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RESEARCH ARTICLE

EFFECTS OF SPENT ENGINE OIL ON SOIL PHYSICOCHEMICAL PROPERTIES OF AND MICROORGANISMS (BACTERIA)

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ABSTRACT

This study aimed at investigating the impact of spent engine oil on soil physicochemical properties and the microorganisms of the soil. Two nursery beds of 5m distance from each other was created at agricultural research farm land, University of Maiduguri, Nigeria and 250ml volume of spent engine oil was added to the first nursery bed for the period of 4weeks (application was three times per week) and 500ml of the spent engine oil was added to the second nursery bed for the same duration. A control soil experiment was equally set up and treated with normal water. The physicochemical properties and bacteria of the respective soils were determined by standard methods. The soil pH was slightly acidic, there was no difference with the control, and the electrical conductivity was low in both the control as well as the contaminated soil samples. There was an increase in organic matter, organic carbon, sodium and potassium content in the soil compared to control. There was phosphorus decreased in nitrogen as well as magnesium, phosphorus decreases at the top but increased at depth in the contaminated soil samples. The bacteria identified in the control at the top soil (*Proteus species*, *Corynebacterium species*, and *Bacillus subtilis*) and depth (*Bacillus subtilis*, *Staphylococcus epidermis*, *Corynebacterium species*, and *Proteus species*), reduced with the application of the spent engine oil at 250ml volume (to *Corynebacterium species* and *Bacillus subtilis*) both at top and depth and at 500ml volume of spent engine oil, *Corynebacterium species* and *Bacillus subtilis* occurred at top and *Escherichia coli*, *Corynebacterium species*, and *Bacillus subtilis*, at depth. This may be due to the increased application of spent engine oil which was not present in the control and soil contaminated with 250ml volume of spent engine oil. This means that spent engine oil may have a unique property that triggers the occurrence of E. coli. It can therefore be concluded that the spent engine oil altered the physicochemical properties and bacteria of the soil.

INTRODUCTION

Engine oil is a complex mixture of hydrocarbons and other organic compounds including some organo-metallic constituents (Butler and Manson, 1997) that is used for lubrication of various internal combustion engines. The main function is to reduce wear on moving parts; it also cleans, inhibits corrosion, improves sealing and cools the engine by carrying heat away from moving parts (Klamman, 1984). Engine oil is derived from petroleum-based and non-petroleum-synthesized chemical compounds. Motor oils today are mainly blended by using base oils composed of hydrocarbons, polyalphaolefin (PAO) and polyinternal olefins (Corsico *et al*., 1999) thus the organic compounds consisting entirely of carbon and hydrogen. The base oils of some high performance engine oils however contain up to 20% by weight of esters (Schlosberg *et al*., 2001).

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Spent engine oil or spent lubricant is usually obtained after servicing and subsequently draining from automobile and generator engines (Anoliefo and Vwioko, 2001). Much of this oil is poured into the soil, gutters, water drains, open vacant plots and farms. In Nigeria, this is a common occurrence and this is mostly done by automatics and allied artisans with workshops on roadsides and open places. Agbogidi (2011) reported that spent oil is the commonest soil contaminant in the rural areas of Nigeria where agriculture/farming forms the mainstay of the rural inhabitants. Spent engine oil, when present in soil creates an unsatisfactory condition for life in the soil which is due to the poor aeration it causes in the soil, immobilization of soil nutrients and lowering of pH. Various contaminants such as used engine oil and heavy metals have been found to alter soil biochemistry, which includes alteration in soil microbial properties, pH, oxygen, and availability of nutrients (Atuanya, 1987). Oil pollution of soils leads to build up of essential elements such as carbon, magnesium, lead, zinc, iron, cobalt, and copper in the soil and the eventual translocation in plant tissues (Vwioko *et al*., 2006). The use of oil contain some toxic materials including heavy polycyclic

aromatic hydrocarbons although some heavy metals at low volumes are essential micronutrients for plants, but at high volumes they may cause metabolic disorders and growth inhibition for most of the plant species (Fernandes and Henriques, 1991) yields and general performance of plants (Agbogidi and Egbuchua, 2010). From the above, this study was carried out to assess the effect of spent engine oil contamination on soil bacteria, physicochemical properties and the elemental composition of the soil.

