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Cleaning and Fortification of Degradation of Crude Oil in Polluted Soil Amended with Groundnut HSUK and Chicken Droppings Bioremidiately

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Abstract

Soil pollution is a serious challenge in crude oil polluted areas in Nigeria. The cleaning of this pollutant in soil has been a major source of challenge to the polluting parties, government and residence of those areas. Bio-augmentation is a cost effective and environmentally friendly method to solve polluted soils. Biomass enhance the degradation of crude oil in soil may be an effective and friendly method to reduce or remove totally oil pollution in soil. This study was carried out to evaluate the effectiveness of using groundnut husk and poultry droppings for bioremediation of crude oil polluted soil. Crude oil contaminated soil of 200 g was divided into four portions: A, B, C and D. A was treated with 70g chicken dropping and 30g Groundnut husk, Portion B was treated with 30g of chicken droppings and 70g of groundnut husk. However, C was treated with 50g of chicken droppings and 50g of groundnut husk and D was the control. Degradation of crude oil polluted soil was observed for 42days. The results revealed that the rates of crude oil biodegradation increased gradually with time and maximum amount lost was 81.81% in soil sample "A" containing 70% chicken droppings and 30% groundnut husk, 71.19% degraded in the sample "B" containing equal percentage of chicken droppings and groundnut husk (50%:50%) and 60.77% in the sample "C" containing 70% groundnut husk and 30% chicken droppings after a period of 6 weeks respectively. In concluded chicken droppings showed better degradation of soil than ground nut husk.

Key words: *Crude oil, Bio-augmentation, Groundnut husk, Poultry droppings, Polluted soil*

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1. Introduction

Treatment of oil polluted soil is important to protect human health and the environment in general. The toxicity of crude oil or petroleum products varies widely depending on the biological state of the organisms at the time of the contamination (Obiore and Anyanwu,2009). Bioremediation is a modern method in which the natural ability of micro-organisms is employed for the reduction for the concentration and/or toxicity of various chemical substances, such as petroleum derivatives, aliphatic and aromatic hydrocarbons, industrial solvents, pesticide and metal. Oil contamination with petroleum and petroleum based hydrocarbons in accidental spills has caused critical concerns in environment, however contamination as a result of petroleum leakages in both underground and above ground tanks via industrial transportation processes are hazardous to humans, animals and plants (Adesodun and Mbagwu, 2008; Hamdi et al. 2007). According to Pala et al. (2006) micro-organisms can decompose or transform the chemical substances present in petroleum derivatives. Bioremediation processes, which take advantage of microbial degradation of organic and inorganic substances, can be defined as the use of micro-organisms to remove environmental pollutants of soils, water and sediments. According to Agarry and Ogunleye (2012); Bioremediation technology through the mechanism of

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biodegradation has been recognized to be a valuable alternative for the detoxification and disposal of toxic substances. Furthermore, bioremediation techniques are cost effective and are not toxic to the environment compared to other physical and chemical methods of remediation (Dados et al., 2015).

Olawale et al., 2015 also concluded in their findings that optimization of diesel polluted soil using RSM resulted in 56.568 % diesel removal oil removal via bio-stimulation from optimum predicted parameters of Tween 80 (10.10ml); poultry droppings (41.46 g) and Hydrogen peroxide (1.10ml) respectively. Nwogu et al. (2015) concluded in their study that at the end of 42 days, there was 62.08% decrease in the concentration of TPH in the amended sample compared to 8.15% decrease in the amended goat manure. The spilled oil pollutes soils and made the soils to be less useful for agricultural activities with soil dependent organisms being adversely affected (Siddiqui and Adams, 2002; Lundstedt, 2003). The effects of crude oil on the growth and performance of plants have been reported in many researches. In the Niger Delta region of Nigeria, terrestrial and aquatic systems are the main recipients of crude oil spillage, sometimes resulting in large-scale contamination of these environments. Crude oil contamination in this area is gaining more prominence as a result of increased upstream and downstream activities of the petroleum industry hence increased deleterious effect on the ecology of this area (UN Report, 2010.)

