EFFECT OF SPENT LUBRICATING OIL ON FARMLAND: A CASE STUDY OF MECHANIC VILLAGE SOIL, ABAK ROAD, UYO, AKWA IBOM STATE, NIGERIA

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ABSTRACT

The study investigated the effect of waste lubricating oil spillage on the soil of mechanic village, Abak Road in Uyo metropolis, Akwa Ibom State, Nigeria. The objectives of the study examined the effect of waste lubricating oils on the soil and the level of toxicity caused by spent oil in the study area. The parameters studied were: PAHs, Pb, Cr, N, P, pH, CEC and particle size. It was found that spilled lubricating oil on the soil in the study area was 38 times greater in spent oil of PAHs compared to the normal soil (control soil) showing high level of toxicity by petroleum products. There was a slight reduction of Nitrogen (0.09 ± 0.006 vs 0.11 ± 0.00) mg/100g followed by the reduction of phosphorus by the contaminated soil (9.89 ± 0.03 vs 16.36 ± 0.005) mg/100g. The pH value was predominantly acidic. CEC was low, thus implying low soil fertility caused by the polluted to read 1.986 ± 0.20 against the control soil of 0.01 ± 0.00. Hg was slightly higher which do not show any serious negative effect, particle size shows that the soil is loamy. It was obvious that the soil spilled with lubricating oil on the study area is toxic and capable of damaging the soil structure, reduce soil quality and health effect on animals including man. It was recommended that environmental workshops be organized for awareness and a good disposal system be designed and collected for recycling and reinjection.

KEYWORDS: Spent Lubricating Oil, Farmland, Mechanic Village Soil, Abak Road, Uyo, Akwa Ibom State and Nigeria.

INTRODUCTION

In Nigeria it is a common practice by automobile mechanics to dispose waste petroleum products especially spent engine oil (SEO) into gutters, waste drains, open vacant plots and farmlands. These waste oils are considered hazardous waste and have some dangerous properties. They may cause both short term and long-term effect if they are allowed to enter the environment through water ways or soil. (Abioye OP, Agamuthu P, Abdul Aziz AR, 2014)

Once an engine oil is drained off, it is polluted, and no longer clean because it has reacted with other materials including dirty particles and other chemicals when the engine is working, has changed its original form to become SEO. As engine oil is used in automobile it picks up a number of other compounds arising from engine wear. Some of these include: iron, Steel, Copper, Zinc, Lead, barium, Cadmium, Sulphur, dirt and ash. Originally motor oil contains additives that facilitates its effectiveness. As the mechanical process incorporates the additives, contaminants and other compound over time in the chemical reaction becomes a waste that is drained off the engine of the car or generator. This used motor oil if not properly disposed can after servicing and subsequently drained from an automobile can constitute a pollutant (Abioye *et al* 2021). Much of these is poured into the soil. The content of the used oil can contain relatively large number of hydrocarbons including the highly toxic polycyclic aromatic hydrocarbons (Wang *et al*, 2000). Also, most heavy metals such as Hb, Pb, Al, N, and Fe which are below detection in unused Lubricating Oil have been reported by Tangi (2014) to give high values (PPM) in used oil. These heavy metals may be retained in solid in the form of oxides, hydroxides, carbonates, exchangeable cations, and or bound to organic matter in the soil (Adewole, *et al.,* 2014). However, the level of contamination can be determined by the kind of soil particles and the prevalent environmental conditions that are reflected by the soil-water (Przemystlowe, 2019). Research has it that SEO have shown a marked change in properties as it occurs in the soils that are contaminated with petroleum-hydrocarbons. These goes further to affect the physical, chemical and microbial properties of the soil. The pollution by oil of such soils can alter the properties of the essential (organic, C, P, ca, mg) and the non-essential (Mg, Pb, Zin, Fe, CoCu) elements in soil. It leads to a buildup or excessiveness of the amount required by the soil and the eventual translocation in plant tissues (Vwioko *et al*, 2014). When heavy metals are at low concentrations they become essential micronutrients for plants uptake, but when the concentration becomes high, they constitute metabolic disorders and growth inhibition for a lot of plant species (Adelekan, B. *et al.,* 2015). Anyway, as one's man's meat becomes another's, so do plants respond differently to pollutant. (Karlen and Douglas L., 2015) pointed out that soil pollution arising from spent engine oil cause poor growth in plants, as it became serious for tomato (Capsicum annum L), maize (Zeamays L), and a lot more cereals in Nigeria and other African Countries.

