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CHANGES IN PHYSICOCHEMICAL AND HEAVY METAL PROPERTIES OF SOIL TREATED WITH SPENT ENGINE OIL AND POULTRY MANURE AFTER 12 WEEKS OF GROWING *Phyllanthus urinaria*

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ABSTRACT

Lubricating oil usually contains chemical additives including amines, phenols, benzenes, calcium, zinc, barium, magnesium, phosphorus, sulphur and lead. This study was done to assess the changes in physicochemical and heavy metal properties of soil treated with spent engine oil and poultry manure after 12 weeks of growing Phyllanthus urinaria. It was done in the screen house of the Department of Plant Science and Biotechnology, Michael Okpara university of Agriculture, Umudike (MOUAU). Soil samples at the depth of 0 – 15 cm, spent engine oil and the manure were sourced from the vicinity of MOUAU. Completely randomized designed (CRD) having only one factor (Spent engine oil) at five different levels (Negative control, Positive control, 1%, 3% and 5%). Samples were tested for heavy metal before and after treatment, physical and chemical properties. Data collected was subjected to descriptive statistics to obtain the means and standard deviations. T-test analysis was used to compare the difference in the heavy metal properties of soil and spent engine oil. Means of laboratory analysis were subjected to analysis of variance (ANOVA). Statistically significant means at 5% probability were separated using Duncan Multiple Range Test (DMRT) all the test was done using statistical package for social sciences (SPSS) version 26. From the result, Significant variation ($P<0.005$) was observed between heavy metal soil and spent engine oil samples. The samples were largely acidic at a range of 4.55±0.07 to 6.91±0.01. The percentage sand level ranged from 55.20±0.00% to 75.81±0.01%, the silt was at a range of 11.41±0.01% of 3% to 22.00±0.00%, while clay was observed to be at a range of 6.81±0.01% to 23.00±1.41%. The highest phosphorus and Nitrogen level were observed to be 128.55±6.68 mg/kg and 0.29±0.01 % respectively. Effect of treatment was significant ($P\leq0.05$) to soil nitrogen levels. Organic Matter (OM) ranges from 2.82±0.01 % of positive control sample to 6.10±0.01 % of 1 % sample. Treatment effect was significant ($P<0.05$) on physical and chemical properties of soil. The physical, chemical and heavy metal were significant ($P\leq0.05$) to changes in their concentrations. Higher heavy metal was observed to be in spent engine oil than those of the farm soil. Confirming spent engine oil as soil contaminant. Higher OC, OM was seen in the soil of samples treated with spent engine oil. No traces of Pb and Zn was seen in the plant and soil used after 12 weeks of observation.

KEYWORDS: *Heavy Metal, Manure Physicochemical, Soil, Waste Engine Oil*

INTRODUCTION

Among the nations of the world, Nigeria is a key petroleum producing country and the exploration and exploitation of petroleum has brought so much pollution to the Nigerian environment, especially in the Niger delta region of the country. Nevertheless, in and beyond the Niger delta, pollution incidence emanating from spent engine lubricating oil has been reported to be more widespread and dominant than that of other petroleum products (Odjegba and Sadiq, 2002).

Lubricating oil is produced by vacuum distillation of petroleum and usually contains chemical additives including amines, phenols, benzenes, calcium, zinc, barium, magnesium, phosphorus, sulphur and lead (Lale *et al*., 2014; Kirk *et al.,* 2005). It includes mono and multi-grade lubricating oils from petrol and diesel engines, together with gear oils and transmission fluids (Kirk *et al.,* 2005). Spent auto engine oil is obtained during routine maintenance of automobile and power generating engines; and often indiscriminately disposed into gutters, municipal drainage systems, open vacant plots and farms in Nigeria by auto technicians and allied artisans with workshops on the road sides and open places (Anoliefo and Vwioko, 1995).Various researchers have investigated and reported the ecological toxicity effect of petroleum and spent auto-engine oil; Ahamefule *et al*. (2015) and Agbogidi and Ejemete (2005) noted that oil (petroleum) in soil have deleterious effects on biological, chemical and physical properties of the soil depending on the dose, type of the oil and other factors.

