Total Hydrocarbon Contents: Spatial Variations in Aquatic Environment of Oyigbo Communities, Rivers State

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Abstract: The Total Hydrocarbon Content (THC) in fresh surface waters and sediments of Oyigbo communities in Rivers State were determined using Gas Chromatography equipped with flame ionization detector (GCFID). Fresh surface water and sediments samples were taken from different locations in four communities namely; Umuagbai, Komkom, Egberu, and Izuoma. Result of the analysis revealed thus: mean of total hydrocarbon content in surface water and sediment as 7.869±1.166 mg/L and 12.01±0.856 mg/kg respectively. The total hydrocarbon content obtained from the various locations in surface water were Umuagbai (8.529±1.208 mg/L), Komkom (9.212±1.009 mg/L), Izuoma (6.701±1.670 mg/L), and Egberu (7.034±0.778 mg/L). In sediment the total hydrocarbon content obtained were; Umuagbai (12.62±0.585 mg/kg), Komkom (16.12±1.790 mg/kg), Izuoma (8.627±0.585 mg/kg), and Egberu (10.67±0.465 mg/kg). The result showed that the sediment had more total hydrocarbon content than the surface water, which is expected because the sediment is a reservoir for the water. The sediment and surface water THC levels were lower than the WHO permissible standard which indicates low risk level. The result showed some elevated concentration especially for the sediment sample which is noticed mostly in sediments and surface waters from Komkom community samples. It is recommended that usage of the water and even consumption of fish from the said river should be limited and anthropogenic actions within the study area should be limited.

Keywords: Total Hydrocarbon Content, Spatial Variations, Sediments, Surface Water, Oyigbo

1. Introduction

Oyigbo is town and a local gov't council in Rivers State located 30 km from the capital city of Port Harcourt. The area is a suburb of the capital city of Port Harcourt characterized with many human activities. The natives are mostly farmers, fishermen and traders with craft work. The community plays host to major multinational oil companies with crude oil installations in the community [1]. The gas pipeline passing from the south to north (Eastern gas pipeline (Alscon pipeline)) passes through the northern part of Oyigbo [2]. The place formerly played host to a gas plant at Obigbo which the federal government of Nigeria under the Nigerian National Petroleum Corporation (NNPC) and the Government of Rivers State were planning to bring back the gas plant to normal capacity with the help of the multinationals operating in the area [3]. The plant which was operated by the SPDC was shut down as a result of the hazard and risk it pose to the populace as it trespasses on the path of the lines conveying gas [4]. The place also has numerous vehicular movements as lorries and tankers load and refuel along Oyigbo axis of the Port Harcourt/Aba express way. This leads to release of dangerous and obnoxious gases into the air that may affect the goodness of the air within such places and the air could be washed down by rain into the soil and water bodies.

The oil production and its allied activities have great deleterious effect on the environment especially arable land

meant for agricultural production which could have help to better the life of the common man, community and the nation at large. The area often experiences periodic spillage emanating from leakages, seepages, equipment damages and failures and such release have mostly negative effect on both inhabitants and other forms of lives within the environment. The effect from activities of multinational oil companies on the area of study is causing a progressive adjustment in the chemical composition of ecosystems within emission sources. The inorganic contaminants carried from the atmosphere by rain to surface waters are also passed down to the sediment, while few are deposited directly on the soil surface. These contaminations are generally as a result of chemicals released from point sources, as researches in developing countries especially Nigeria, have indicated that petroleum and natural gas are their main natural resource [5]. Although diverse sources contributes to the contamination of the environment, it is established that crude oil exploitation and production activities are leading source of related contamination into the soil [6, 7], though, diffuse sources can also add to the presence of these parameters in the soil.

The aim of this study is to examine the Total Hydrocarbon Contents (THC) in surface water and sediments around Oyigbo communities and check its impact on water quality.

