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Potentials of cocoa pod husk and plantain peels in the degradation of total petroleum hydrocarbon content of crude oil polluted soil

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ABSTRACT

The potentials of cocoa pod husk and plantain peels in the degradation of total petroleum hydrocarbon content of crude oil polluted soil were investigated in Calabar, Nigeria. Two kilogram of soil contained in 36 plastic buckets were polluted with 250ml of Bonny light crude oil obtained from Nigerian Agip Company Port Harcourt. The treatments were applied in single form (400CPH, 500CPH, 400PP, 500PP) and in combined form (200CPH+ 200PP and 250CPH+ 250PP). The result shows that 84.22% sand 87.44% of TPH were degraded in 400CPH and 500CPH treated soil respectively while 80.69% and 81.04% of TPH were degraded in 400PP and 500PP treated soil respectively and 81.92% and 83.53% of TPH were degraded in 250CPH+250PP and 200CPH+200PP treated soil respectively. It can be concluded that 500CPH was effective in enhancing the degradation of TPH in contaminated soil.

Key: Crude oil, Plantain peels, Cocoa pod husk, Total petroleum hydrocarbon.

INTRODUCTION

Bioremediation is the intentional use of biological degradation procedures to remove or reduce the concentration of environmental pollutants from sites where they have been released. The concentrations of pollutants are reduced to levels considered acceptable to site owners and/or regulatory agencies. Bioremediation however, employs the use of naturally occurring bacteria and fungi to degrade environmental pollutants. It is a technology for removing pollutants from the environment, restoring contaminated sites and preventing future pollution [1]. Bioremediation is the promising technology for the treatment of contaminated sites since it is cost effective and will lead to complete mineralization. Bioremediation functions basically on biodegradation, which may be refer to as complete mineralization of organic contaminants into carbon dioxide, water, inorganic compounds and cell protein or transformation of complex organic contaminants to other simpler organic compounds by biological agents like microorganisms [2]. Bioremediation is also the act of adding fertilizers or other materials to contaminated environments such as oil spill sites to accelerate the natural biodegradation process. Bioremediation of petroleum hydrocarbon polluted soil relies on the petroleum degradation ability of the microbial consortium resident in the soil [3, 4 and 5]. Bioremediation has been successfully used in the cleanup of thousands of leaking underground gasoline storage tanks, commonly found at filling stations. The process involves digging out and removing the tanks, adding growth- promoters nutrients such as nitrogen and phosphorus fertilizers to the surrounding soil, and tilling the soil to introduce oxygen. This study is aimed at assessing the potentials of cocoa pod husk and plantain peels in the degradation of crude oil polluted soil.

MATERIALS AND METHODS

Experimental design

Top soil (0-15cm depth) was randomly collected from four points, using a dutch auger, bulked to form a composite sample and two kilogram each of the composite samples were weighed and transferred into thirty six labeled plastic buckets (PB) with drainage holes at the base, plugged with cotton wool to retain the soil [6]. The plastic buckets were arranged in triplicate in a completely randomized design. Crude oil (Bonny light) obtained from Nigeria Agip oil Company, Port-Harcourt, River State was applied as the pollutant. 250ml of crude oil was applied to each plastic bucket labeled in single form (COC_1, 400CPH, 500CPH, COC_2, 400PP, 500PP), and in combined forms (COC3, 200CPH + 200PP, 250CPH + 250PP), with the control as PC_1, PC_2, PC_3 (0g) without crude oil. The oil was thoroughly mixed with the soil in the plastic buckets and the set up were allowed to stand for one week for acclimatization between the soil and the oil. After one week post- contamination the amendments were applied and mixed thoroughly with the soil. 250mls of distill water was applied every one week in other to adjust the moisture content of each sample to 60% of the soil moisture holding capacity [7].

Determination of total petroleum hydrocarbon

The amount of crude oil in the soil sample was determined using air dried soil that was sieved through 1mm mesh. 1g of the soil sample was dissolved in 10ml of hexane and shaken for ten minutes using a mechanical shaker. The solution was filtered using a Whatman filter paper and the filtrate diluted by taking 1ml of the extract into 50ml of hexane [8]. The absorbance of this solution was read at 430nm with Jenway 6405 UV/Vis Spectrophotometer using n-hexane as blank. Computation of percentage hydrocarbon saturation at 90 days, percentage degradation and degradation rate respectively were carried out as follows:

(I) Percentage hydrocarbon saturation during the 90 days
$(TPH_{90} \div TPH_{initial}) \times 100$
(II) Percentage hydrocarbon degradation
$100 - (TPH_{90} \div TPH_{initial}) \times 100$
(III) Time required for 100% TPH degradation (Year)
$(90 \text{ days} \div \% TPH_{90}) \times 100 \div 365$ days
(IV) Degradation rate of TPH per day
$(TPH_{initial} - TPH_{90}) \div T$
Source: [6]

Statistical analysis

Collected data were subjected to analysis of variance (ANOVA) test using 3-factor factorial in a Completely Randomized Design (CRD). Means were separated using least significant difference (LSD) test.