This research was carried out to determine the feasibility of using groundnut husk and poultry dungs to enhance the degradation of crude oil polluted soil.

2. **Materials and Method**

2.1 Sample Collection and Processing

Crude oil was collected from SEPLAT petroleum development company, Sapele Delta State, Nigeria. The chicken droppings were collected from the boiler section of commercial farm, Landmark University Omu-Aran, Kwara state and then sun-dried for 72hrs, ground and stored in polythene bags. The groundnut husk was also gotten from Omu-aran town, Kwara state; Nigeria was sun-dried for 72hrs, ground and stored. The soil was sieved with 5mm mesh size before use.

2.2 Determination of the Physico-chemical Parameters of Soil.

The physico-chemical properties of the soil were determined as follows: Moisture content, Organic matter, soil pH. Digestion was carried out by mixing 1 g of each soil sample with 10 ml of acid digestion the mixture and heated until there was evolution of white fumes. The physicochemical properties of the soil were determined.

The physico-chemical constituents of the chicken droppings and Groundnut husk were also analyzed.

2.2 Bio-augmentation Studies

Two hundred grams (200g) of soil sample each was introduced into four different Erlenmeyer flask labeled A to D. The flask A to C was treated with 20ml of crude oil each, while D had no crude oil and served as the control. The flasks were treated with 10ml of distilled water and the contents were thoroughly stirred and incubated at room temperature, then soil sample in the Erlenmeyer flasks mixed with the crude oil was left for a period of 168hrs to acclimate the micro-organisms in the soil to the oil, during this period the oil contaminated soil was aerated by turning the mixture over at regular intervals.

Flask A was treated with 70g chicken dropping and 30g Groundnut husk; flask B was treated with 30g of chicken droppings and 70g of groundnut husk and then flask C was treated with 50g of chicken droppings and 50g of groundnut husk. However, flask D was set up as the control. Degradation of crude oil was monitored and recorded for 42 days.

2.3 Biodegradation of Crude oil

The amount of crude oil degraded in each soil sample was determined by the weight loss method of Bossert and Bartha (1984). This was done by suspending 3g of soil in 10ml of diethyl ether in a universal bottle and shaken vigorously to extract the oil. The solvent-oil mixture was transferred slowly into a beaker of known weight. This was repeated until all the oil was extracted from the soil. The solvent-oil mixture was exposed at room temperature overnight to allow the solvent to evaporate completely. The new weight of the beaker containing the residual oil was taken and the

percentage of oil degraded was calculated (Ijah and Ukpe, 1999; Ijah and Ukpe 2003). Furthermore, pH of the sample was determined using pH meter on 1:2.5 (w/v) soil/water mixture.

3. Results and Discussion

3.1 Results of Soil Parameters

Soil parameters of the crude oil polluted soil is shown in Table 1 and physio-chemical properties of chicken droppings is as shown in Table 2.

Table 1. Soil parameters for the crude oil polluted soil

Soil Parameters	***Values***
pH *	7.49
Water holding capacity	14±2
Nitrogen content	0.56mg/l
Potassium content	6.4mg/l
Calcium content	18mg/l
Phosphorous content	0.19mg/l

*The soil pH was determined with a pH meter.

Table 2. Result of physio-chemical properties of chicken droppings.

Parameters	***Percentage***
Nitrogen	58%
Potassium	35%
Calcium	3%
Magnesium	1.17%
Phosphorous	2.83%

3.2 Result on Groundnut Husk Analysis

Chemical constituents of groundnut husk are shown in Table 3 and the Proximate analysis of the physio-chemical properties of groundnut husk is shown in Table 4.

Table 3. showing the chemical constituents of Groundnut husk.

Constituent	***Percentage (%)***
Cellulose	57.8
Carbohydrate	25.9
Protein	10.6
Minerals	4.5
Lipids	1.2

Table 4. showing the proximate analysis, the physio-chemical properties of Groundnut husk

Parameters	***Values (%)***
Carbon content	26.0
Ash content	10.30
Moisture content	6.46

The groundnut husk is light brown in colour and has a relatively coarse texture.

