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Assessment of Total Hydrocarbon Soil Content of *Rhizophora mangle* and *Nypa fruticans* at Onne and Eagle Island

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Abstract: The assessment of total hydrocarbon soil (THC) content of *Rhizophora mangle* and *Nypa fruticans* was investigated. Plant part of the studied plants (leaves, root, and stem) were collected from the studied forest. In each study area a 20 x 20m plot was delineated. Within each plot 10 trees were sampled randomly using stratified systematic analyzed sampling method. For the soil analysis, fresh samples were collected insitu with a soil augur weighed and placed in a sterile polythene bags and sent to laboratory, each location 3 replicates from each sampling plot were used for both locations. leaves, pieces of root and stem of red mangrove were harvested similar techniques were adopted for Nypa palm and placed in the cooler and taken to the laboratory for analysis. The collected samples were analyzed for THC in plant parts, THC and physicochemical parameters for soil and water. The result generated showed a significant variation of THC accumulation was more in root of *Nypa fruticans* than *Rhizophora mangle* roots. The leaves and bark of *Rhizophora Mangle* accumulated high concentration of THC. This study showed that higher productivity and litter fall in *Rhizophora mangle* is a mechanism to counter the effect of total hydrocarbon pollution in a polluted rain forest environment. *Rhizophora mangle* could be referred also as hyper accumulator due to its ability in accumulating the high amount of THC in leaves.

Keywords: Hydrocarbon, *Nypa fruticans, Rhizophora mangle*, Soil, Vegetation

1. Introduction

Crude oil which was first discovered in 1956 and 1957 at Oloibiri in Bayelsa and Ogoni in Rivers State respectively, is a complex mixture of hydrocarbon emanating from various petroleum products [12]. Otitoloju and Olagoke, [8], reported high volumes of oil exploration activities in the region, having negative impact on the environment (plants, animals and human) due to oil spillage. Over 7,000 oil spill incidences have been reported in the Niger Delta region alone; therefore, it could be more if other incidences in other production areas were included [1]. Mangrove ecosystems are one of the most affected by oil pollution and contamination of the environment as the paths involved in oil exploration and transportation are the natural habitats of most mangroves [1]. Alrumman *et al.,* [2] reported high concentrations of crude oil from exploration sites into soil and water environments of mangroves, its effects can lead to changes in the growth and development, reduction in the functional ability of the plants, mortality of the fauna that depend on mangrove habitats for survival. Moreover, the foremost causative agents of environmental pollution are the incidence of hydrocarbons in the environment [5].

Hydrocarbon compounds primarily are composed of carbon and hydrogen as major component of crude oil, natural gas and pesticides, and it negative effects contribute to the greenhouse effect and also inhibit the photosynthetic ability of plants, humans are not left behind because it also increase occurrences of cancer and respiratory disorders [6]. Petroleum hydrocarbons are identified as major pollutants of mangrove ecosystems, as mangrove habitats are usually the

distribution routes of the petroleum hydrocarbons [7]. As previously mentioned, most of the activities involving petroleum hydrocarbons are mostly carried out in the deltaic areas that are homes or natural habitats for mangroves. Very often during oil exploration and transportation of pipelines in the region are damaged and sometimes by vandalism. When this ensues, it results in oil spillage leading to some adverse effects on the mangrove habitats and accumulation of petroleum hydrocarbons in their soils; this also affects other organisms in the environment, including those that depend on the mangroves for feeding and survival [12]. It is based on these standpoints that this study was planned and designed to determine the THC in the soil of studied mangrove species, which are commonly found mangroves in the Niger delta area as well as to determine whether there are significant differences in the THC in the soils of these mangrove species and plant parts of associated species such as Nypa Palm.

2. Materials and Methods

2.1. Description of Study Area

Onne sampling area (4°7N and 7°10E) is located in the Odidu clan of Eleme Local Government Area of Rivers State. This area is close to a major refinery that supplies petrochemical products and crude oil via a jetty. This area is also abundance in *Nypa fruticans* (Nypa palm). The people of the area involve massively in farming and fishing while some depend majorly on the mangrove forest as their only source of livelihood. Eagle Island is the second study area in coastal community (4°47N and 6°58E) that has rich amount of mangrove forest and *Nypa fruticans.*

Source: Nona net.

