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Determination of Physicochemical Properties of Spent Engine Oil Polluted Soils Sites in Bali and its Environs, Taraba State, Nigeria

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ABSTRACT

The present study aimed to investigate the physicochemical properties of spent engine oil polluted soil sites in Bali and its Environs, Taraba State, Nigeria. The result revealed the particle size distribution show that polluted soils were categorized by relatively high sand content ranging from 30.2 – 80.2 %, and an average mean 58.08 %; silt 15.3-65.1 % (34.88 %) and clay 3.0-11.6 % (7.04 %). The textural descriptions of soils from the study sites were mostly sandy loam. The soil samples from Bali 1, Bali 2, Maihula, Garba Chede and Gazabu were of varying texture; sandy loam, loamy sand, sandy loam, silt loam and loamy respectively. The physicochemical properties of the soil samples show the temperature ranges from 31.33 - 31.58 0C with Garba Chede and Bali 2 having the lowest and highest respectively. The p^H range between 5.6 - 6.2 with Bali 1 and Bali 2 having the lowest and highest respectively. The result shows that the soil samples are all slightly acidic. Samples from Bali 2 and Bali 1 were discovered to be the highest with 69.5% and least with 68.1% respectively for humidity. The electrical conductivity of the soil range is 1027.25 µs/cm and 474.0 µs/cm with Garba Chede and Gazabu having the highest and lowest respectively. The amount of total dissolved solid range is 14.5 – 30.0 mg/L making Gazabu have the highest lowest and Garba Chede the highest. Bali 1 and Bali 2 have the Cu range values of 3.500 and 1.080 ppm, showing the highest and lowest respectively. Pb and Cr were not detected in the samples.

INTRODUCTION

Soil plays an important role in upholding the equilibrium of the earth's ecosystem but contamination by petroleum products is a recent problem in some countries in the world where petroleum is their source of revenue. The harmful effects of these petroleum products and auto-mechanic workshop activities on humans and the soil ecosystem as well as arable lands, are due to poisonous components (Nesme *et al.*, 2014: Ujowundu *et al.*, 2011). The petroleum fuels are composed of saturated hydrocarbon, aromatic hydrocarbon and non-hydrocarbon compounds (Lin *et al.*, 2010), and traces of nitrogen, phosphorus and organic matter, which are easily absorbed in the soil surface (Wang *et al.*, 2009).

The alteration of crude oil into petrochemicals, including gasoline and lubricating oil for use by automobiles, has led to worldwide contamination of air, water and soils are dangerous for human and ecosystem health (Ahmad *et al.*, 2016; Patil *et al.*, 2004; WHO, 2014). Soil plays a vital role in maintaining the balance of the earth's ecosystem (Nesme *et al.*, 2014), but contamination by petroleum products is a current problem in several countries in the world. The deleterious effects of these petroleum products on the soil ecosystem are due to toxic components (Ujowundu *et al.*, 2011). The detrimental effects of auto-mechanic workshop activities on humans and soils, as well as arable lands, have been reported in Nigeria (Nkwoada *et al.*, 2018; Oluwajiose *et al.*, 2015; Demie, 2015). Studies have revealed that hydrocarbon with benzene ring are quite complex, insoluble in water and are noteasily removed from the soil due to low boiling of the hydrocarbons (Guo *et al.*, 2016; Bayat, 2015). The petroleum hydrocarbon affects the soils hydrophobicity and moisture holding capacity (Balks *et al.*, 2002); permeability and porosity of soils (Wang, *et al.*, 2009; He et al, 1999); fungal and bacterial growths, and have higher metal enrichment (Zhang *et al.*, 2018); soil physicochemical properties (Wan, 2014; Ezeigbo *et al.*, 2013; Nwaogu and Onyeze, 2010), and eventually damage the soil environment (Dindar *et al.*, 2015). The bulk density, porosity, and nutrient levels: nitrogen, carbon and phosphorus absorption of crops in hydrocarbon contaminated soils have been affected (Liao et al, 2015; Kumar & Rao, 2012). Most auto-mechanic workshops and garages in developing countries do not have regulatory codes for their operations, especially the disposal of their used oil and other wastes (Kpakpavi, 2015). The soils in these operational sites are major repositories of different wastes and pollutants generated from activities of these shops, hence the natural soils in mechanical garages are mainly contaminated with residual polycyclic aromatic hydrocarbons and non-hydrocarbons. Garage and auto-mechanical workshops are also a source of a hazardous pollutant for soil resource, causing deterioration of quality of soil and disruption of normal function of soil resources. Most of the investigations carried out at some of these sites focused on the effects of heavy metal pollution of soils from spilled oils and other contaminants on the physicochemical properties of the soils.