RESULTS AND DISCUSSION

The potentials of Agro-wastes (cocoa pod husk and plantain peels) in the degradation of total petroleum hydrocarbon (TPH) in crude oil polluted soil were investigated in Nigeria. The result shows that they were significant reduction ($p < 0.05$) in the TPH of the soil which occurs with time. The result indicates that the duration of treatment influences the degradation rate of hydrocarbons in the soil. Figure 1 showed that 23.86%, 84.22% and 87.44% of TPH were degraded in crude oil polluted control, 400CPH and 500CPH amended soil respectively, and 23.58%, 80.69%, 81.04% of TPH were degraded in crude oil polluted control, 400PP and 500PP amended soil respectively while 23.86%, 81.92%, 83.53% were degraded in crude oil polluted control, 200CPH+200PP and 250CPH+250PP amended soil respectively. This result indicate that the TPH degraded in cocoa pod husk (CPH) treated soil was higher than that of plantain peels (PP) and combination of cocoa pod husk + plantain peels (1:1) treated soil. However in all the treated soil, high concentration (500g) of the agro-wastes showed a significant reduction ($P < 0.05$) in TPH than the lower concentration (400g) of the agro-wastes. [9] observed that spent mushroom, cow dung, poultry droppings are effective nutrient sources in the degradation of TPH in the soil.

Table 1 Total petroleum hydrocarbon ($mgkg^{-1}$) degradation in crude oil polluted soil

	Cocoa pod husk				Plantain peels				Cocoa pod husk + Plantain peels (1:1)			
Durations	PC_1	COC_2	400g	500g	PC_2	COC_2	400g	500g	PC_3	COC_3	400g	500g
30 days	$33^{n}\pm 2.08$	$922^{a}\pm 3.06$	$632^{f}\pm 3.79$	$600^{g}\pm 35.54$	$34^{n}\pm 1.53$	$926^{a}\pm 5.30$	$697^{d}\pm 3.52$	$653.33^{d}\pm 14.55$	$34.33^{n}\pm 2.03$	$922.67^{a}\pm 3.85$	$636.67^{f}\pm 3.39$	$590^{g}\pm 11.56$
60 days	$32^{n}\pm 2.89$	$869.67^{b}\pm 13.95$	$399.33^{i}\pm 6.37$	$370^{j}\pm 12.60$	$33^{n}\pm 3.2$	$864.67^{b}\pm 14.46$	$481.33^{h}\pm 10.82$	$411.33^{i}\pm 1.86$	$32.33^{n}\pm 2.34$	$32.33^{b}\pm 2.34$	$399^{i}\pm 1.00$	$375.67^{j}\pm 11.92$
90 days	$33^{n}\pm 2.54$	$804.33^{c}\pm 3.85$	$166.67^{l}\pm 6.97$	$132.67^{m}\pm 7.23$	$31.67^{n}\pm 1.46$	$807.33^{c}\pm 3.39$	$204^{k}\pm 3.22$	$200.33^{k}\pm 4.85$	$33^{n}\pm 1.53$	$804.33^{c}\pm 4.38$	$191^{k}\pm 6.67$	$174^{l}\pm 3.47$

Data were expressed in mean and standard error (X ±S.E) in triplicate. Mean followed with the same superscript along each horizontal array indicate no significant difference ($p > 0.05$).

Key: *PC pristine control, COC crude oil polluted control, $mgkg^{-1}$ milligrams per kilogram*