2. Materials and Method

2.1. Study Area

The area of research is situated in delta area of River Niger, always referred to as Niger Delta in the Southern part of Nigeria. The Niger Delta is made up of states like Abia, Akwa-Ibom, Bayelsa, Cross River, Delta, Edo, Imo, Ondo and Rivers which are crude oil producing. These states provide resources that serve as the mainstay of the nation's economy. Geographically the Niger Delta is said to cover over 70,000 square kilometres of land mass in the Southern part of Nigeria and made of creeks and channels through which the water from the river Benue and Niger is discharged into the Ocean (Atlantic). The study area is made up of over 20 communities, playing host to Shell Petroleum Development Company (SPDC) with other oil installations like gas plants, thermal stations and oil pipelines.

Oyigbo is a suburb of Port Harcourt metropolitan city and a town in Oyigbo Local Government council of Rivers State, occupying approximately 30 km away from the city centre, with a population of about 200,000. It is a centre of packing and refuelling for tankers and lorries moving to other parts of the country. The town is located by the bank of Otamiri River and is a centre of mining, lumbering, administration, commercial and industrial activities. It is situated between latitude 4.87806 N and longitude 7.12833 E in the state, situated at the boundary of Rivers state and Abia State. It shares boundary with Abia, Eleme, Etche, Ikwerre and Obio/Akpor Local government areas. The expected mean height is 12km beyond normal sea level. The average maximum and minimum temperature are about 34°C and

21°C separately. The month of April through October having the highest temperature.

2.2. Collection of Samples and Preparation

A proportional cross-sectional research design method was employed, which involved the collection of fresh surface waters from Umuagbai, Egberu, Komkom, and Izuoma. Prior to collection of samples, the glass bottles were washed and sun-dried; and at the points of collection, the glass bottles were rinsed twice with the same water samples they are to contain. In each incident, water samples were collected at a depth of 20cm beneath the surface of the water via amber-coloured 1 litre size glass bottles [8]. The filled bottles were immediately covered, properly labelled, and placed in an ice chest with ice for further treatment and analysis in the laboratory.

Sediment samples were collected with soil auger at three locations across the creek. The samples collected were further subjected to drying by air, then slight oven drying and then homogenized in clean plastic containers that were previously washed, before taken for further analysis.

2.3. Determination of Total Hydrocarbon Contents

2.3.1. Sediment Samples Extraction

Ten (10g) grams of sediment sample was added into a glass bottle, and anhydrous sodium sulfate (Na_2SO_4) was also added. The mixture was then stirred. The function of the sodium sulfate Na_2SO_4 was to absorb moisture from the sediment sample. Three hundred microgram per millilitre (300μg/ml) of surrogate (1-chlorooctadecane) standard solution was added to the sample. Thirty millilitres (30ml) of dichloromethane (DCM) was also added to the sample as solvent for extraction and was covered very tight and transferred to a mechanical shaking machine. Then it was shaken for five (5) to six 6 hour at ambient room temperature with the help of a mechanical shaking machine. Finally, it was allowed to settle for one (1) hour and filtered with a 110mm filter paper into a clean beaker. The filtrate was concentrated to 1ml by evaporation overnight in a fume hood [8].

2.3.2. Clean-up and Separation

The sample extract (sediment and water) were transferred into a standard chromatographic column which was packed with activated silica gel slurry of ten grams (10g) and 2.5 cm anhydrous sodium sulfate coating on topmost part. The hydrocarbon fraction was obtained by eluting the column with 30 ml of n-hexane. Thereafter the eluates were reduced to 2 ml in concentration with the rotary evaporator at a temperature of 30°C. For the purpose of quality assurance and control the spiked sample was treated in similar way as the main sample [9].

2.3.3. Sample Analysis

The separation and detection of total petroleum content in sediment samples was done using Agilent 6890N Gas chromatography – flame ionization Detector (GC-FID)

instrument [10]. Three (3) µl of concentrated extract sample gotten from the column was injected into micro-syringe of the GC to clean the syringe (3 times) before the sample was analyzed. Thereafter, the sample was taking to the fractionation column for separation of the different components of the sample. The separated aliphatic and aromatic components were first stored differently, then the aliphatic part passed through a flame Ionization detector. The flame ionization detector then detects the hydrocarbon components in the sample. The amount of THC was resolved at a particular chromatogram in mg/kg.

3. Results and Discussions

3.1. Levels of Total Hydrocarbon Contents in Water

The result of the Total hydrocarbon contents in surface water from the study area is shown in Tables 1.

