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Assessment Of The Survivability Of Selected Organisms In Soils Polluted With Petroleum Products From Artisanal Refineries

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ABSTRACT

This study was basically designed to determine the degradability of six different diesel and petrol samples in soil from two artisanal refineries, comparing with conventional refinery in Bayelsa state and investigating the survivability of *Phaseolus vulgaris* (Beans), and *Lumbricus terrestris* (Earthworm) in impacted soil. Beans planted on the monitored soil samples were able to grow and produce seedlings up to the 7th day after planting. Most plots studied however showed some deficiencies in plant including leave defoliation and stunted growth. Percentage seed germination was highest on day 7 before a drastic deterioration in growth was observed. Earthworms were not able to survive up to 24hrs in the monitored soil as they were the most sensitive of the organisms studied.

Keywords*:* Survivability, artisanal refinery, *Phaseolus vulgaris, Lumbricus terrestris*

1.0 INTRODUCTION

One of Nigeria's main sectors and a key component of the economy is petroleum refining. Some of the derivatives obtained from refining include gasoline and diesel. A flammable hydrocarbon liquid is gasoline (Anon, 2009). Early commercial goods were made by distilling bitumen and shale oil. Modern refineries today distill gasoline. In Nigeria, gasoline (petrol) is the primary fuel used for vehicles and generator-powered emergency lighting.

Artisanal refining is used to create a significant portion of the petroleum products that are currently available. Over time, artisanal petroleum refining has taken center stage in Bayelsa State and the Niger Delta, Nigeria's south-south geopolitical zone. Along with producing products of extremely low quality, this illegal petroleum refining and its related activities have also caused significant environmental contamination and ecosystem destruction in the Niger Delta. Environmental problems have become worse as a result of the expansion of illicit refineries in the area during the past few years.

Over time, hydrocarbon pollution of soil environments has spread throughout the world. This has been directly related to the world's significant reliance on crude oil and its products as a primary source of energy, fast industrialization, population increase, and utter disregard for the health of the environment. With a margin of error of 200,000 metric tons per year, the amount of natural crude oil released into the environment was estimated to be roughly 600,000 metric tons per year (Kvenvolden & Cooper, 2003). One of the main causes of water and soil pollution is the release of hydrocarbons into the environment, whether accidently or as a result of anthropogenic activities (Wang, *et al*., 2018).

Pollution has an impact on the ecosystem and biodiversity. Some of the environmental effects of the petroleum industry include the intensification of the greenhouse effect linked to global warming and climate change, acid rain, photochemical smog, reduced atmospheric visibility, lack of forests, ozone layer depletion, soot/heavy metals deposition, poor water quality, surface water/groundwater contamination, soil contamination, disturbance of communities, flora/fauna, and ecosystem destruction (Mariano and La Rovere, 2007; Orszulik, 2008; Isa, 2012; & Jafarinejad, 2015). Products from illicit refineries are very different from what is considered to be the norm for petroleum products globally.

2.0 MATERIALS AND METHOD

2.1 Sampling

The soil samples were collected from polluted sites at two selected artisanal refineries located at Korokorosei, in Southern Ijaw LGA (Latitude 4º 44' 49.182" N; Longitude 6º 0' 34.92" E) and Owegbene in Ekeremor LGA (Latitude 5º 1' 15.432" N; Longitude 5º 42' 11.268" E) in Bayelsa State. However, the control Soil samples were sourced from NNPC, located in Yenagoa, Bayelsa State. Polluted soil samples were collected randomly from different spots and mixed properly to obtain composite soil samples. The soil samples were collected from the surface to a depth of 0-15cm with sterile soil auger into fresh unused black polyethylene bags and transported to the microbiology laboratory for setup and analyses.

2.2 Soil Sample Preparation

The soil was obtained using manual soil auger to a 0-15cm depth into sterile plastic bags and sent to the laboratory without delay. Samples were de-stoned, sieved, and homogenized with a 2mm sieve, homogenize and acclimatized (air dried) for 24 hours and stored in dark polyethylene bags for subsequent usage.

2.3 Survivability Testing

Earthworms (*Lumbricus terrestris*) for survivability testing were obtained from a mangrove forest in Emohua. Mini pits were dug and nippa palm leaves were thrown in and allowed for a day. The worms were harvested during the cool morning and in containers containing soil and nippa palm leaves. Viable Beans (*Phaseolus vulgaris*) seeds were purchased from Choba Market in ObioAkpor Local Government Area.

2.4 Survivability Testing for Earthworm, Bean Seeds and Microorganisms

The mortality test for earthworms (*Lumbricus terrestris*) was carried out following the norm of ISO/DIS 15799 (Geissen *et al*., 2008). An addition of 10 adult *Lumbricus terrestris* individuals into each container containing the 100g of the impacted soil after 56days, and nympa palm leaves, were added, moisturized and stored in the dark at 22±1ºC, maintaining a constant humidity of 60% maximum water holding capacity. It was checked daily to determine the number by hand-sorting; then a mortality rate (N %) was determined. Soil moisture was kept constant at field capacity.

The survivability test for bean seed was conducted according to Cruz *et al* (2013) with some modifications. Seeds were sown in polyethylene bags containing 50 g of contaminated soil. The tests were performed in triplicates containing 5 seeds each. The plants were measured after 14 days. The length, dry weight, number of seedlings and leave characteristics were measured. Impacted soil with diesel and petrol after 56days was used to plant bean seed to observe the effect of the different test samples on germination and production of seedlings. Leave scorching, defoliation, stunted growth as well as necrosis of the plant were observed after 14 days of planting.