Figure 1. *Map of Onne in Rivers State Port Harcourt.*

2.2. Sample Collection

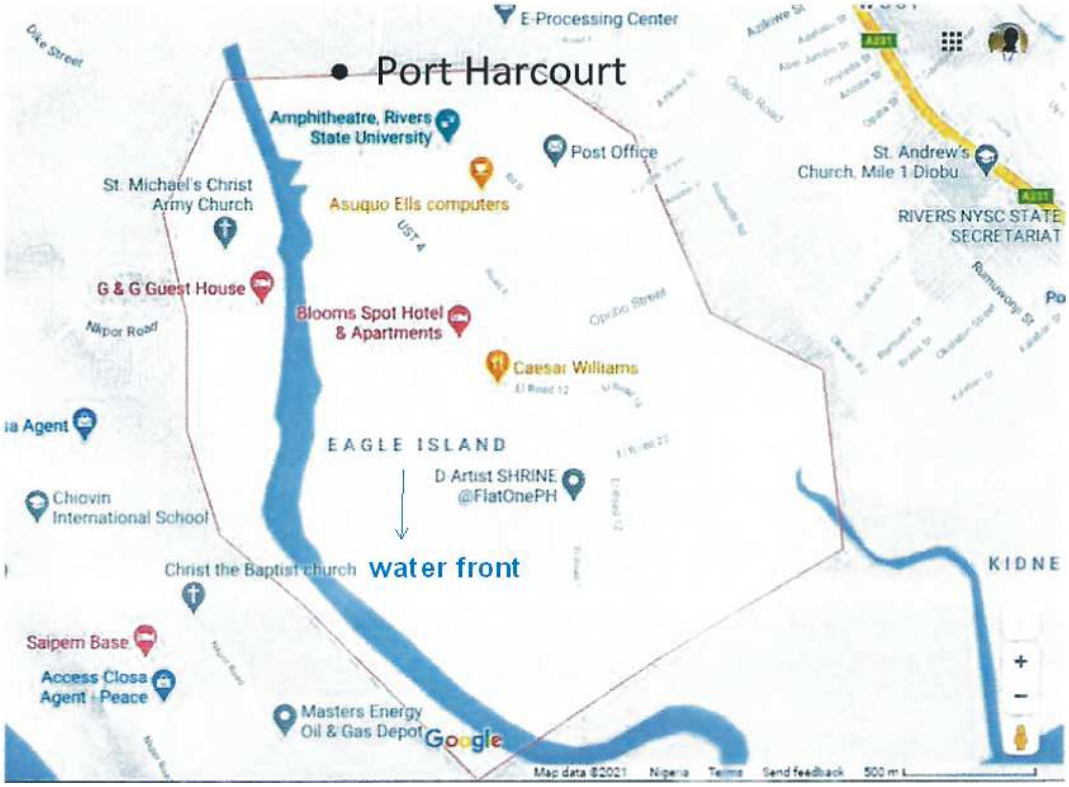
Mangrove forest at two locations Onne and Eagle Island were sampled, which are the two locations. In each study area a 20 x 20m plot was delineated. Within each plot 10 trees were sampled randomly using stratified systematic analyzed sampling method. Twenty leaves, pieces of root and stem of red mangrove was plucked, cut and dug out, similar techniques was adopted for Nypa palm and placed in the cooler and taken to the laboratory for analysis while a section was taking to taxonomic laboratory in the Department of Plant Science and Biotechnology University of Port Harcourt for species identification. The following soil characteristics were measured: pH, temperature, salinity, THC in soil and water. For the soil analysis, fresh samples were collected insitu with a soil augur weighed and placed in a sterile polythene bags and sent to laboratory, each location 3 replicates from each sampling plot were used for both location.

2.3. Parameters of Assessment and Determination

2.3.1. Total Hydrocarbon Content

The method of analysis used is the atomic absorption spectrophotometric method using Harch DR 890 Colorimeter (warc length column). The root, stem and leaves samples were oven dried at 60°C in the drying oven (Memert 11270)

for 24 hours to get rid of the moisture. The dried samples were crushed and 2g of it was weighed into a glass beaker and 2ml of hexane added. The sample was homogenized with the use of a glass rod by stirring. After that, the samples were filtered through a glass funnel packed with cotton wool, silica, gel, anhydrous sodium sulphate. After the filtration, 10ml of the filtered organic extract was transferred into 10ml sample covet and inseiled into the colorimeter. Total hydrocarbon content was expressed which is equivalent to mg/l.



Source: Nona net.

Figure 2. *Map of Eagle Island in Rivers State Port Harcourt.*

2.3.2. Soil/Water pH

The pH of the sediment was determined using a digital pH meter (Model Hi8314, membrane HANNA instrument). The sediment sample was mixed in a ratio of 1:1 with distilled water in a beaker. The pH probes were immersed in the beaker containing the solution, allowed to stabilize and reading was taken. The same was repeated in soil samples.