Waste oils cause great damage to soil in following ways:

i) It creates unsatisfactory condition for life in the soil
ii) It causes poor aeration
iii) It causes immobilization of soil nutrients and
iv) It lowers the soil pH (Ugoh and Moneke, 2017).

Waste lubricating oil contains a mixture of different chemicals including low to high molecular weight (C_{15}-C_{21}) compounds, lubricants, additives and decomposition products and heavy metals which have been found to be harmful to the soil and human health, remarked Duffus (2014) and he goes further to say that they are remarkable changes in properties especially in the physical, chemical and microbiological properties of soils contaminated with lubricant oil. Oil displaces air and water leading to anaerobic condition. The presence of spent lubricant oil in soil increases bulk density, decreases water holding capacity and aeration propensity.

Noted by Odjegba (2014) it is also that there is a buildup of essential elements such as organic carbon and organic matter and their eventual translocation to plant tissues. These conditions generally cause unsatisfactory seed germination, growth and yield in soil contaminated with waste oils.

In most cities and towns in Nigeria, some farmers or residents grow vegetables, maize and other crops around the mechanic villages or sink borehole without considering the health risks involved.

Chronic pollution due to used motor oil reaches several millions of tons yearly. In contrast to petroleum pollution, used motor oil pollution is worldwide because the major sources are automotive traffic and industrial activity. Moreover, apart from hydrocarbons and heavy metals used motor oil contains other compounds that are dangerous to the environment, such as lubrication additives. Motor oil pollution can damage the soil as well as atmosphere when the waste oil is burned. This paper critically examines the issue of environmental degradation especially the dangers posed on the mechanic village vicinity and the cautions that every technician working there should follow with knowledge that will be derived from this study.

STATEMENT OF THE PROBLEM

The incessant spillage of spent engine oils in Abak Road Mechanic Village by auto mechanics and other technicians working there is becoming alarming considering its environmental degradation and health implication. A lot of them are ignorant of their unsafe acts and their consequences. Environmental pollution with petroleum and petrochemical products has attracted much attention in recent time. The presence of different types of automobiles and machinery has resulted in an increase in the use of lubricating oil. Spillage of used motor oils such as diesel or jet fuel contaminates our natural environment with hydrocarbon. Hydrocarbon contamination of the air, soil, and freshwater especially by PAHs attracts public attention because many PAHs are toxic, mutagenic, and carcinogenic.

In most towns in Nigeria, some farmers or residents grow vegetables, maize and other crops around mechanic village or sink boreholes without considering the health risks involved. Prolonged exposure to high oil concentration may cause the development of liver or kidney disease, possible damage to the bone marrow, and an increased risk of cancer. In addition, PAHs have a widespread occurrence in various ecosystems that contribute to the persistence of these compounds in the environment. The illegal dumping of used motor oil is an environmental hazard with global ramifications. Used motor oil contains metals and heavy polycyclic aromatic hydrocarbons (PAHs) that could contribute to chronic hazards including mutagenicity and carcinogenicity. Although the heavy chemicals are sometimes essential micronutrients for plants, they have also caused metabolic disorders and growth inhibition when the concentration is high.

OBJECTIVE OF THE STUDY

The objective of this research work is as follows:

- To examine the effect of used lubricating oil on the soil in the study area
- To examine the level of toxicity caused by lubricating oil in the area.