The survivability for microorganisms were done using standard inocula of *Pseudomona* sp and *Bacillus* sp (0.5 McFarland) equivalent to $1.5x10^8$ CFU/ml. Ten milliliter (10ml) of standard inocula was added into 100g of impacted soil from artisanal and conventional refineries. Sterile water was added at intervals to moisten the mixture. One gram (1g) of test sample was removed for counts at 0hr, 24hrs, and 48hrs up to 144hrs.

2.5 Statistical Analysis

The version 23 of SPSS was used for the statistical analysis. Data was expressed as Mean±Standard deviation. The mean was separated using analysis of variance (ANOVA), while Duncan was used to test the degree of significance.

3.0 RESULT AND DISCUSSION

3.1 Growth of Bean Plant in impacted soil after day 56

As presented in Table 1, after 14 days of planting average length of stem ranged from 3.35 – 8.24 cm, with the least value from sample from NNPC. There was no observed case of leaf scorching, defoliation, necrosis or stunt growth. The average fresh mass ranged from 0.58 – 1.72 g with dry mass ranging from 0.08 – 0.22 g.

Table 1: Effect of impacted Soil on Beans Plant Germination After 14 days of Planting

Appearance	AD	AP	BD	BP	CD	CP
Leave Scorching	Absent	Absent	Absent	Present	Present	Absent
Leave defoliation	Absent	Absent	Present	Present	Present	Absent
Stunted Growth	Absent	Absent	Present	Present	Present	Present
Necrosis	Absent	Absent	Present	Present	Absent	Present
Av. Fresh Biomass (g)	1.72	1.42	1.18	1.04	0.58	1.30
Av. Dry Biomass (g)	0.09	0.22	0.10	0.14	0.08	0.19
Av. Length of Stem(cm)	8.24	11.1	7.5	7.44	5.3	3.25

Results showed that Southern Ijaw products had less toxic effect on *Phaseolus vulgaris*. Ekeremor reordered less toxic effects compared to NNPC products as more of the parameter were conspicuous. Seed germination was monitored on Days-3, Day-7 and Day-14. AD and BP shows highest in seed germination 8 (>100%) and 8(>100%) respectively, while BD recorded the lest seed germination with 2(40,0%) (Table 2).

Table 2: Percentage of Seed Germination

Appearance	AD	AP	BD	BP	CD	CP
Day 0	0	0	0	0	0	0
Day 3	83.30	100	40	60.60	50	83.30
Day 7	100	100	60.60	100	60.60	100
Day 14	0	0	0	0	0	0

3.2 Effect of impacted Soil on Earthworm Population

Earthworms *(Lumbricus terrestris)* were exposed to impacted soil after 56days from samples in different locations (artisanal and conventional refineries). Most of the soil samples were lethal to earthworm population after 24hours exposure. Only sample from Southern Ijaw (AP) had 30% survivors out of the Ten (10) exposed matured earthworm samples. See Table 3.

Table 2: Survivability Rates of Earthworm Tested against Monitored Soil Samples (%)

Appearance	AD	AP	BD	BP	CD	CP
0hrs	100	100	100	100	100	100
24hrs	0	0	0	0	0	0
48hrs	0	0	0	0	0	0

The survivability test on *Phaseolus vulgaris* after day 56 in impacted soils from artisanal and conventional refineries revealed the following results: petrol sample from Ekeremor (BP) show highest in morphological changes and samples from Southern Ijaw recorded least morphological changes in leave scorching, leave defoliation, stunted growth and necrosis. According to (Milena 2017, Caravaca and Rodan 2003; Iturbe *et al*, 2007), petroleum substances cause far-reaching changes in the amount and composition of organic content, a reduction of water holding capacity, an increase in the demand for oxygen; they hamper or completely block air transport between the atmosphere and the soil.

Soil contaminated with petroleum causes the sorption complex capacity to drop and reduces the ability to exchange calcium, magnesium, and potassium while also decreasing the availability of these macro components (Agbogidi *et al*. 2007; Wyszkowski & Ziolkowska, 2008). The survivability test on *Lumbricus terrestris* after day 56 in impacted soils from artisanal and conventional refineries show low survival rate of the earthworms as death was recorded within 24hours in all samples exception of Southern Ijaw sample (AP) showed 30% survival after 24hoursl in impacted soil.

CONCLUSION

The Beans plant and was able to survive the presence of certain concentrations of petroleum products but more sensitive microorganisms (Earthworms) were not able to withstand the concentrations studied even after a substantial amount of hydrocarbon has been removed. The findings from the study strongly suggest that most of the petroleum products are readily biodegradable. Southern Ijaw Diesel (AD) is the least degradable at day 56 and Ekeremor petrol (BP) recorded the least at day 56. The study further shows that artisanal refinery product from Ekeremor LGA, Owegbene (BP; petrol and BD: diesel is more toxic to the environment as they recorded highest effect of bean plant morphological changes. We recommend the prohibition of artisanal refinery on one hand and the establishment of modular refinery on the other hand as a replacement. Also all stakeholders should be brought together to ensure the smooth refining of hydrocarbon products.

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