MATERIALS AND METHODS

Spent engine oil used for this study was obtained from *TOTAL* Filling Station along Bama Road, Maiduguri, Borno State. The study site was situated at the Agriculture Research Farm, University of Maiduguri, Borno State. Two nursery beds (created 2 by 2 meters) of sandy loam soil contaminated with spent engine oil at different volumes of 250ml and 500ml. The nursery beds contamination of spent engine oil was done by irrigating the soil with the appropriate oil volume with water using a watering can. Only water was used to irrigate the control nursery bed (located five meters away from the two contaminated nursery bed). Soil treatment/irrigation lasted for four weeks (3 times per week). At the end of the four weeks, soil samples were collected from each bed by digging up to about 6cm deep (top) and 12cm deep (depth) with hand trowel and transferred directly into clean containers for bacterial and physicochemical analysis. Soil pH was measured using the Bechman Zeromatic pH meter as specified by the manufacturer. The electrical conductivity of the soil samples were measured using conductivity meter. Total nitrogen was determined by the Kjeldahl method (Black, 1965). Flame photometry was used in determining the sodium and potassium ions. Calcium and magnesium were measured by titration methods. Available phosphate was determined as described by Mehlich (1984). Organic carbon was determined according to the method of Walkey and Black (1934). Bacteria present in soil samples were isolated by serial dilution agar plate method. Organisms were identified by their morphological and biochemical characteristics as described in Berger's manual of determinative bacteriology as revised by Bchannan and Gibbons, (1974).

RESULTS AND DISCUSSION

The physicochemical analysis carried out in this study before and after treatment with spent engine oil, showed that there was no much difference in the soil pH between the control and the contaminated soil samples (Table 1). Soil pH is a major factor influencing the availability of elements in the soil for plant uptake (Marschar, 1995). The electrical conductivity increased compared to the control both at top and depth. However, the electrical conductivity for all the soil samples was below 200 µs/cm. That means there were no enough nutrients available to the plant and perhaps showed microbial activities. The nitrogen content of the contaminated soil dropped compared to the control, this decrease in nitrogen content of the contaminated soil sample may be attributed to the fact that, in the presence of contamination in soil, the supply of carbon significantly increases and the availability of nitrogen becomes limited (Atlas, 1985). The phosphorus content reduced in the contaminated soil sample compared to the control. This agrees with the findings of Ogbogghodo *et al*. (2004). Sodium and potassium increased considerably in the presence of spent engine oil in the contaminated soil sample. Calcium content in the contaminated soil reduced at the top but increased at the depth soil compared to the control.

Table 1. Physicochemical parameters of the soil samples

Parameter	Control		250ml SEO contaminated soil		500ml SEO contaminated soil	
	Top (0-6cm)	Depth (6-12cm)	Top (0-6cm)	Depth (6-12cm)	Top (0-6cm)	Depth (6-12cm)
pH (1:25)	6.94	6.87	6.61	6.66	6.59	6.15
EC (µs/cm)	56.20	36.60	94.30	86.70	66.80	44.90

Key; SEO= spent engine oil, EC= electrical conductivity

Table 2. Elemental compositions of the soil samples

Parameter	Control		250ml SEO contaminated soil		500ml SEO contaminated soil	
	Top (0-6cm)	Depth (6-12cm)	Top (0-6cm)	Depth (6-12cm)	Top (0-6cm)	Depth (6-12cm)
N	0.196	0.224	0.140	0.168	0.154	0.168
P	10.52	5.93	3.75	7.65	6.87	6.56
K	1.14	1.14	6.65	11.02	5.50	13.18
Na	18.18	18.40	18.92	18.36	18.57	19.14
Ca	0.68	0.51	0.50	0.55	0.58	0.58
Mg	0.87	0.45	0.53	0.45	0.52	0.61
%OC	0.264	0.284	0.361	0.165	0.297	0.297
%OM	0.456	0.429	0.624	0.285	0.514	0.514
CEC	3.20	3.92	4.75	5.52	4.74	6.31

Key: OC= organic carbon, OM= organic matter, CEC= cation exchange capacity, SEO= spent engine oil.