Spent auto-engine oil is known to contain increased amounts of heavy metals compared to the unused oil (Kirk *et al.,* 2005). Okonokhua *et al*. (2007) reported that the proportion and type of these heavy metals present in spent auto-engine oil were dependent on the process generating the waste. These quantitative variations in the chemical properties of spent auto-engine oil and the heterogeneity of soil should expectedly give rise to dissimilarities in research results coupled with the fact that physiological and anatomical differences predispose plants to various degrees of response and response pathways (Lale *et al*., 2014). In this vein, Badrul (2015) reported that oil tends to accumulate in disposal sites in the long-term and may lead to formation of oily scum, which according to Sihag *et al*. (2014), impedes O_2 and water availability to biota and creates anaerobic conditions in the subsoil, which aids the persistence of the oil.

The genus *Phyllanthus* (L.) belongs to a family of flowering plants Phyllanthaceae and consists of more than 1000 species widely distributed in various parts of the world (Mao *et al*., 2016). The species of this genus including trees, herbs and shrubs that are pharmacologically valuable as they contain various bioactive compounds (Calixto *et al*., 1998; Mao *et al*., 2016). Because organic manure distributes nutrients more gradually and acts as a soil conditioner, it is a more environmentally friendly solution (Khudur *et al*., 2018; Hussain *et al*., 2018; Vidonish *et al*., 2016). Moreover, the nutrients in organic manure - nitrogen, magnesium, sulphur, phosphorus, and potassium - support the growth of plants (Khudur *et al*., 2018). A sufficient supply of soil organic matter with high microbial loads is further maintained by organic manure, which also improves the physical and chemical characteristics of the soil (Cheng *et al*., 2016). These permits pollutants made of hydrocarbons to degrade more quickly (Hussain *et al*., 2018; Vidonish *et al*., 2016). Using organic manure is a more environmentally friendly, Kaimi *et al*. (2006) found evidence that adding compost manure to the soil speeds up the removal of Petroleum Hydrocarbons (PHCs), while Obasi *et al*. (2013) found that soils treated with manure and municipal biowaste compost removed 60 - 65% of the hydrocarbons. In contrast to those studies, this one focused on the biostimulation of phytoremediators using poultry manure because it is so common in various habitats and is therefore practically free.

Ifediora *et al*. (2019) stated that increase in percentage spent engine oil in soil caused significant increase in heavy metal properties of soil and concluded that plants grown on such soil showed phyto-extraction potentials of the heavy metals. Hence, the need to further study the phytoextract effect of *Phyllanthus urinaria* and the ameliorative impact of poultry manure on soil treated with waste engine oil on is explained in this current study. This study is aimed at assessing the changes in physicochemical and heavy metal properties of soil treated with spent engine oil and poultry manure after 12 weeks of growing *Phyllanthus urinaria.*

MATERIAL AND METHODS

Study Area

This study was done in the screen house of the Department of Plant Science and Biotechnology, Michael Okpara university of Agriculture, Umudike.

Sample Collection

Plant Sample

Plant samples were collected from the surroundings of Michael Okpara University of Agriculture, Umudike. It was identified by Prof. H. O. Edeoga of the Department of Plant Science and Biotechnology.

Spent Engine Oil

Samples of used engine oil were collected from motor mechanics shops around Michael Okpara university of Agriculture, Umudike.

Soil Samples

Soil samples were collected at the depth of 0 – 15 cm in crop farms around Michael Okpara university of Agriculture, Umudike with the aid of a soil auger.

Research Design

The research design of this experiment was completely randomized designed having only one factor (Spent engine oil). Levels of poultry manure were constant to amount of soil needed. While the spent engine oil were varied in 1%, 3% and 5% to the soil and poultry manure content. Control samples had zero levels of spent engine. Each sample was replicated three times.

