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Impact of the eleme petrochemicals company on the levels of some physicochemical parameters and total petroleum hydrocarbons (TPH) in the soil from eleme

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Abstract
This study investigated the level of some physicochemical parameters (pH, electrical conductivity, % TOM, % TOC, % total nitrogen, % available phosphorous and particle size distribution) and total petroleum hydrocarbons (TPH) in Eleme soil. Samples were collected from six different locations. The physicochemical parameters were determined using standard analytical methods and the total petroleum hydrocarbons was done using gas chromatography equipped with FID. The results of physicochemical parameters were higher than the ones obtained by Eleme petrochemicals company EIA. The pH values of soils from the study area were moderately acidic; the electrical conductivity indicates a non-saline soil in the various locations. All the %TOC values were within the limit recommended by Brady for agricultural soils except in location 5 where a slightly higher value was obtained. The total nitrogen values varied from very low to high. The soils across the six locations showed a coarse textured soil. The value for available phosphorous varied from 0.119 – 0.200%.
The levels of total petroleum hydrocarbon in some locations were within the DPR recommended limit of 50mg/kg while others were higher than the DPR limit.

Keywords: petrochemicals, physicochemical parameters, total petroleum hydrocarbons, soil, eleme, location

Introduction
The petrochemical industry has been of great benefit to human life and is providing the major basic needs of rapidly growing, expanding and highly technical civilization as source of energy for domestic, industrial, transport sectors and as feedstock for fertilizers, synthetic fibers, synthetic rubbers, polymers, intermediates, explosives, agrochemicals, dye and paints due to these enormous benefits, we rely so greatly on these products from the petrochemical industries for our day to day life. However environmental issues have now become important consideration because Petrochemical plants generate solid wastes and sludges, some of which may be considered hazardous because of the presence of toxic organics and heavy metals [22]. Accidental discharges due to abnormal operation, especially from polyethylene and ethylene oxide-glycol plants in a petrochemical industry, can be a serious environmental hazard, releasing large quantities of pollutants and products into the environment [5]. Effluent from petrochemical industries contains large quantities of heavy metals, polycyclic aromatic hydrocarbons, phenols and other chemicals. Effluent may be a serious environmental problem that can lead to the accumulation of toxic substances in the receiving water which can have a negative effect on the ecosystem [22]. Indorama (Eleme) Petrochemicals limited is a Nigerian based provider of fertilizer, olefins, butene, polyethylene and polypropylene, the company generates large quantities of effluents daily. These effluents are discharged into natural water bodies after treatment. Though, the compositions of the effluents are regulated by various laws, it is not known whether they comply with the legally accepted toxicant levels for refineries and petrochemical plants in Nigeria.

A research carried out by Nwineewii and Ibok [19] to investigate the impact of Eleme Petrochemicals Company on the level of some physicochemical parameters in soil revealed that the results found were out of range when compared with the impact assessment study carried by the Eleme Petrochemicals company in 1992 indicating that the operations and construction within the company may have been responsible for it. Also, Ambo *et al*. [3] investigated the level of heavy metals and P^H in the surface Soil from Eleme and other oil producing areas, it was found out that the percentage of heavy metals obtained at Eleme was higher than those obtained from other areas probably due to the presence of the Petrochemicals and other oil producing companies at Eleme.

Study Location
Eleme Petrochemicals complex site is spatially approximately between l0km North-East of Port
Harcourt, the capital city of Rivers State of Nigeria and 40km South-West of the largest commercial Town, Aba in Abia State. The Port Harcourt township is located on the South-East Flank of Niger Delta on the edge of the dry main land which is contiguous with the site of the Petrochemicals Company and occupies about 4,200 hectares of land in the vicinity of the villages of Akpajo, Aleto and Agbonchia in Eleme, Eleme Local Government Area of Rivers State on the Port Harcourt-Bori segment of the East-West road [9].

Sampling procedure
Soil samples were collected from six locations around the vicinity of the Eleme Petrochemicals Company. The distance between

each sampling point was at least 300m apart. The sample points were drilled with soil auger from the top soil to the depth of 30cm (0-30cm) and hand trowel was used to scoop the soil samples and transferred into already well-labeled polythene bags, after which they were taken to the laboratory for analysis

Total Petroleum Hydrocarbons Determination

2.0g each of the ground soil samples was weighed into an extracting vessel. Enough sodium sulphate was added in other to remove the water molecule with a continuous stirring. This was followed by the addition of 25ml Dichloromethane (DCM) to extract the hydrocarbons content from the soil i.e. (extraction solvent). According to Imeh [12], DCM proved to be the most suitable solvent over hexane, acetone and toluene for this extraction due to its consistency, efficiency and ability of not interfering with BTEX. This was followed by the addition of Silica gel to remove the debris from the sample. The sample was left for 45mins before filtering. The sample was poured into a separating funnel with a filter paper, a cotton wool, sodium sulphate (Na_2SO_4) and silica gel. The filtered sample was passed through a chromatographic column which is made up of cotton wool, sodium sulphate and silica gel and then was collected in the vial. To concentrate the content in the vial, it was passed through ambient air. After this, 10µL of the extracting solvent was injected to mix the sample solution in the vail. Finally, 2ml of the sample solution was introduced into the injection port of the G. C through the Septum and was separated into its different components

Determination of pH

20g of soil sample was weighed into a 100ml beaker and 40ml of distilled water was added to it. The solution was stirred at a regular interval for 30 minutes. A pH meter was immersed into the solution and the reading was recorded.