Table 3. Bacteria identified from the soil samples

Sample	Control	250ml SEO contaminated soil	500ml SEO contaminated soil
Top (0-6cm)	*Proteus spp*, *Corynebacterium spp*, and *Bacillus subtilis*	*Corynebacterium spp*, and *Bacillus subtilis*	*Corynebacterium spp*, and *Bacillus subtilis*
Depth (6-12cm)	*Proteus spp*, *Corynebacterium spp*, *Staphylococcus epidermis*, and *Bacillus subtilis*	*Corynebacterium spp*, and *Bacillus subtilis*	*Escherichia coli*, *Corynebacterium spp*, and *Bacillus subtilis*

Key: SEO= spent engine oil

There was decrease in the available magnesium content in the spent engine oil contaminated soil samples (Table 2). An increase in the organic carbon and organic matter was observed in contaminated soils. This may have resulted from the application of the spent engine oil. Crude oil, from which spent engine oil was derived from contained principal elements such as oxygen, nitrogen, and other than hydrogen and carbon (Selly, 1998) and also probably due to the addition of carbon already present in the soil. The cation exchange capacity (CEC) increased considerably with the increase in spent engine oil compared to control (Table 2). The microbial assay carried out on the soil sample before and after treatment with spent engine oil showed the presence of *Proteus spp*, *Corynebacterium spp*, and *Bacillus subtilis* at the top soil sample and the presence of *Proteus spp*, *Corynebacterium spp*, *Staphylococcus epidermis*, and *Bacillus subtilis* at the depth soil sample. In the sample contaminated with 250ml volume of spent engine oil at the top and depth soil sample, *Proteus spp* disappeared due to the application of the spent engine oil and showed the presence of *Corynebacterium spp*, and *Bacillus subtilis*. This may mean *Corynebacterium spp*, and *Bacillus subtilis* are capable of utilizing hydrocarbon. At 500ml volume of spent engine oil contaminated site at the top *Corynebacterium spp* and *Bacillus subtilis* were still present and at depth, *Escherichia coli*, *Corynebacterium spp*, and *Bacillus subtilis* were present.

Escherichia coli showed up at the depth of 500ml volume indicating that spent engine oil may have a unique relationship with the *Escherichia coli*. This agrees with the findings of Bhatacharya *et al*. (2002) who stated that hydrocarbons including polycyclic aromatic hydrocarbons have been long recognized as substrates supporting microbial growth. Generally, the results obtained revealed that spent engine oil at the volumes used altered the physicochemical properties and bacteria of the soil. It has a slight effect on the soil structural classes (makes the soil condition unsatisfactory for plants) and as well leads to occurrence of *Escherichia coli*. Spent engine oil affected the soil aeration in the contaminated site, previous assertion by Bossert and Bartha (1984) revealed that crude oil readily penetrate the pore space of terrestrial vegetation and land following any spill with heavier friction which may block the pore of the soil particles. Spent engine oil is likely to have similar effect on land. Spent engine oil reduced phosphorus, nitrogen, calcium, and magnesium content of the soil. The low phosphorus and nitrogen content and increased organic content observed in this study agreed with the results of Ogiri *et al*., 2001; Gbaruko *et al*., 2005; and Benka-Coker and Ekundayo, 1995, who all reported similar effects.

Conclusion

The result of this study revealed that contamination of vegetative soil with spent engine oil altered the physicochemical properties and bacteria of the soil. It therefore renders the soil structural classes unproductive for crops.

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