DELIMITATIONS OF THE STUDY

The study was delimited to the effects of used lubricating oil on soil fertility in the vicinity of mechanic village, Abak road, Uyo. Soil samples were basically two types; the spent oil soil and the control soil. Scope covers parameters to be examined to include PAHs, Pb, hg, Cr, N, P, PH, CEC and particle size. The result obtained were examined to ensure whether they pass tolerable rate by the World Health Environmental Standard. Research also covered composition of used motor oil, Soil types, Level of oil pollution, Health consequences of used oil. Topics mentioned which are not part of this work include; oil additives factor and fuel consumption in automobiles.

REVIEW OF LITERATURE

INTRODUCTION

As engine oil is used in automobile, it picks up a number of additional compounds from engine wear. These include iron, steel, copper, zinc, lead, barium, cadmium, sulfur, dirt and ash. Because of the additives and contaminants, used motor oil disposal can be more environmentally damaging than crude oil pollution (Abioye *et al* 2014). These additives and contaminants may cause both short- and long-term effect if they are allowed to enter the environment through water ways or soil (Hadi, 2023). Once engine oil is drained off an engine, it is no longer clean because it has picked up materials, dirt particles, and other chemicals during engine operation, thus such lubricating oil is now classified as waste oil. The increase in the number of vehicles in Nigeria has necessitated a higher production and use of waste oil. This has subsequently given rise to the generation of large quantities of waste oil, at the time of servicing the vehicles. This waste oil is considered as ordinary waste by majority of the workers of the automobile mechanic workshops in Nigeria, who dispose this oil by dumping on surface soil. This practice of disposal is a continuous exercise, except when the waste oil is collected by unregistered and unregulated vendors.

In Nigeria, automobile mechanic workshops are located or concentrated in areas known as mechanic villages. These places are officially designated for repairs and servicing of motor vehicles. They are also used for other purposes such as recreational, residential and agricultural purposes (Evans *et al.,* 2018). The waste generated by automobile mechanics in these villages may include gasoline (petrol), diesel, spent engine oil and paints among others

(Nwachukwu *et al*., 2014). These categories of wastes are generated and dumped by individuals, who may not know the potential human risks of exposure to such pollutants. They therefore dump them in the vicinity, where there is no further treatment and causes environmental risk to humans, animals and plants. This is probably because automobile mechanic activities in Nigeria are currently under the control of semi-literate individuals (Willkinson, *et al.,* 2022). Abioye, *et al.,* (2017) specifically, indicated that the pollution effects of mechanic village activities in Nigeria have received limited attention even though these activities have been shown to produce petroleum-based wastes (Nwachukwu *et al*., 2014). There is therefore the need to continually assess their nature, volume, direct harmful effects and current methods of disposal as well as potential impacts on the environment. This is critical since human activities such as auto mechanic works generate hydrocarbon pollutants, which may disperse throughout the environment, leading to serious pollution problems (WHO and UNICEF, 2017). Some of the substances dispersed may remain highly recalcitrant to biodegradation processes (EeLuiAng and Jeffrey, 2014). Excessive accumulation of heavy metal from petroleum and other related human activities have been documented in soils (Johnson, *et al.,* 2021) and have been shown to pose major environmental and human health problems (Evans *et al.,* 2018). In addition, high metal concentration in contaminated soil results to decreased soil microbial activity, soil fertility and increased yield losses (Agbogidi, 2015). The metals they contain are frequently bio-accumulated by agricultural crops and may through them be consumed by humans and animals of economic importance (Alloway, 2015).

PRODUCTION AND CONSUMPTION OF AUTOMOBILE OIL

After the petroleum refining process, several products, mainly fuel and lubricating base oils, are obtained. Apart from engine oil there are many other lubricating oils e.g. industrial treatment oils, heat-transfer oils, cutting oils, electric oils, rolling oils, food-machinery oils etc. Since 1980 almost all of the lubricating oil is obtained from petroleum.