3.3 Degradation Results

The results on the degradation of crude oil polluted soil using 70% chicken droppings and 30% groundnut husk in "Sample A, 50% chicken droppings and 50% in "Sample B" groundnut husk 30% chicken droppings 70% groundnut husk in "Sample C" are shown in Tables 5a and 5b.

Table 5a. showing the amount of crude oil degraded in (ml)

DAY	**SAMPLE A 70% Chicken drops + 30% Groundnut husk**	**SAMPLE B 50% Chicken drops + 50% Groundnut husk**	**SAMPLE C 30% Chicken drops + 70% Groundnut husk**
Day 1	0.0353	0.0158	0.0095
Day 3	0.06785	0.0413	0.01465
Day 6	0.10895	0.0607	0.02155
Day 9	0.14235	0.07345	0.0491
Day 12	0.15945	0.0941	0.0693
Day 15	0.1864	0.1118	0.09195
Day 18	0.2083	0.13655	0.1184
Day 21	0.2537	0.16395	0.1536
Day 24	0.27515	0.19405	0.16895
Day 27	0.3129	0.2044	0.1928
Day 30	0.3291	0.22385	0.2131
Day 33	0.34485	0.2487	0.22905
Day 36	0.35415	0.2929	0.25295
Day 39	0.3797	0.3169	0.28945
Day 42	0.40905	0.35595	0.30385

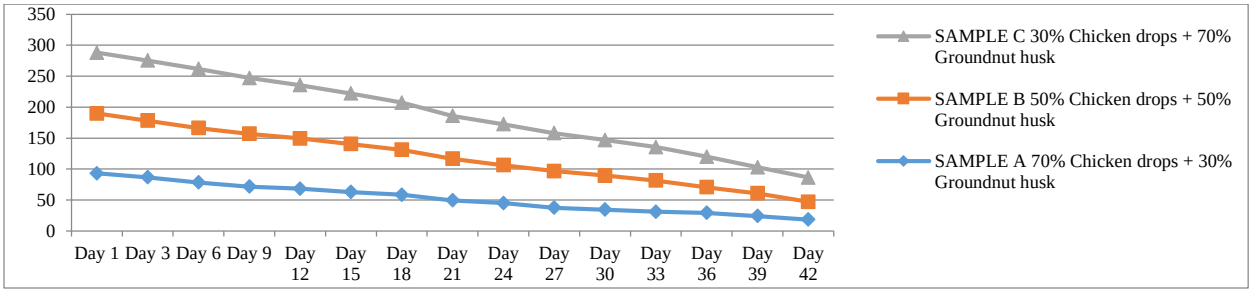

Figure 1a. showing the amount of crude oil degraded in (ml)

Table 5b. Results showing crude oil degraded in (%)

DAY	SAMPLE A 70% Chicken drops + 30% Groundnut husk	SAMPLE B 50% Chicken drops + 50% Groundnut husk	SAMPLE C 30% Chicken drops + 70% Groundnut husk
Day 1	7.06	3.16	1.90
Day 3	13.57	8.26	2.93
Day 6	21.79	12.14	4.31
Day 9	28.47	14.69	9.82
Day 12	31.89	18.82	13.86
Day 15	37.28	22.36	18.39
Day 18	41.66	27.31	23.68
Day 21	50.74	32.79	30.72
Day 24	55.03	38.81	33.79
Day 27	62.58	40.88	38.56
Day 30	65.82	44.77	42.62
Day 33	68.97	49.74	45.81
Day 36	70.83	58.58	50.59
Day 39	75.94	63.38	57.89
Day 42	81.81	71.19	60.77