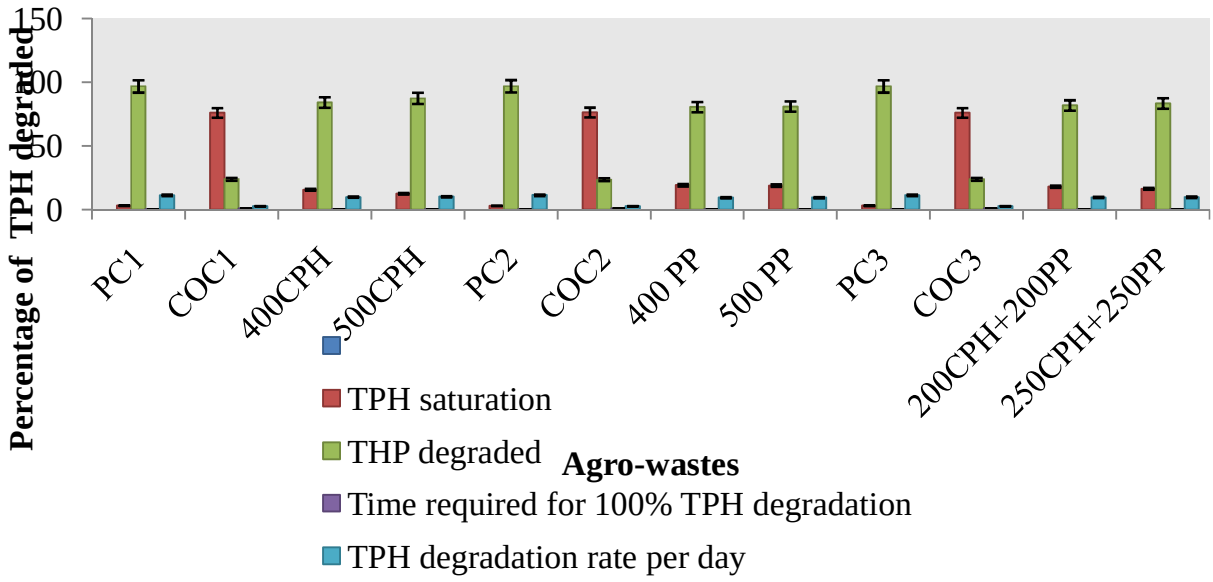

Fig. 1: Total petroleum hydrocarbon (mg/kg) degradation in crude oil polluted soil amended with agro-wastes in 90 days

The result obtained also showed that the amendments possess the degradation potentials in removing or degrading petroleum hydrocarbons, this not in doubt since most of our local farmers used these wastes in increasing the fertility of the soil for improved plants yield. The improved in plants yield can thus be attributed to the high nitrogen and phosphorus content of the plant (Table 1). This observation is in agreement with the findings of [10], who reported that cocoa pod husk increases nitrogen, phosphorus, potassium, calcium, magnesium, pH and organic matter content of the soil, when he evaluated its use in improving soil fertility for the growth performance of coffee seedlings (*Coffee arabica*). [11] also found that cocoa pod husk increases growth of kola (*Cola nitida*) because of it high nitrogen and phosphorus content. The significant reduction in TPH content in the amended soil may be attributed to the high nutrient level especially nitrogen and phosphorus which are essential in stimulating the proliferation of microbial population and activities in soil. [12] asserted that the logic of applying fertilizers as bioremediation strategy was that under pre-spill conditions, crude oil degrading bacteria were limited by the availability of oil as a carbon source. The rate of degradation of TPH in the soil per day was higher in the amended soil than the crude oil polluted control without the amendments. [13] reported that lack of sources of readily utilizable nitrogen and phosphorus might limit growth of microorganisms and hence crude oil degradation in soil. These results suggest that cocoa pod husk and the combination of cocoa pod husk + plantain peels possess bio-utilizing potentials than plantain peels. The Table 1 also shows that soil amended with higher concentration of the agro-wastes were more effective in balancing the nutritional requirement of microorganisms in the polluted soil than the lower concentration. This implies that the percentage hydrocarbon degradation increases with increased in concentration of amendments. It can be concluded that cocoa pod husk, plantain peels and cocoa pod husk + plantain peels (1:1) possess the bio-utilizing potentials in enhancing the degradation of total petroleum hydrocarbon,

however among this amendments and from the result of these study cocoa pod husk at high concentration should be considered as one of the best option in restoring crude oil polluted environment.

REFERENCES

[3] JF Braddock, ML Ruth, PH Catterall, JL Walworth, and KA McCarthy, **1997**, *Environmental Science Technology*. 31, 2078-2084.
[1] RC Dubey, **(2006),** *A Textbook of Biotechnology*, S. Chand & Co. Ram Nagar, New Delhi, 570.
[4] PD Franzmann, WJ Robertson, LR Zappia, and GB Davis, **2002,** *Biodegradation*, 13, 65-78.
[13] CTI Odu, **1981,** *Petroleum Training Institute, Warri, pp.* 143 - 153.
[2] GS Sayler, and S Ripp, **2000**, *Current Opinion of Biotechnology*, 11: 286-289.
[5] K Venkateswaran, and S Harayama, **1995**, *Canadian Journal of Microbiology*, 41:767-778.
[6] CM Jidere, and FOR Akamigbo, **2009**, *Journal of Tropical Agriculture, Food, Environment and Extension,* 8(1) 24 – 31.
[10] EI MoyinJesu, **2008,** *African Journal of Science and Technology*, 9(2): 105 – 112.
[11] CA Ajayi., MA Awodun and SO Ojeniyi, **2007,** *International Journal of Soil Science*, 2(2): 148-153.
[9] AA Ibiene., FA Orji., CO Ezidi, and CL Ngwobia, **2011**, *Nigerian Journal of Agriculture, Food and Environment*, 7(3):1-7.
[12] CP Roger., EB Richard., NG Graham., EH Copper., JG Matthew., RG Lute., LE David., M Vera., JD Senius., LG Keim., RC Russell and S Hinton, **1993**, The effect of bioremediation on the microbial population of oiled beaches in Prince William Sound, Alaska 1993 Oil Spill Conference Proceedings. 469 – 475.
[8] OV Akpoveta., F Egharevba., OW Medjor., KI Osaro and ED Enyemike, **2011,** *Research Journal of Chemical Sciences*, Vol. 1(16), 8-14.
[7] PA Olabisi, AA Olabimpe and JJJ Udeme, **2009**, *AU.J.T.* 1, 34-38.