The lubricating base oils from the refining process of crude oil are very complex mixtures of hydrocarbons: linear and branched paraffin's, and cyclic alkanes and aromatic hydrocarbon (> C15 with boiling points between 300 and 600° C, However, lubricating oils obtained from the residual fractions have some compounds with boiling points of up to 815° C. The technology used in the fabrication of different lubricating oil is specific for each commercial company. Moreover, the type and quantity of additives are determined by future utilization and by commercial patent. The normal production process of lubricating oils after the refining processes are propane DE asphalting, solvent extraction, hydro treating, solvent dewaxing, acid treating and finishing.

The world population of lubricating oil is almost 1-2% of refined crude oil **and the world consumption (excluding Eastern Europe and China) was 23.8 million tons in 1980.** A good contemporary estimate of world consumption is 35-38 million tons of lubricating oil yearly.

COMPOSITION OF USED MOTOR OIL

The chemical composition of lubricating oils, as with all other petroleum products, varies with the crude-oil source, the refining process and the additives present. The fabrication process of lubricating oil has changed significantly in recent years in order to eliminate undesirable compounds, such as polyaromatic hydrocarbons (PAH). For this reason, two-thirds of the base oil produced in industrialized countries is solvent-refined.

Generally, aliphatic compounds represent between 73 and 80% of the total weight of the oil. This fraction is composed of alkanes and cycloalkanes of 1-6 rings. Monoaromatic hydrocarbons make up 11-15% of the weight, diaromatics2-5% and polyaromatic and polar fractions 4-8%. The polar fraction is made up of aromatic compounds which contain Sulphur, nitrogen or oxygen. In certain cases, probably when the oil has not been refined very well, thearomatic compounds can represent 37-50% of the oil. The fraction of aromatic hydrocarbons is composed of compounds with 1-5 aromatic rings. Before discussing the relationship between oil composition and use, it is important to mention that lubricating oils are characterized by their high additive content. During oil fabrication, and in order to improve its physical and chemical properties, several types of additives are employed. The different types of additives are summarized in Table 1 as shown below.

TABLE 1. Examples of used oil, related wastes, wastes that are not used oil

Used oil	Used oil related wastes	Wastes that are not used oil
Motor oil	Used oil filters	Fuel oil and other fuels
Transmission fluid	Used floor dry	Crude oil
Hydraulic fluid	Contaminated sawdust	Vegetable oil
Brake fluid	Oily wipes and sorbents	Tallow and animal greases
Compressor oil	Used oil spill debris	Vehicle antifreeze coolant
Refrigerant oil		Fuel tank sludge
Cutting oil		Solvents and oils used as solvent
Quenching oil		Parts washer sludge
Oil-water separator skim		Floor drain sludge
Non-PCB transformer oil		PCB hazardous waste oil
Petroleum-based grease		Mixtures of oil and other wastes

The additive content of lubricating oils can be as much as 20%, the most important being detergents and dispersants at 2-15% of the weight of the oil. Of the oil additives, several compounds are known to be dangerous environmental contaminants. Zinc diaryl or dialkyldithiophosphates, molybdenum disulphide, zinc dithiophosphate, heavy-metal soaps and other organometallic and compounds contain heavy metals [R. Vazquez-Duhalt and H. Greppin. That is why the zinc content of new motor oil is high, new motor oil contains -1500 μg s " of zinc and 87 μg kg-1 of cadmium. During motor operation, lubricating oil is chemically transformed by oxidation, nitration, cracking of polymers, decomposition of organometallic compounds, etc. This change is due to the high temperature and the high mechanic strains that the oil is subjected to during motor operation [J. Severinski, what can the LR. spectrum say about a motor oil during service (Adelekan *et al.,* 2015). On the other hand, motor oil accumulates different contaminants, such as fuel (petrol or diesel), water, antifreeze and insoluble particles. These particles principally originate from atmospheric dust, metals, metal oxides and combustion products. The water content can be as much as 9%, fuels can represent up to10% and solid particles up to 8%. (Adewole *et al.,* 2014) The nitrogen content of used motor oil is generally 0.05-0.18%, Sulphur content 0.22----0.55%, phosphorus content 80--32000 µgg-1 and chloride content -3500µgg-1.