The harmful effects of auto-mechanic workshop activities on humans and soils, as well as arable lands, have been reported in Nigeria (Nkwoada *et al.*, 2018; Oluwajiose *et*

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al., 2015; Demie, 2015). The transforming crude oil into petrochemicals, including gasoline and lubricating oil for use by automobiles, has led to worldwide contamination of air, water and soils are dangerous for human and ecosystem health (Ahmad *et al*., 2016; Patil *et al*., 2004; WHO, 2014). The petroleum fuels are composed of saturated hydrocarbon, aromatic hydrocarbon and nonhydrocarbon compounds (Lin *et al*., 2010), and traces of nitrogen, phosphorus and organic matter, which are easily absorbed in the soil surface (Wang *et al*., 2009). The use by automobiles also led to changes in the physicochemical properties by spent engine oil. Hence this justifies the research "determination of physicochemical properties of spent engine oil polluted soils sites in Bali and its Environs, Taraba State, Nigeria.

MATERIALS AND METHOD

Site and Location of the Study Area

The study areas are five (5) soils sites contaminated with spent engine oil: Bali 1, Bali 2 , Gazabu, Maihula and Garba Chede of Bali Local Government Area, Taraba State and the sites were mainly automotive mechanic garages. Bali Local Government Area (LGA) of Taraba State, Nigeria. Bali Local Government Area lies between latitude $7^0$46 N and $7^0$54 N of the equator and longitude 10 ^{0}30 E and 11^0 00 E of the prime meridian (Topographic sheet, 1968). This falls within the dry guinea savannah.

Sample Collection

Soil samples (50g) from spent engine oil polluted sites were collected from various automotive mechanic garages at Bali 1, Bali 2, Gazabu, Maihula and Garba Chede of Bali Local Government Area, Taraba State. Clean plastic containers were used for samples collection, samples were then be placed in different packs and transported to the laboratory for analysis as described by Owuama (2016).

Physicochemical Analysis of Spent Engine Oil Polluted Soil

Physicochemical analyses that would be carried out on the soil samples would include: Soil pH, Moisture content, Humidity, Electrical conductivity, Total dissolved solids, porosity, particle size distribution and texture (Muhammad 2014). The pH, moisture content, humidity, total dissolved solids and conductivity of the soil samples were determined using a pH meter (Jenway 3051), moisture meter (nnn), humidity meter (HTC-2) total dissolved solid meter (HI-96301) and conductivity meter (DDS-307) with a cell constant of 1.2 respectively in 1:1 soil solution in distilled water in accordance with the manufacturer's directions and a thermometer of a range 0^0C – 100^0C (Cowan and Steel, 2004).

The porosity, which represents the total amount of pore spaces present in soil inorganic was determined. Each composite soil sample was analyzed for the relative proportions of mineral soil separates namely; sand, silt, and clay using the sieve analysis method of ASTM D6913/D6913M-17, with slight modification. Selected sieve sizes for sand, silt, and clay with diameter ranges of 0.05 – 2.0 mm, 0.002 – 0.05 mm< 0.002 mm, respectfully were used in the analysis. The sieves were tightly packed such that the one with the largest openings was at the top and the smallest at the base and 500 g of oven-dried soil sample were poured into the top sieve and covered. The stacked sieves with the oven-dried soil were strongly agitated in a mechanical shaker for about 15 minutes. Each sieve was removed separately and the soil portions (sand, silt, and clay) retained were weighed and expressed in percentage of the total weight of the initial soil sample used. The textural classes were determined using the USDA textural triangle.