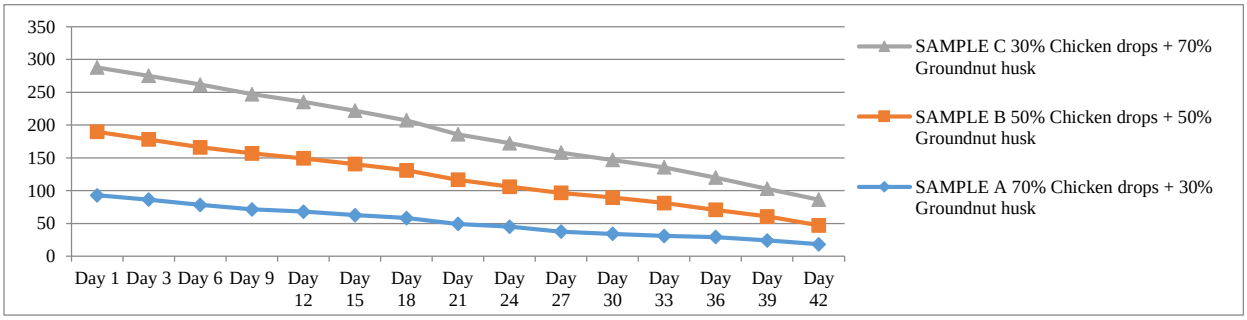

Figure 1b. Results showing crude oil degraded in (%)

3.4 Results of crude oil recovered

The results of crude oil still present in the polluted soil after Bio- augmentation of the crude oil polluted soil using 70% chicken droppings and 30% groundnut husk in "Sample A, 50% chicken droppings and 50% in "Sample B" groundnut husk 30% chicken droppings 70% groundnut husk in "Sample C" are shown in Table 6a and 6b.

Table 6a. Showing the amount of crude oil recovered in (ml)

DAY	SAMPLE A 70% Chicken drops + 30% Groundnut husk	SAMPLE B 50% Chicken drops + 50% Groundnut husk	SAMPLE C 30% Chicken drops + 70% Groundnut husk
Day 1	0.4647	0.4842	0.4905
Day 3	0.43215	0.4587	0.48535
Day 6	0.39105	0.4393	0.47845
Day 9	0.35765	0.42655	0.4509
Day 12	0.34055	0.4059	0.4307
Day 15	0.3136	0.3882	0.40805
Day 18	0.2917	0.3632	0.3816
Day 21	0.2463	0.33605	0.3464
Day 24	0.22485	0.30595	0.33105
Day 27	0.1871	0.2956	0.3072
Day 30	0.1709	0.27615	0.2869
Day 33	0.15515	0.2513	0.27095
Day 36	0.14585	0.2071	0.24555
Day 39	0.1203	0.1831	0.21055
Day 42	0.09095	0.14405	0.19615

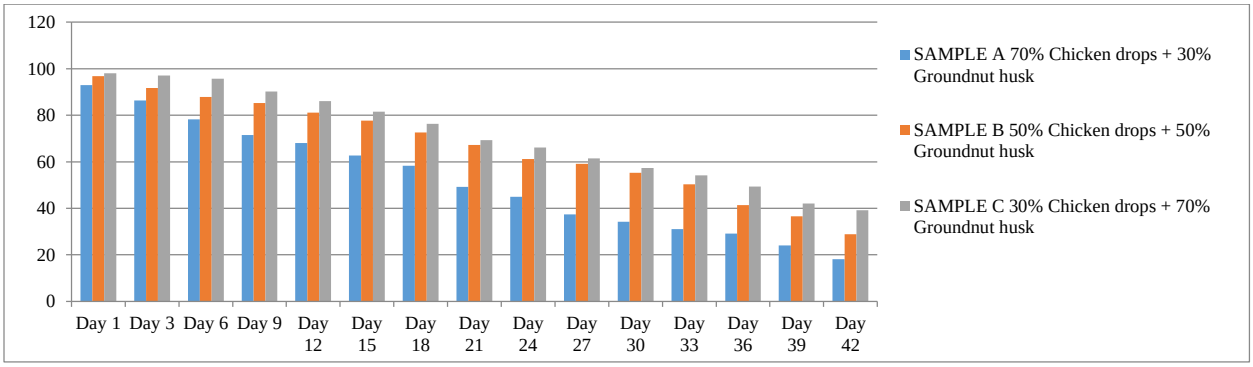

Figure 2a. Showing the amount of crude oil recovered in (ml)

Table 6b. Results showing crude oil recovered in (%)