2.3.3. Soil/Water Temperature

The soil temperature was measured using mercury in glass thermometer. The sediment sample was thoroughly mixed with distilled water in the ratio of 1:1 in a container. A thermometer was dipped in the sediment solution and the reading was taken and recorded.

2.3.4. Salinity

The salinity of the water samples, from each of the station was determined in the laboratory using multi-water measuring meter-horiba water checker model U-10 µ. Sufficient to proper contact with the electrode (probe) of the meter were poured into different beakers representing each station. The reading were taken by dipping the probe of the meter into the beakers containing the water samples and left for about three minutes for the meter to standardize and the reading was taken in S = %.

2.4. Statistical Analysis

Results of the treatment fitted into CRD were analyzed with one way Analysis of variance with descriptive analysis, bar graphs were plotted to illustrate the significance and differences in the concentrations using [11].

3. Results

3.1. Physico-chemistry of Study Site

The physico-chemistry of both study sites for water samples and sediments are given in Tables 1 and 2. The mean water pH 6.53 for Eagle Island and 5.63 for Onne, which are neutral to acidic respectively. The salinity level is slightly higher in Onne (4.15 ppm) than Eagle Island (2.8 ppm). Temperature for both sites ranges from 30-32°C. Water THC was higher for Eagle Island than Onne. The mean soil pH ranges from 5.02-5.82 for both locations. There were no significant differences in soil pH for both locations. The

salinity level was significantly higher in Onne (1.14 ppm) than Eagle Island (0.58 ppm). There was no significant difference in soil temperature for both sites. THC was significantly higher for Eagle Island than Onne.

Table 1. *Physicochemical parameters of study location Onne and Eagle Island water sample.*

Location	Mean pH	Mean Salinity	Mean Temp.	THC
Onne	5.63+ 0.112[b]	4.15+ 0.02[a]	30.6+0.069	0.68+0.001[b]
Eagle Island	6.53+0.62[a]	2.86+0.12[b]	32+0.06[a]	33.8+0.05[a]
LSD	0.06	0.05	0.06	0.06

Table 2. *Physicochemical parameters of study location Onne and Eagle Island soil sample.*

Location	Mean pH	Mean Salinity	Mean Temp.	THC
Onne	5.02+0.001[a]	1.14+0.008[a]	32.3+0.52[a]	0.63+0.008[b]
Eagle Island	5.82+0.021[a]	0.58+0.001[b]	32+0.04[a]	3.2+0.001[a]
LSD	0.04	0.02	0.02	0.04

3.2. Total Hydrocarbon Content Between the Studied Plant Parts at Onne

Hydrocarbon concentration in parts of *Rhizophora mangle* and *Nypa fruticans* plants varied significantly. Root of Nypa *fruticans* accumulated high level of THC, while the least in THC accumulation was found in the root of *Rhizophora mangle*. The leaves of *Rhizophora mangle* showed significant difference in accumulation of THC as compared to leaves of *Nypa fruticans*. Correspondingly, similar accumulation rate in THC was found in stem (Bark), the bark of *Rhizophora mangle* accumulated higher amount of THC as compared to stem of *Nypa fruticans*. There were significant differences in THC accumulation, their accumulation rate as showing in Figure 3.