Mineral Composition Analysis

The mineral composition in oil polluted soil would involve the use of atomic absorption spectrophotometer for the presence of Lead (Pb), Chromium (Cr), and Copper (Cu) as described by AOAC, 2005. The heavy metal content of the soil was determined using atomic absorption spectrophotometer (AA320N) following digestion with nitric acid and extraction of the soil samples.

RESULTS AND DISCUSSION

Table 1: Mean particle size distribution and textural designations of soils

	Sand %	Silt %	Clay %	Textural Class
Bali 1	73.1	15.3	11.6	Sandy loam
Bali 2	80.2	12.7	7.1	Loamy sand
Maihula	72.6	24.4	3	Sandy loam
Garba Chede	30.2	65.1	4.7	Silt loam
Gazabu	34.3	56.9	8.8	Loamy

Table 2: Physicochemical Analysis of Spent Engine Oil Polluted Soil

Parameter	Bali 1	Bali 2	Maihula	Garba Chede	Gazabu
Temp (^{0}C)	31.35	31.58	31.35	31.33	31.38
pH	6.2	5.6	6	5.8	6.1
Humidity (%)	68.5	69.5	69.25	69	68.75
EC (µs/cm)	543.25	504	905.25	1027.25	474

TDS (mg/L)	16.5	15	25	30	14.5
Pb (ppm)	0	0	0	0	0
Cr (ppm)	0	0	0	0	0
Cu (ppm)	3.5	1.08	2.76	1.2	2.04

Key: EC= Electrical conductivity, TDS = Total dissolve solid, Cu = Copper, Pb = Lead, Cr = Chromium

The particle size distribution (Table 1) shows that polluted soils were categorized by relatively high sand content ranging from 30.2 – 80.2 %, and an average mean 58.08 %; silt 15.3-65.1 % (34.88 %) and clay 3.0-11.6 % (7.04 %). The textural descriptions of soils from the study sites were mostly sandy loam. The soil samples from Bali 1, Bali 2, Maihula, Garba Chede and Gazabu were of varying texture; sandy loam, loamy sand, sandy loam, silt loam and loamy respectively.

The physicochemical properties of the soil samples (Table 2) analysed show the temperature ranges from 31.33 - 31.58 ^{0}C with Garba Chede and Bali 2 having the lowest and highest respectively. The pH range between 5.6 - 6.2 with Bali 1 and Bali 2 having the lowest and highest respectively. The result shows that the soil samples are all slightly acidic. Samples from Bali 2 and Bali 1 were discovered to be the highest with 69.5% and least with 68.1% respectively for humidity.

The range values of electrical conductivity of the soil is 1027.25 µs/cm and 474.0 µs/cm with Garba Chede and Gazabu having the highest and lowest respectively. The amount of total dissolved solid range is 14.5 – 30.0 mg/L making Gazabu have the highest lowest and Garba Chede the highest. Bali 1 and Bali 2 have the Cu range values of 3.500 and 1.080 ppm, showing the highest and lowest respectively. Pb and Cr were not detected in the samples.

CONCLUSION

This research revealed that the that polluted soils show the particle size distribution were categorized by relatively high sand content ranging from 30.2 – 80.2 %, and an average mean 58.08 %; silt 15.3-65.1 % (34.88 %) and clay 3.0-11.6 % (7.04 %). The textural descriptions of soils from the study sites were mostly sandy loam. The physicochemical properties of the soil samples investigated show the temperature ranges from 31.33 - 31.58 ^{0}C and the p^H range between 5.6 - 6.2. The result revealed that the soil samples are all slightly acidic and humidity of 69.5% - 68.1%. The range values of electrical conductivity of the soil is 1027.25 µs/cm and 474.0 µs/cm. The amount of total dissolved solid range is 14.5 – 30.0 mg/L, the Cu range values of 3.500 and 1.080 ppm, Pb and Cr were not detected in the samples.

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