One of the more important differences between new and used motor oil is the heavy metal content. The metal content of used motor oil is very important, because many of these metals are potentially very dangerous to living organisms. These metals originate from the fuel and from motor wear. Used motor oil contains high concentrations of Pb, Zn, Ca, Ba and Mg, and lower concentrations of Fe, Na, Cu, Al, Cr, Mn, K, Ni, Sn, Si, and Mo [R. Vazquez-Duhaltand H. Greppin, Biodegradation of used motor oil by bacteria promotes the solubilization of heavy metals, Sci. Total Environ., 52 (1986) 109-121]. The concentration of metals in lubricating oil increase with motor operating time and the amount is dependent on fuel type and the mechanical condition of the engine.

This increase varies according to engine type. For example, the PAH content of used crankcase oil from the Diesel motors of lorries can be three times higher than that of new oil, for diesel buses it can be six times higher than that of new oil, and for diesel cars it can be 30 times higher than that of new oil. The PAH content of used motor oil from petrol motors can be 180 times higher than that of new and crankcase oil.

SPILLAGE OF USED MOTOR OIL INTO THE SOIL

Soil is the mixture of minerals, organic matters, gases, liquids, and the countless organisms that together support life on earth. Soil is a natural body known as the pedosphere, and which performs four important functions:

It is a medium for plant growth

It is a means of water storage, supply and purification

It is a modifier of earth's atmosphere;

It is a habitat for organisms all of which, in turn, modify the soil.

Used motor oil can be dispersed into the soil in different ways

escape and loss of oil during motor operation;

during application on rural roads for dust control;

during asphalting with asphalt-containing waste crankcase oil

when it is placed directly in a landfill

Manhandling by mechanics. Etc.

Here, the consequences of the used motor oil on the soil environment are analyzed. One-third of the lubricating oil sold is lost during use; some is lost on the pavement surface, in the streets, roads and in car parks or in the service Centre. The oil remains on these surfaces until rain water wash the oil off into the oils.

A primary effect of the dispersion of used motor oil in the soil is a very important change in the amount and species of microorganisms. The application of hydrocarbons in the soil promotes an increase in microorganisms able to biodegrade these substrates. A study of used motor oil biodegradation in different soils (Abioye *et al.,* 2014) has shown that such changes in the soil microorganisms occur when a hydrocarbon mixture is applied. An increase in the population of specific hydrocarbon-biodegrading microorganisms was evident a year after application.

The spillage of petroleum on soil produces some important changes in the microorganism communities that participate in the nitrogen cycle, as well as in the metabolic activity of the aerobic microorganisms able to oxidize hydrocarbons. The petroleum fills the pores between the soil particles and hampers oxygen access. A significant number of microzones arise, in the soil aggregates, which have an oxygen deficiency. Another factor that promotes the development of an anerobicmicrozonesin the contaminated soil is the development of aerobic hydrocarbon-oxidizing microorganisms. The numbers of nitrogen fixing, denitrifying and ammonifying microorganisms in the contaminated soil are greater than in the uncontaminated soil (Wu *et al.,* 2020). The increase in the soil of the content of easily accessible substances, arising from aerobic hydrocarbon biodegradation, stimulates an increase in the numbers of anaerobic nitrogen• fixing microorganisms, such as *Clostridium.* Because of this the nitrogen content of the contaminated soil is greater than that of the uncontaminated soil. Denitrifying microorganism numbers are also increased by the presence of hydrocarbons. This type of microorganism is stimulated by the increase in organic substrates and the low oxidation-reduction potential. This increase has no effect on the intensity of the denitrifying process, which is the same in the contaminated and uncontaminated soils. As is well known, hydrocarbon oxidation is catalyzed by aerobic organisms, with the participation of oxidoreductase enzymes, and the initial oxidation requires the presence of atmospheric oxygen as an electron acceptor. Also, nitrate reeducates, responsible for reducing nitrate, is activated only under anaerobic conditions and is inhibited by oxygen. This means that the diminution of nitrate reeducates activity is compensated for by the increase in the quantity of denitrifying microorganisms. Finally, protease activity is also inhibited by the presence of petroleum in the soil, but this is compensated for by an increase in ammonifying microorganisms, which increase the amount of protease excreted to the environment. Indeed, autoregulation of the nitrogen cycle due to the presence of hydrocarbons reduces the effects of pollution in this cycle, but there is no evidence that this occurs in other biological cycles in the soil.