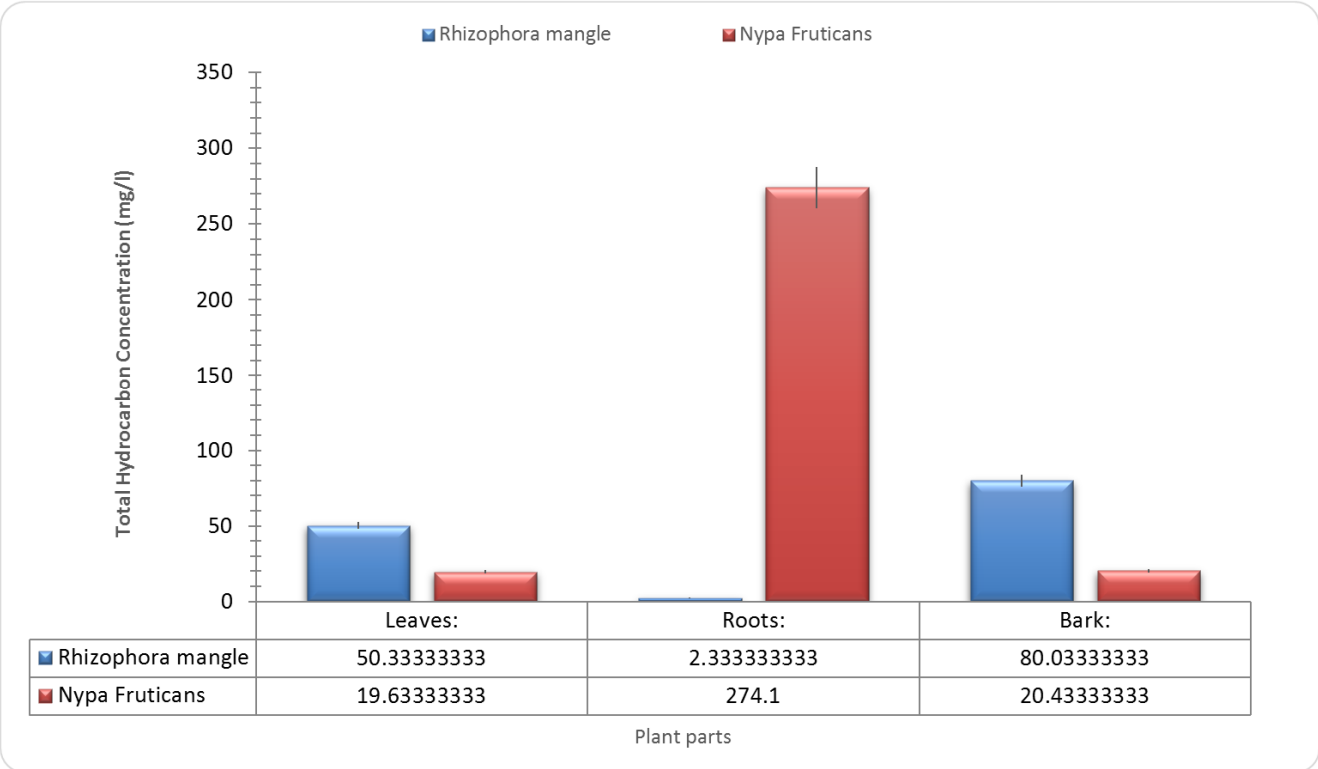


Figure 3. *THC concentrations of plant parts at Onne Values are mean ± SD. Bars indicate the standard error.*

3.3. Total Hydrocarbon Content Between the Studied Plant Parts at Eagle Island

Total hydrocarbon concentration in parts of *Rhizophora mangle* and *Nypa fruticans* plants varied significantly. The leaves of *Rhizophora mangle* showed significant increase in the accumulation of THC as compared to leaves of *Nypa fruticans*. Root of Nypa *fruticans* showed the least level in THC accumulation, while higher THC accumulation was found in the root of *Rhizophora mangle*. There was significant difference in their accumulation rates. Conversely, THC accumulation rate was found high in the stem (Bark) of *Nypa fruticans*, while least amount of THC accumulation was recorded for the stem of *Rhizophora mangle*. There were significant differences in accumulation rate as showing in Figure 4.