Sample Preparation

Soil samples were sieved with 2 mm sieve and was mixed in the following way;

0% of 4000 grams of poultry manure + 4000 grams of farm soil = Negative control
10% of 4000 grams of poultry manure + 3600 grams of soil = Positive control
10% of 4000 grams of poultry manure + 3600 grams of soil + 40 mills of spent engine oil = 1 %
10% of 4000 grams of poultry manure + 3600 grams of soil + 120 mills of spent engine oil = 3 %
10% of 4000 grams of poultry manure + 3600 grams of soil + 220 mills of spent engine oil = 1%
Initial growth data of Leaf number, plant height and stem girth were taken from the plant and three plants were plant in each perforated sack bags filled with the above mentioned treatment.

Laboratory Analysis

Soil pH

Soil pH was determined with the use of pH indicator (3015 Jenway meter).

Phosphorus and Potassium Content

This was determined by the Bray and Kutz method with the use of absorption spectrophotometer.

Total Organic Carbon

Total organic carbon (TOC) was determined by the Walkey and Black wet dichromate oxidation method (Nelson and Sommer, 1996).

Total Nitrogen

Total nitrogen was measured by the macro Kjedahi digestion procedure as described by Bremner and Mulvancy (1982).

Cation Exchange Capacity

Cation exchange capacity (CEC) was determined by the ammonium acetate displacement method.

Heavy Metal Analysis in Soil

Bio-available or soluble concentration of heavy metal was determined by Aqua Regia method. The procedure involved digestion of 3g air dried pre-sieved (<2mm) soil sample with 10 m1 HC1 and 3.5 M1 HNO_3. Every digest batch include two blanks and one international atomic. Energy Agency (IACA) reference sample. The mixtures were left overnight in the digestion block without heating under the switch on fume cupboard. The following day, they were heated with a heater for 2 hours up to 140°C, gradually increasing the temperature to control foaming. Distilled water will be added to cool the digestates and then flittered with whattman No.542 filter paper (pre-washed with 0.5 $MHNO_3$ and wash solution discarded) and topped up to 100 ml with distilled water.The filtrates was analyzed for Cu using atomic Absorption spectrophotometer
The filtrates was analyzed for Fe using atomic Absorption spectrophotometer
The filtrates was analyzed for Pb using atomic Absorption spectrophotometer
And the filtrates was analyzed for Zn using atomic Absorption spectrophotometer (AAS). The values were compared with the widely used normal and critical levels of total concentration of heavy metal for soil by environmental Agencies given by Kabata-pendias and Pendias (1984) the contaminant limit (c), pin dex was calculated as the ratio between the heavy metal content in the soil and the toxicity criteria (the tolerable levels).

Data Analysis and Presentation

Data collected was subjected to descriptive statistics to obtain the means and standard deviations. T-test analysis was used to compare the difference in the heavy metal properties of soil and spent engine oil. Means of laboratory analysis were subjected to analysis of variance (ANOVA). Statistically significant means at 5 % probability were separated using Duncan Multiple Range Test (DMRT) all the test were done using statistical package for social sciences (SPSS) version 26. Results presented in tables.

RESULTS

Comparison of heavy metal concentrations in soil before treatment and raw spent engine oil

The t-test comparison of heavy metal concentrations in soil before treatment and raw spent engine oil is presented in Table I. From the result, Zn in the soil was 0.025 mg/kg while that of spent engine oil was 9.310 mg/kg. Hg in the soil was 0.025 mg/kg while that of spent engine oil was 7.250 mg/kg. Mn in the soil was 0.615 mg/kg while that of spent engine oil was 33.725 mg/kg. Fe was in the soil was 0.465 mg/kg while that of spent engine oil was 14.885 mg/kg. Pb in the soil was 0.000 mg/kg while that of spent engine oil was 119.300 mg/kg. Cu in the soil was 0.000 mg/kg while that of spent engine oil was 10.825 mg/kg. Cr in the soil was 0.035 mg/kg while that of spent engine oil was 17.270 mg/kg. Cd in the soil was 0.045 mg/kg while that of spent engine oil was 14.360 mg/kg. There was significant difference (P≤0.05) in the concentration all the heavy metals in soil and that of spent engine oil.