DAY	SAMPLE A 70% Chicken drops + 30% Groundnut husk	SAMPLE B 50% Chicken drops + 50% Groundnut husk	SAMPLE C 30% Chicken drops + 70% Groundnut husk
Day 1	92.94	96.84	98.10
Day 3	86.43	91.74	97.07
Day 6	78.21	87.86	95.69
Day 9	71.53	85.31	90.18
Day 12	68.11	81.18	86.14
Day 15	62.72	77.64	81.61
Day 18	58.34	72.64	76.32
Day 21	49.26	67.21	69.28
Day 24	44.97	61.19	66.21
Day 27	37.42	59.12	61.44
Day 30	34.18	55.23	57.38
Day 33	31.03	50.26	54.19
Day 36	29.17	41.42	49.41
Day 39	24.06	36.62	42.11
Day 42	18.19	28.81	39.23

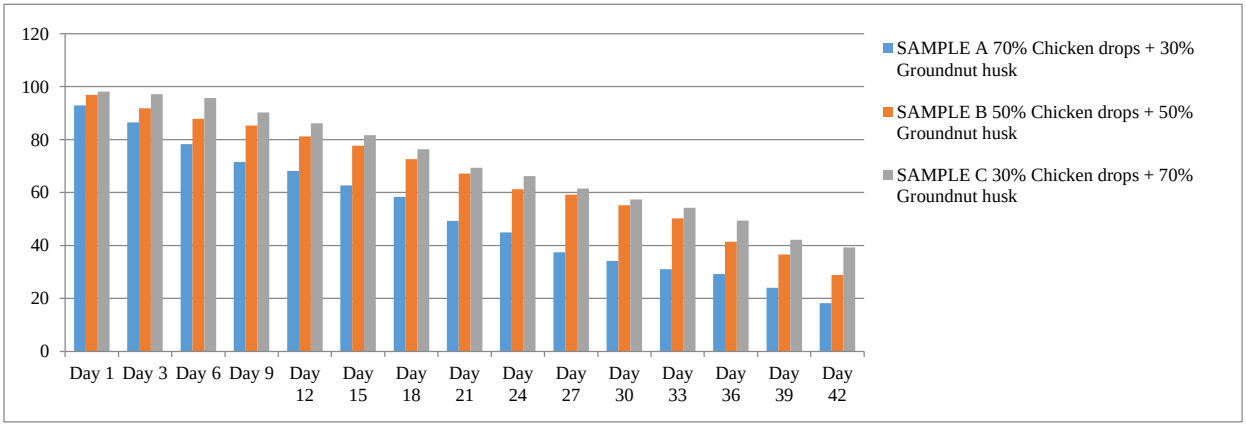

Figure 2b. Results showing crude oil recovered in (%)

3.5 Discussion of Result

The extent of biodegradation of crude oil in the polluted soil portions shown in Tables 5 and 6 showed that the rate of bioremediation of crude oil in the samples differs with the amount of chicken droppings and groundnut husk respectively in each sample. The results revealed that the rates of crude oil biodegradation increased gradually with time and maximum amount lost was 81.81% in soil sample "A" containing 70% chicken droppings and 30% groundnut husk, 71.19% degraded in the sample "B" containing equal percentage of chicken droppings and groundnut husk (50%:50%) and 60.77% in the sample "C" containing 70% groundnut husk and 30% chicken droppings after a period of 6 weeks in all the three portions of soil respectively. The result also shows that more biodegradation has occurred in soil amended with a higher percentage of chicken droppings than the groundnut husk, meaning that chicken dropping is an enhancer of crude oil biodegradation in the soil. This enhancement was due to the nutrients present in

chicken droppings (High level of nitrogen and phosphorous). The results confirmed that the chicken droppings had advantage over groundnut husk in this aspect since the slightly alkaline nature of the soil encouraged the growth of crude oil degrading bacteria and promote biodegradation of the crude oil. These findings agreed with the report of Abioye et al. 2009.

Conclusion

This study demonstrated that groundnut husk and chicken droppings were highly effective in degradation of crude oil polluted soil. The result also showed that more biodegradation occurred in soil amended with a higher percentage of chicken droppings than in groundnut husk, which revealed that chicken dropping showed better degradation of soil than groundnut husk.

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