Determination of Electrical Conductivity

20g of soil sample was weighed into a beaker, 50ml of distilled water was added. The mixture was stirred with glass rod for 10 minutes and was allowed for 30 minutes without any disturbance. The electrical conductivity was measured by immersing a conductivity meter into the solution and the reading was recorded in µs/cm.

Determination of % Total Organic Carbon

The organic carbon content of the soil samples was determined by titrimetric method of walkley and Black. 1g of finely ground soil sample was passed through 0.5mm sieve and taken into 500ml conical flask, 10ml of potassium dichromate and 20ml sulfuric acid were added. The contents were shaken for a minute and allowed to stand for 30 minutes. 200ml of distilled water, 10ml of orthophosphoric acid and 2ml diphenylamine indicator were added. The solution was titrated against ammonium ferrous sulfate until the colour flashes from purple to green and the reading was noted for calculation. The blank titration was carried at the beginning without soil. The results were calculated using the formula;

% organic carbon ═ [10- (10 B/A)] × 0.3

B ═ Reading

A ═ Blank reading

Determination of % Total Organic Matter

A conversion factor of 1.724 was used to convert organic carbon to organic matter.

Determination of particle size distribution

Particle size distribution was determined by hydrometric method

Determination of % phosphorous:

% phosphorous was determined by direct reading with Hach DR 3900

Results and Discussion

The results of the physicochemical parameters and total petroleum hydrocarbons (TPH) obtained from the soil samples are shown in table 1 and 2 below.

Table 1: Physicochemical Parameters of Soil Samples from the Vicinity of Eleme Petrochemicals Company

Physicochemical parameters	Location 1	Location 2	Location 3	Location 4	Location 5	Location 6	Mean ± SD	EIA
PH	5.75	5.60	5.75	6.10	5.90	5.85	5.825±0.167	7.08
Electrical conductivity (µs/cm)	110	90	220	130	110	135	132.5± 45.798	
% Total Organic Matter	1.402	4.750	2.507	2.354	5.955	5.441	3.735± 1.829	
% Total Organic Carbon	0.813	2.744	1.454	1.365	3.454	3.1565	2.164 ±1.091	0.34
% Total Nitrogen	0.041	0.068	0.027	0.068	0.170	0.159	0.089 ±0.061	
% Available phosphorous	0.182	0.36	0.119	0.152	0.172	0.200	0.198±0.084	26
Magnesium (Mg) (mg/kg)	9.413	23.790	11.395	13.758	14.206	15.602	14.694±4.536	0.15
Potassium (K) Mg/Kg	241.266	261.169	130.836	71.520	35.790	27.012	47.932±6.384	0.15
Particle size Distribution (%)	Sand – 75 Clay – 32 Silt – 15	Sand – 81 Clay – 29 Silt – 10	Sand – 78 Clay – 9 Silt – 13	Sand – 76 Clay – 10 Silt – 14	Sand – 99 Clay – 12 Silt – 9	Sand – 75 Clay – 14 Silt – 11	80.667±9.266 17.667±10.132 12±2.366	

Table 2: Total Petroleum Hydrocarbon (TPH) of soil samples from the vicinity of Eleme Petrochemical Company

Sample Locations	Total petroleum Hydrocarbon (mg/kg)
Location 1	39.77989
Location 2	95.50155
Location 3	43.46522
Location 4	105.19781
Location 5	89.04148

Location 6	39.07872
Mean ± SD	68.677±31.032
DPR limit	50

Soil P^{H}

The soil pH obtained from the study ranged from 5.75 to 6.10 indicating moderately acidic soil. This observation corroborates the findings by Inuwa *et al*. [15] but contradicts the alkaline range of 7.64 to 8.10 reported by Ini and Charles [14] in soil from Alesa Eleme.

Soil pH can affect plants growth through its effects on nutrient availability. Low or high soil pH causes deficiency in essential nutrients needed by plants for its growth. Soil pH is important because it influences the availability of essential nutrients. Most horticultural crops will grow better in soils having a pH between 6 and 7.5 [14]. However, for plants, a soil pH below 6.0 is considerable [16]. Eleme petrochemical company EIA (1992) recorded a pH of 7.08.