Table I: T-test comparison of heavy metal concentrations in soil before treatment and raw spent engine oil

	Samples	Mean	STD	SEM	Sig. (2tailed)	FAO/WHO_{PL}
Zn (mg/kg)	Soil	0.025	0.021	0.015	0.000***	50
	Engine Oil	9.310	0.042	0.030		
Hg (mg/kg)	Soil	0.025	0.007	0.005	0.000***	270.00
	Engine Oil	7.250	0.156	0.110		
Mn (mg/kg)	Soil	0.615	0.007	0.005	0.000***	-
	Engine Oil	33.725	0.035	0.025		
Fe (mg/kg)	Soil	0.465	0.007	0.005	0.000***	425.5
	Engine Oil	14.885	0.106	0.075		
Pb (mg/kg)	Soil	0.000	0.000	0.000	0.000***	85
	Engine Oil	119.300	0.127	0.090		
Cu (mg/kg)	Soil	0.115	0.007	0.005	0.000***	36
	Engine Oil	10.825	0.247	0.175		
Cr (mg/kg)	Soil	0.035	0.007	0.005	0.000***	100
	Engine Oil	17.270	0.127	0.090		
Cd (mg/kg)	Soil	0.045	0.007	0.005	0.000***	85
	Engine Oil	14.360	0.283	0.200		

* (p≤0.05), ** (p≤0.01), *** (p≤0.001), NS (not significant) (p>0.05)

The effect of different levels of SEO enhanced with poultry manure on soil physical properties

The analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil physical properties after *P. urinaria* is presented in Table II. From the results, sand ranges from 55.20±0.00% of negative control sample to 75.81±0.01% of positive control and 3% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil sand levels. The silt levels range from 11.41±0.01% of 3% spent engine oil sample to 22.00±0.00% of negative control sample. Effect of treatment was significant (P≤0.05) to soil silt levels. The soil clay levels range from 6.81±0.01% of positive control sample to 23.00±1.41% of negative control sample. Effect of treatment was significant (P≤0.05) to soil clay levels.

Table II: Analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil physical properties after *P. urinaria* harvest

Treatment	Sand (%)	Silt (%)	Clay (%)
- control	55.20±0.00[a]	22.00±0.00[c]	23.80±1.41[d]
+ control	75.81±0.01[d]	17.41±0.01[bc]	6.81±0.01[a]
1%	73.81±0.01[c]	8.41±7.06[a]	12.81±0.01[b]
3%	75.81±0.01[d]	11.41±0.01[ab]	12.81±0.01[b]
5%	71.81±0.01[b]	13.41±0.01[ab]	14.81±0.01[c]
Total	70.49±8.21	14.53±5.53	14.21±5.81
p≤0.05	0.000***	0.043*	0.000***

* (p≤0.05), ** (p≤0.01), *** (p≤0.001), NS (not significant) (p>0.05) – control (soil from farm land)

The effect of different levels of SEO enhanced with poultry manure on soil chemical properties

The analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil chemical properties after *P. urinaria* is presented in Table IIIa. From the results, pH ranges from 4.55±0.07 of negative control sample to 6.91±0.01 of 1% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil pH levels. Phosphorus (P) ranges from 44.37±0.01 mg/kg of positive control sample to 128.55±6.68 mg/kg of negative control sample. Effect of treatment was significant (P≤0.05) to soil phosphorus levels. Nitrogen (N) ranges from 0.11±0.01% of positive control sample to 0.29±0.01% of negative control sample. Effect of treatment was significant (P≤0.05) to soil nitrogen levels. Organic Carbon (OC) ranges from 1.64±0.01% of positive control sample to 3.46±0.01 % of 5% sample. Effect of treatment was significant (P≤0.05) to soil organic carbon levels. Organic Matter (OM) ranges from 2.82±0.01% of positive control sample to 6.10±0.01% of 1% sample. Effect of treatment was significant (P≤0.05) to soil organic matter levels. Calcium (Ca) ranges from 5.11±0.31 Cmol Kg^{-1} of negative control sample to 14.21±0.01 Cmol Kg^{-1} of 1% sample. Effect of treatment was significant (P≤0.05) to soil organic calcium levels.