It is known that the presence of heavy metals in used motor oil can strongly inhibit primary production, carbon mineralization, nitrogen transformations and mineralization of Sulphur and phosphorus. In the case of used motor oil, the presence of lead can diminish hydrocarbon biodegradation, as has been shown to occur when lead has been added to contaminated soils in petroleum. Used motor oil and the lead contained in this oil remain in the first 20 cm of soil for a year after the spillage, i.e. it remains at a depth where most microbial activity take place (Abosede, 2014).

Soil fertility refers to the ability of a soil to sustain plant growth, i.e. to provide plant habitat and result in lasting constant yields of high quality. A. soil has the following properties: it is rich in nutrients necessary for basic plant nutrition, including nitrogen, phosphorus and potassium. Soil fertility test can determine fertility, or the expected growth potential of the soil which indicates nutrient deficiencies, potential toxicities from excessive fertility and inhibitions from the presence of non-essential trace minerals. The test is used to mimic the function of roots to assimilate minerals.

Soil fertility parameters are the parameters used to analyze a soil sample to determine nutrient and contaminated content, composition, and other characteristics such as the acidity or pH level.

RESEARCH METHODOLOGY

MATERIAL AND METHOD

The study area, Abak Road Mechanic Village, Uyo, Akwa Ibom state was selected because it is one of the largest functioning mechanic villages in Akwa Ibom state. The study area geographically falls under Uyo local government Area of the state and its longitude ranges between 7003' and 7005'E and 5026' and 5035'N in latitude. The climatic condition of the area has its parameter as; temperature range of 210C and 270C, relative humidity ranges between 60 – 80%. The area lies within the sub-equatorial, sub-humid region with March to October as rainy season and November to February as dry season. Annual average rainfall is about 1500mm with a monthly average of 30mm. The study area has its drainage source as Itu River running from Itak Inyang.

SAMPLING DESIGN, COLLECTION AND PREPARATION

Waste oil soil samples were collected using a Dutch soil auger in a randomized method along a transect at 100m interval for two (2) different locations within the study area, these sample points were constantly receiving waste engine oil and were labeled samples CI and CII. The samples were homogenized in a clean plastic bucket and a composite sample was drawn from each. This process was repeated for all the experimental units. All the composite samples were air dried and allowed to pass through a 2-mm sieve, which were then poured into polythene bags, labeled adequately and transported to the laboratory immediately for analyses. A total of 4 soil samples were analyzed from the study area. The sieved soil samples less than 2mm diameter were then taken to the laboratory and analyzed for the elemental concentration of Pb, Cr, Hg, P, N, and PAH. To analyses for Pb, Cr, Hg, P and

N the digested samples of sand (total) were weighed 0.5kg in each case of the control and spent oil of the crushed, sieved sample into Teflon flask.

Hot concentrated HNO_3, $HClO_4$ and HF of the three compounds were added each in the ratio 1:1:1 (5ml) each this was digested on a water bath to near dryness.

The residue was to leached with 5ml of 20% HNO_3 and the volume was made up to 20ml with distilled water.

A blank determination was treated in the same method but omitting the sample.

The extract was then poured into a set of vials for the determination of the elemental concentration of Pb, Cr, Hg, P and N.

Estimation of PAH in Soil

5g of soil each was extracted using mixture of acetone and hexane in the ratio of 1:1.

