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

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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 vandalism, 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 C₆ - C₃₅ 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; Alagoga 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°29’ 18.7” E and 6°30’ 20.5 E and 5°10’ 35.8” N and 5°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°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°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°C was used to evaporate the sample to dryness and the eluates concentrated to 3ml. The sediment samples were treated by the method of Maialio 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°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. Statistical Analysis

The results obtained 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.

Table 1. Total Petroleum Hydrocarbon concentrations in Sediments of Taylor Creek in December.

| Carbon Length (m/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  | -        | -        | -        |
## Table 2. 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  | -        | 2.27064  | -        |
| C29                  | 0.41673  | -        | 0.07904  | -        |
| C30                  | -        | -        | -        | -        |
| C31                  | 1.75753  | -        | -        | -        |
| C32                  | -        | -        | -        | -        |
| C33                  | -        | -        | -        | -        |
| C34                  | -        | -        | -        | -        |
| C35                  | -        | -        | -        | -        |
| C36                  | -        | -        | -        | -        |
| C37                  | -        | -        | -        | -        |
| C38                  | -        | -        | -        | -        |
| C39                  | -        | -        | -        | -        |
| C40                  | -        | -        | -        | -        |
| Total                | 11.45118 | 36.06666 | 8.33891  | 22.97539 |

## Table 3. 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 | - | 0.0209087 | 37.84556 | - | 0.0713792
C26 | 0.0209087 | - | 37.84556 | - | 0.0713792
C30 | 0.0623183 | - | - | 3.59668 | 0.0713792
C31 | - | - | - | - | 0.0713792
C32 | - | 0.0623183 | - | - | 0.0713792
C33 | - | 0.0623183 | - | - | 0.0713792
C34 | - | 0.0623183 | - | - | 0.0713792
C35 | - | 0.0623183 | - | - | 0.0713792
C36 | - | 0.0623183 | - | - | 0.0713792
C37 | - | 0.0623183 | - | - | 0.0713792
C38 | - | 0.0623183 | - | - | 0.0713792
C39 | - | 0.0623183 | - | - | 0.0713792
C40 | - | 0.0623183 | - | - | 0.0713792
Total | 7.5571544 | 42.23962 | 24.27905 | 20.4939308 | 0.0713792

Table 4. 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 were 64.7605944ml/Kg and 16.1901486ml/Kg for station 1, 139.15801ml/Kg and 34.789525ml/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 \pm 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. Inyanget al., (2018) also had a mean sediment value of 606.83\pm229.48mg/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 (ToIose 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 et al., 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 | 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 |

| Table 6. Mean Spatial (Station) Variation of Total Petroleum Concentrations (ml/L) in Sediments within the examined Months |
|---------------------------------------------------------------|
| Stations | Months |
| December | 1 | 2 | 3 | 4 |
| 7.557 | 42.240 | 24.279 | 20.493 |
| 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.

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