Table IIIa: Analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil chemical properties after *P. urinaria* harvest

Treatment	pH (H2O)	P (mg/kg)	N (%)	OC (%)	OM (%)	Ca
-control	4.55±0.07[a]	128.55±6.68[d]	0.29±0.01[c]	2.43±0.02[b]	4.18±0.04[b]	5.11±0.31[a]
+ control	6.81±0.01[c]	44.37±0.01[a]	0.14±0.01[ab]	1.64±0.01[a]	2.82±0.01[a]	10.81±0.01[b]
1%	6.91±0.01[d]	67.91±0.01[c]	0.15±0.01[c]	3.54±0.01[e]	6.10±0.01[e]	14.21±0.01[d]
3%	6.71±0.01[b]	56.34±0.01[b]	0.12±0.01[ab]	3.04±0.01[c]	5.22±0.01[c]	12.01±0.01[c]
5%	6.71±0.01[b]	56.84±0.01[b]	0.11±0.01[a]	3.46±0.01[d]	5.96±0.01[d]	12.81±0.01[d]
Total	6.34±0.95	70.80±31.51	0.16±0.07	2.82±0.75	4.85±1.29	10.99±3.31
p≤0.05	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***

* (p≤0.05), ** (p≤0.01), *** (p≤0.001), NS (not significant) (p>0.05)

The effect of different levels of SEO enhanced with poultry manure on soil chemical properties

The analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil chemical properties after *P. urinaria* is presented in Table IIIb. From the results, Magnesium (Mg) ranges from 4.09±0.25 Cmol Kg^{-1} of negative control sample to 10.61±0.01 of 1 Cmol Kg^{-1} spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Mg levels. Potassium (K) ranges from 0.14±0.01 Cmol Kg^{-1} of 5% spent engine oil sample to 0.36 ± 0.00 Cmol Kg^{-1} of negative control sample. Effect of treatment was significant (P≤0.05) to soil potassium levels. Sodium (Na) ranges from 0.10±0.01 Cmol Kg^{-1} of 3% spent engine oil sample to 0.23±0.03 Cmol Kg^{-1} of negative control sample. Effect of treatment was significant (P≤0.05) to soil sodium levels. Exchangeable Acidity (EA) ranges from 0.49±0.01 Cmol Kg^{-1} of 3% spent engine oil sample to 1.40±0.06 Cmol Kg^{-1} of negative control sample. Effect of treatment was significant (P≤0.05) to soil EA levels. ECEC ranges from 11.19±0.66 Cmol Kg^{-1} of negative control sample to 25.72±0.01 Cmol Kg^{-1} of 1 % sample. Effect of treatment was significant (P≤0.05) to soil ECEC levels. Base Saturation (BS) ranges from 87.48±0.23% of negative control sample to 97.50±0.01 % of 1% sample. Effect of treatment was significant (P≤0.05) to soil base saturation levels.

Table IIIb: Analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil chemical properties after *P. urinaria* harvest

Treatment	Mg	K	Na	EA	ECEC	BS (%)
- control	4.09±0.25[a]	0.36±0.00[b]	0.23±0.03[b]	1.40±0.06[e]	11.19±0.66[a]	87.48±0.23[a]
+control	7.21±0.01[c]	0.15±0.01[a]	0.11±0.01[a]	0.73±0.01[c]	18.87±0.13[b]	96.19±0.01[b]
1%	10.61±0.01[e]	0.17±0.01[a]	0.12±0.01[a]	0.65±0.01[b]	25.72±0.01[d]	97.50±0.01[c]
3%	6.41±0.01[b]	0.15±0.01[a]	0.10±0.01[a]	0.49±0.01[a]	19.12±0.01[b]	97.48±0.01[c]
5%	7.61±0.01[d]	0.14±0.01[a]	0.11±0.01[a]	0.81±0.01[d]	21.42±0.01[c]	96.27±0.01[b]
Total	7.19±2.22	0.19±0.09	0.13±0.05	0.81±0.33	19.26±4.99	94.98±4.00
p≤0.05	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***

