adjacent to a lubricating oil producing factory, Delta State, Nigeria. *International Research Journal of Public and Environmental Health*, 1(2): 40-53.

[29] Tolosa, I., De Mora, S. J., Fowler, S. W., Villeneuve, J. P., Bartocci, J. and Cattini, C. (2005). Aliphatic and Aromatic Hydrocarbons in marine biota and coastal sediments from the Gulf and the Gulf Oman. *MarinePollutionBulletin*, 50(12): 1619-1633.

[30] United States Environmental Protection Agency(USEPA) (1986). Quality criteria for water 1986, US Environmental Protection Agency, Office of water regulations: standard, Washinton, DC, EPA, 440/5-86-001.

[31] Vandermeulen, J. H., Foda, A. and Stuttard, C. (1985). Toxic vs mutagenicity of some crude oils distillates and the water-soluble fractions. *WaterResearch*, 19(10): 1283-1289.

[32] Variance, U. and Malins, D. C. (1977). Metabolism petroleum hydrocarbons: accumulation and biotransformation in marine organisms, In effects of petroleum on Artic and Subartic marine environments and organisms, volume Biological Effects, D. C. Malins (ed), Academic Press, New York, 175-270.

[33] Wanat, Y. Jin, X. H. and Jin, F. (2007). Trophic dilution of polycyclic aromatic hydrocarbon (PAHs) in marine food web from Bohai Bay, North China. *Environmental Science and Technology*, 41: 3109-3114.

Citation: *Edori, E. S, Marcus, A. C., "Total Petroleum Hydrocarbons content of Taylor Creek, Rivers State, Niger Delta Nigeria", International Journal of Advanced Research in Chemical Science, vol. 6, no. 12, p. 16-23, 2019. DOI: http://dx.doi.org/10.20431/2349-0403.0612003*