Electrical Conductivity

The electrical conductivity values ranged from 90 to 220 µs/cm with a mean of 132.5 ± 45.79µs/cm. This range of values indicates that the soils across the six samples locations are nonsaline as all the values are below 4000µs/cm [18] and do not exceed the critical value of 2000µs/cm for sensitive crop species. Similar results were reported by other researchers [8, 21]. However, these results are in contrast with the ones obtained by Badmus *et al*. [4] and Obasi *et al*. [20], they reported higher values that ranged from 5030-6080µs/cm and 1379 to 3120µs/cm respectively. Electrical conductivity is an indication of the availability of nutrients in the soil and low electrical conductivity levels indicate low availability of nutrients in the soil which will affect plants growth drastically, while high electrical conductivity of soil is an indication of higher significant presence of ions [10].

Total Organic Carbon and Matter

In this study, a conversion factor of 1.724 was used to convert organic carbon to organic matter. The results ranged from 0.813 to 3.454% for total organic carbon and 1.402 to 5.95%. The highest value of 3.454% was observed for organic carbon in location 5 and it is slightly below the limit of 3.5% recommended for organic carbon in soil by Brady [6]. This result is consistent with reports by Ini and Charles [14] who reported a TOC range of 0.6 to 3.4% in soil samples from Eleme. However, the result was far below reports by Edori and Iyama [8] who reported a TOC range of 12.69 to 16.79% in soil sample from Port Harcourt. The values of total organic carbon in all the six sampling locations were higher than that of the Eleme Petrochemicals EIA, 1992. The amount of total organic matter in soil determines the nutrients content and any other changes that will alter the quantity and quality of soil fertility [8]. Organic matter provides nutrients and habitat to organisms living in the soil, also binds soil particles into aggregates and improves the water holding capacity of soil.

% Total Nitrogen

The total nitrogen values ranged from 0.027 to 0.170% for the six different soil samples analyzed.

Horneck *et al*. [11] classified soil total nitrogen as; very low <0.5, low 0.05 to 0.15, medium 0.15 to 0.25, high 0.25 to 0.50, very high >0.5. The values obtained in this work are comparatively higher than the values reported by other scholars. [23, 24, 13]. Nitrogen is very essential for all living things as it is an essential component of protein such as DNA, RNA, and vitamins as well as hormones and enzymes [11].

Available Phosphorous

The values for the concentration of available phosphorous ranged from 0.119 to 0.36mg/kg. This range of available phosphorous correlates with work reported for Eleme soil by Ini and Charles [14] but higher when compared to reports by other scholars [23, 24]. Available phosphorous is an essential nutrient in soil fertility because of its fixation and transformation in the soil system [18]. Deficiency of phosphorous in soil may cause plant leaves to develop purple coloration, stunted plant growth and decay in plant development while excess of it may cause micronutrient deficiency especially iron and zinc [24].

Particle Size Distribution

The soil particle size distribution had the mean values of 80.67%, 29% and 12% for sand, clay and silt respectively. Sand has the highest fraction followed by clay and then silt. This is consistent with reports from other studies [21, 14] and it has been reported to be the characteristic of the soils found in the Niger Delta region [23]. The proportion of sand, clay and silt found in this study suggested that the soils were coarse in texture. Coarse textured sandy soils usually have low supply of nutrient and moisture but provide physical support to plant.

Total Petroleum Hydrocarbon

The results of the levels of total petroleum hydrocarbon (TPH) from the six sample locations are given in table 2. The mean value of TPH as presented in table 2 is 68.677 ± 31.032mg/kg with the highest concentration at location 4 and the lowest concentration at location 6. The results indicate that location 2, 4 and 5 of the soil samples studied were contaminated with total petroleum hydrocarbon in view of the high concentration obtained at these locations when compared to the 50mg/kg limit recommend by Department of Petroleum Resources [7].

The levels of total petroleum hydrocarbon recorded in this study are lower than TPH on of soil samples conducted by other scholars [1, 17, 12, 2] near a petrochemical complex who recorded high total petroleum hydrocarbon within the range of 1179.3 to 6354.9mg/kg. Petroleum hydrocarbons can impact soil ecosystems sufficiently to result in significant losses in soil quality [17]. Study of contaminated soils have demonstrated that elevated loadings of these contaminations can result in diminished microbial biomass, reduced viable bacterial population densities, inhibition of organic matter mineralization as well as decreased leaf litter decomposition [1].

Conclusion

This study was conducted to determine the impact of Eleme petrochemicals-company on the levels of some physicochemical parameters and total petroleum hydrocarbons in soil within the company's environment. The result revealed that the levels of the physicochemical parameters were in contrast with the values

recorded by the Eleme petrochemicals company EIA (1992). The level of total petroleum hydrocarbons in some locations were above the recommended limit set by DPR. This implies that the soil is contaminated which can lead to low agricultural productivity and poor means of livelihood for the inhabitants of this area. The study recommends that further studies be conducted on the degree of pollution of Eleme soil and appropriate monitoring by relevant environmental agencies to ensure strict compliance in the treatment of effluent by Eleme petrochemicals Company before discharge.

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