* (p≤0.05), ** (p≤0.01), *** (p≤0.001), NS (not significant) (p>0.05)

The effect of different levels of SEO enhanced with poultry manure on soil heavy metal properties

The analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil heavy metal properties after *P. urinaria* harvest is presented in Table IV. From the results, Zinc (Zn) ranges from 0.00 ±0.00 mg/kg of the positive control sample to 0.53 ±0.01 mg/kg of the 5% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Zn levels. Mercury (Hg) ranges from 0.00 ±0.00 mg/kg of the positive control, 1%, 3%, and 5% spent engine oil sample to 0.03 ±0.01 mg/kg of the negative control sample. Effect of treatment was significant (P≤0.05) to soil Hg levels. Manganese (Mn) ranges from 0.05 ±0.01 mg/kg of the positive control sample to 0.2.59 ±0.01 mg/kg of the 3% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Mn levels. Iron (Fe) ranges from 0.47 ±0.01 mg/kg of the negative control sample to 3.41 ±0.01 mg/kg of the 5% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Fe levels. Lead (Pb) was not detected in the soil. Copper (Cu) ranges from 0.00 ±0.00 mg/kg of the positive control sample to 1.59 ±0.01 mg/kg of the 1% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Cu levels. Chromium (Cr) ranges from 0.00 ±0.00 mg/kg of the positive control sample and 1 % spent engine oil sample to 0.25 ± 0.01 mg/kg of the 3% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Cr levels. Cadmium (Cd) ranges from 0.00 ±0.00 mg/kg of the positive control sample to 0.23 ±0.01 mg/kg of the 5% spent engine oil sample. Effect of treatment was significant (P≤0.05) to soil Cd levels.

Table IV: Analysis of variance on the effect of different levels of SEO enhanced with poultry manure on soil heavy metal properties after *P. urinaria* harvest

Treatment	Zn (mg/kg)	Hg (mg/kg)	Mn (mg/kg)	Fe (mg/kg)	Pb (mg/kg)	Cu (mg/kg)	Cr (mg/kg)	Cd (mg/kg)
-control	0.03±0.02[a]	0.03±0.01[b]	0.62±0.01[b]	0.47±0.01[a]	-ve	0.12±0.01[b]	0.04±0.01[b]	0.05±0.01[b]
+control	0.00±0.00[a]	0.00±0.00[a]	0.05±0.01[a]	1.05±0.01[b]	-ve	0.00±0.00[a]	0.00±0.00[a]	0.00±0.00[a]
1%	0.13±0.01[b]	0.00±0.00[a]	0.75±0.01[c]	1.19±0.01[c]	-ve	1.59±0.01[e]	0.00±0.00[a]	0.19±0.01[d]
3%	0.33±0.01[c]	0.00±0.00[a]	2.59±0.01[e]	2.77±0.01[d]	-ve	1.27±0.01[d]	0.25±0.01[d]	0.15±0.01[c]
5%	0.53±0.01[d]	0.00±0.00[a]	1.11±0.01[d]	3.41±0.01[e]	-ve	0.53±0.01[c]	0.21±0.01[e]	0.23±0.01[e]
Total	0.20±0.21	0.01±0.01	1.02±0.90	1.78±1.18	-	0.70±0.66	0.10±0.11	0.12±0.09
p≤0.05	0.000***	0.002**	0.000***	0.000***	-	0.000***	0.000***	0.000***
WHO/FAO	50.00	270.00	-	425.50	85.00	36.00	100.00	85.00

* (p≤0.05), ** (p≤0.01), *** (p≤0.001), NS (not significant) (p>0.05)