Table 1. Total hydrocarbon contents in surface water (mg/L) from the study area.

S/No	Location	Station I	Staion II	Mean	WHO
1	Umugbai	7.321	9.737	8.529±1.208	10
2	Komkom	10.22	8.202	9.212±1.009	10
3	Izuoma	5.031	8.371	6.701±1.670	10
4	Egberu	6.256	7.812	7.034±0.778	10
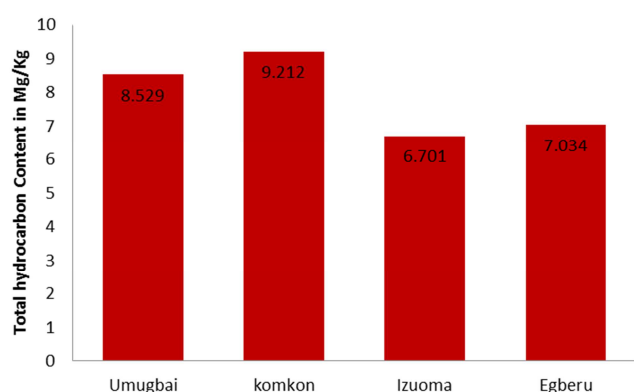
Figure 1. Spatial distribution of THC (mg/kg) in surface water from Oyigbo communities.

The table above revealed that the mean concentration of total hydrocarbon contents in surface water sample was 8.529±1.108, 9.212±1.009, 6.701±1.670, and 7.034±0.778 mg/L for Umuagbai, Komkom, Izuoma and Egberu communities respectively, which were all below the World Health Organisation permissible limit for total hydrocarbon contents in water at 10 mg/L. The spatial distribution of THC showed that the four locations sampled had varying concentrations with Komkom location having the highest concentration and the others locations were also lower than the WHO limits. Komkom location which is a direct recipient of effluent from NNPC and shell pipelines had the highest concentration; this may be due to the position of the creek. The high value for this location may also be due to pipe leakages from the gas lines that transport gas from NNPC gas lines in Rivers State. The amount of THC in surface water

from surface waters in Oyigbo is in line with reports on THC in surface water, with values ranging from 4.52 to 17.48 mg/L, though one of their locations had a very high value [11]. This study showed high value compare to report on surface water around Kua/Kinabere Creek in Ogoni land, an estuary of Bonny River who recorded the concentration range of 1.86 to 2.55 mg/l [12] and that by Enetimi et al., [13], they recorded a concentration range of 2.06 to 2.32 mg/l for THC in surface water around Imiringi Oil Field.

3.2. Levels of Total Hydrocarbon Contents in Sediment

The result of the Total hydrocarbon contents in Sediment from the study area is shown in Tables 2.

Table 2. Total hydrocarbon concentration in sediment (mg/kg) from the study area.

| S/No	Location	Station I	Station II	Mean	WHO
1	Umuagbai	12.03	13.20	12.62±0.585	30
2	Komkom	14.03	18.21	16.12±1.790	30
3	Izuoma	8.041	9.212	8.627±0.585	30
4	Egberu	10.21	11.14	10.67±0.465	30
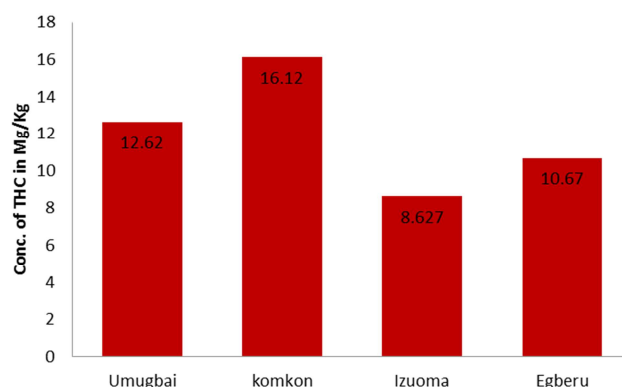
Figure 2. Spatial distribution of total hydrocarbon content (mg/kg) from the study.