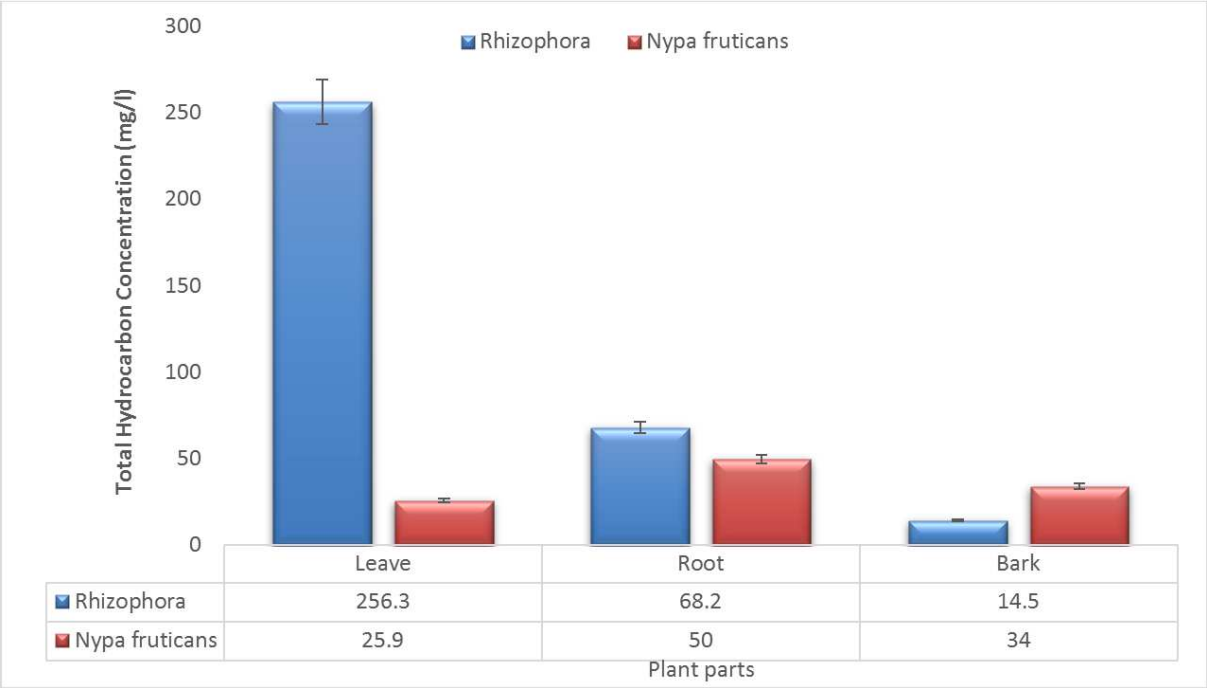


Figure 4. *Concentration of THC in plant parts at Eagle Island.*

4. Discussion

The variation observed in the physio chemical properties could be attributed to anthropogenic activities in the study area. Most chemical activities areas are release on the environment which later finds its way into the water bodies through erosion. This finding, also corroborate with Ohimain *et al* [9] who report the changes in soil physicochemical properties is highly influence by human interference. There was high concentration of THC in leave of *Rhizophora mangle* as compared to other parts. This variation could be attributed to the excretory capability of the leaves to expelling toxic materials absorbed from the soil. This finding is in agreement with Ohimain *et al* [9] who reported that this variation occurs through yellowing and defoliation of leaves that have high concentration of pollutants. Consequently, other parts of the plant do not possess such quality. The ability of mangroves to absorbing substances from the soil to the leaves is a bottom up mechanism and has been described [5]. Conversely, mangroves have natural ability to act as a sink of anthropogenic and industrial pollutants [5]. In the same vein, mangrove ecosystem retains toxic metals and stops it from infiltrating into the marine ecosystems. The metal concentrations in mangrove sediment, along with their bioavailability and bioaccumulation in tissues were studied by several workers [5]. The high THC concentration in root of *Nypa fruticans* at Onne may be attributed to the physiology of the plant in translocating pollutants from soil to harvestable regions. This also agreed with the findings of Amadi et al., [3] who reported that accumulation of pollutant into plant biomass is plant specific, since plants has different genetical mechanism in the sequestration of pollutants. Additionally, this restriction may interfere with its salt intake ability and result to a trade off by causing more restriction in the intake of excess hydrocarbons into plant leaves. This finding corroborated with the approach of Page *et al.,* [10] who proved that petroleum hydrocarbons induce stress in salt-extracting plants, by disrupting the ability of the roots to exclude ions from sea or brackish waters. The researchers indicated that hydrocarbon pollution is caused by oil spillage and industrial and domestic waste dumped in creeks. Crude oil in the soil may reduce sediment porosity and gaseous exchange that in turn may have a negative effect on the physiological function of the plant [4], which may include its pollutant absorption capability. This availability is determined by both external (soil associated) and internal (plant-associated) factors. There was a variation in uptake of THC on the studied plant parts. This could be attributed to the availability of this pollutants to the plant. This finding is in agreement with the report of the uptake of pollutant from the soil is a function of the nature, concentration and availability its availability [3]. The variation found in increase of THC at Eagle Island may be attributed to illegal oil business which might have transported THC content from point sources to non-point areas.

5. Conclusion

This study showed that higher productivity and litter fall in *Rhizophora mangle* is a mechanism to counter the effect of total hydrocarbon pollution in a polluted rain forest environment. In line with this ability, the combined effects of

Rhizophora mangle and *Nypa fruticans* can be used for bioremediation of polluted areas since they serve as sink to pollutants. High THC in leaves of Rhizophora *mangle* can used to improve phytoaccumulation mechanisms which in turns will improve the stability of the soil for agricultural purpose. The consumption of *Rhizophora mangle* and *Nypa fruticans* by the West African Red mangrove crabs (*Goniopsis pelii*) portends danger for other organisms in the food chain due to biomagnification of metals, which might be inimical to human health if consumed. This study is significant because it provides data for bio-monitoring of THC concentration in mangrove parts and other forest dwelling organisms to prevent increase in toxicity level that is inimical to humans if they feed on sea food.

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