DISCUSSION

This study was done to examine the effect of organic manure addition on the growth of *P. urinaria* in a waste engine polluted soil. The findings of this study showed that soil from farm lands in Umudike had very low heavy metal (Zn, Hg, Mn, Fe, Pb, Cu, Cr, and Cd) concentration. However, compared to the soil concentrations of heavy metal in raw spent engine oil were higher. Hence, the significant variation ($P \leq 0.05$) existing between the soil heavy metal and spent engine. This therefore confirms that spent engine oil contaminates the soil with toxic heavy metals. Kashif *et al*. (2018) compared fresh and unused engine oil with spent engine and confirmed that higher Pb, Cu, Cr, Ni and Fe were found in spent engine oil. They then concluded that used oil is a threat to the environment due to presence of hazardous substances. Findings of Ugwu *et al*. (2019) in the study phytoremediation of heavy metals in spent engine oil-polluted soil by *Senna alata* L. was similar to the findings of this study which presented Cu, Pb, Zn and Fe concentration in spent engine oil higher than those of the vegetative and non-vegetative soil.

The soil physical parameter were significantly ($P \leq 0.05$) higher than the spent engine oil treated samples. The result of this study was not in agreement with the report of Nwite *et al.* (2016) who stated that physical properties of soil following kerosene oil contamination and poultry manure amendment. Poultry manure amendment had no significant ($P > 0.05$) treatment effect on bulk density of kerosene oil contaminated soil. Hence, sieving of the soil, introduction of spent engine oil and poultry manure affected the soil silt, sand and clay concentration. Higher sand levels, lower silt and clay were observed in the treated soil that the original soil from farm land. This infer that such soil will have lower nutrient holding capacity. Previous studies on hydrocarbon oil contamination of soil by Mbah *et al*. (2009), Nwite (2013) and Ogbohodo *et al*. (2001) reported similar findings. They argued that treatment loosened soil compaction and increased its total porosity, improved aggregate stability as well as moisture content of soil.

Soil samples treated with spent engine oil and the poultry manure treated control (positive control) had higher organic matter, organic carbon, Ca, and Mg hence, this may be connected carbon reach nature of spent engine oil and poultry manure. However, lower concentration of nitrogen, phosphorus and potassium (NPK) which vital for plant growth and development were recorded for spent engine oil treated samples. This was in agreement with the report of Nwite *et al*. (2016) who reported higher OC, Mg, and Ca in hydrocarbon polluted soil. Similarly, this study was in agreement with Osaigbovo *et al*. (2012) who reported Nitrogen, phosphorus and potassium (NPK) in soil treated with spent engine oil and amended with fertilizer.

Heavy metal levels in the soil for both treated and untreated samples were below the world health organization standards. However, trace levels of metals seen in the soil may pose toxic threat, if through food chain it gets into animal or human system. Stout *et al.* (2018) in the study metal concentrations in used engine oils: relevance to site assessments of soils reported that used engine oils contain metals, which upon entering soils may pose risks to human health or the environment. Soil heavy metal were basically low in control sample and were higher in waste engine oil treated samples. This confirms that spent engine oil remains a soil toxicity channel in soil heavy metal toxicity. Effect of difference in treatment was significant ($P<0.05$). Hence, increase in spent engine oil percentage to soil was seen to cause increase in available metals. In this current study soil *P urinaria* completely remediated Pb in the soil 12 weeks after. Hence, Pb was not detected in the soil but was in high concentration in the spent engine oil analysis.

CONCLUSION

The physical, chemical and heavy metal were significant ($P\leq0.05$) to changes in their concentrations. Higher heavy metal was observed to be in spent engine oil than those of the farm soil. Confirming spent engine oil as soil contaminant. Higher OC, OM was seen in the soil of samples treated with spent engine oil. No traces of Pb and Zn was seen in the plant and soil used after 12 weeks of observation. This indicates the potentials of *P urinaria* in phytoremediation. Reduction in heavy metal properties of soil after harvest of plants proves the efficacy of poultry manure enhancer to *P urinaria* in phytoextraction.

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