The table above indicated the values for THC in sediment from the study area with the values ranging from 8.041 to 18.21 mg/kg and the mean value was 12.01±0.856 mg/kg. The result also showed that Komkom location had the highest THC concentration with values at 16.12±1.790 mg/kg. This was followed by Umuagbai location (12.62±0.585 mg/kg), Egberu location (10.67±0.465 mg/kg) was third and the location with the least value was Izuoma (8.627±0.585 mg/kg). The result showed that all the locations and the mean was lower than the World Health Organisation permissible limit at 30 mg/kg. The Komkom location which is of the closest proximity to the major source of the hydrocarbon discharge had the highest value though all the other stations had THC in substantial amount which goes to show the level of contamination of the sediment within the study area. This high contamination cannot be separated from gas flaring, effluent discharge and crude oil spillages [14].

The mean result from this work is lower than that reported by Aigberua et al., [15] (21.2 mg/kg) but lower

than report by Edwin-wosu and Albert [16] (151.00 mg/kg). This report is also lower than that by Ibigoni et al., [17] (386.44 mg/kg). It is worthy of note that the level of THC in the study area is high enough for general attention to be drawn by the stakeholders especially reason that the said creeks are fishing areas for inhabitants within the area. The accumulation of hydrocarbons within the body system has numerous health effects like pulmonary inflammation, pneumonia, lung cancer, atelectasis and fever. The results indicates contamination from petroleum products, there is need for immediate action as to prevent impending danger. The toxicity level of the components of petroleum hydrocarbon in the environment particularly sediment and soil has a standard which stood at concentration that ranges from greater than 1000.00 mg/kg [18]. High level of total hydrocarbon content have been said to cause headaches and dizziness and most times nervy disorder often called "peripheral neuropathy" which comprises of numbness in the feet and legs. It has also been proven that compounds containing THC causes side effects on the blood, immune system, lungs, skin and eyes [19]. The levels of the THC at the three areas shows that the soil sample may easily absorb such from the sediment via erosion which may be absorbed by plants and other living organisms within such area, therefore its presence is of concern to the health of the populace [20]. It is worthy of note that the immediate remediation of these areas should be carried out to avoid imminent danger.
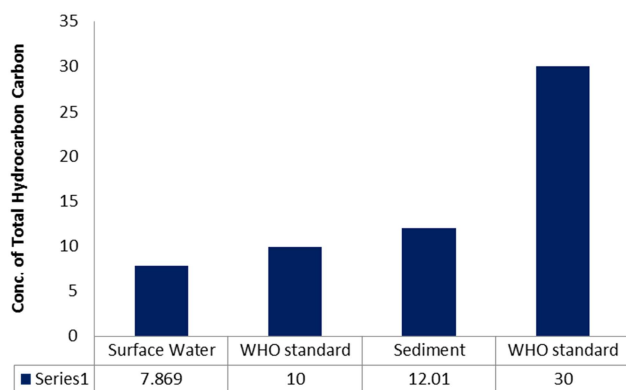
Figure 3. Mean of THC in surface water and sediment compare with WHO limit.

The figure 3 above showed mean of total hydrocarbon concentration in surface water and sediment compare with WHO permissible limits, which indicated lower value for the surface water and the sediment. The findings suggest contamination of water sources which is low but there is need for attention as to check its excesses in the future.

4. Conclusion

The results of the total hydrocarbon concentration examination indicated that for the surface water samples the values were lower than the WHO permissible limit of 10 mg/L. The order of concentration is Komkom>Umuagbai>Egberu>Izuoma. The mean of THC in the surface water was also slightly lower than the WHO limit. The concentrations of THC determined were in order Komkom>Umuagbai>Egberu>Izuoma for all the sediment samples from the area of study, all plus the mean were lower than the limit. From the outcome of this study, it can be concluded that surface water and sediment from surface waters around Oyigbo communities contain the hydrocarbon pollutants which may be of possible danger for users of such environment, these contaminants presence cannot be far from oil and gas activities, leakages from petroleum product delivery and gas flaring. It can be deduce that consumption of the water, fishes may be of risk due the bodily accumulation.

Ethical Approval

This study was approved by Department of Industrial Chemistry/Petrochemical technology, school of science Laboratory technology's Ethics Committee for Environmental Research, University of Port Harcourt.

Acknowledgements

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