The filtrates were then filtered to remove any foreign body within the pollution.

The various soil extracts were now read in a UV – spectrophotometer (Genesis 50 thermos scientific) at a wave length between 190 -360mm. the PAH was estimated using formulas.

The various bands and peaks were noted but the highest peak was used for the calculation and was gotten at 290nm. The result was calculated and recorded.

Atomic Absorption spectrophotometer (UNICAM) was used to determine the concentration of metals in all the samples.

Determination of the concentration of the various metals were carried out by direct aspiration of samples into air using acetylene flame. Before any sample is examined of any sample, it is imperative for to work out the calibration curve of the metals using aliquot from Std stock solution of the metals or salt of the metals in preparing the working Std. this method requires to sprang the sample solution in such a way that it goes into flame such that it will reduce a part of the mixture to free atoms of its various portions.

The free atom is raised to an excited state by absorbing light energy equal to the difference in energy between the ground state and the excited state. It follows that the light of a resonant wave length of a particular element is passed through the flame into a solution of a particular compound of that element that is being sprayed.

As it goes on a fraction of that light will be absorbed by the ground state atoms of the element and the degree of absorption to which the incident light is diminished on passing of the species of the absorbing atom. From the calibration curve, the concentration of the metals in the sample were determined. Otherwise, the concentration of the metals in the samples were directly related to the concentration of the calibration curve, where dilution of the sample was carried out, thereafter the concentration of the metals was multiplied by the diluted factor.

All calculation was 1000Mg/L working Std of the stock solution were measured and stored in plastic bottles instead of glass wares to prevent contamination and absorption. This is based on the principle of Lambert law stipulating that the amount of light absorbed by a material is directly proportional to the concentration of the absorbing species in the materials.

That is:

$$A = EBC$$

Where A = Absorbance

E = Molar absorptivity

B = Path length

C = Concentration

RESULTS AND DISCUSSION

4.1 RESULTS

Results show the mean values of physico-chemical properties in soil at various sample points and the control. There was no significant difference in the soil PH within the contaminated soil and control. The range recorded was between 5.54 and 6.87. Soil PH is very significant as it determines the availability of elements in the soil for plants use during osmosis. (Alexandrou *et al.,* 2018). A lot of cations react at low solubility below 5.5 such as Cd, Cu, Hg, Ni, Pb and Zn (WHO and UNICEF, 2017) the retention of metals to soil organic matter is also weaker at low pH, resulting in more available metal in the soil solution for root absorption.

Table I: Distribution of pH in soil at the study area for both the control and spent oil.

S/N		SEO			CONTROL		
	PH	S_1	S_2	S_3	C_1	C_2	C_3
	PH	5.67	6.69	5.91	5.69	6.83	6.71

Table II: Shows the elemental concentration (ng/100g) of the soil sample

Sample Id	Pb	Cr	Hg	P
Spent Soil	4.078 ± 0.007	1.986 ± 0.020	0.033 ± 0.006	9.89 ± 0.003
Control Soil	0.28 ± 0.003	$< 0.001 \pm 0.000$	0.001 ± 0.000	16.36 ± 0.005

Sample Id	N	PAH
Spent Soil	0.09 ± 0.006	38.94 ± 3.507
Control Soil	0.11 ± 0.001	1.65 ± 0.051

4.2 DISCUSSION

Lead in Soil

Table II shows the elemental concentration of lead in the two contrasting soils; the spent oil and the controlled soil. The assessment of the concentration of lead (Pb) is the study areas showed significant differences between treatments at both test points. The value of lead at the control soil was 0.82 ± 0.003 against the valve obtained at spent soil which was 4.078 ± 0.007 (mg/100g). this marked difference shows that the concentration of lead in the spent oil was higher than the normal or control soil within the same vicinity. Which means that lead is present in both soils, but the normal soil contains a tolerable quantity which is not toxic to the soil opposed to the spent soil in the study area.

Comparatively, it was to be lower than 4.822 (mg/100g) of Abak, Nigeria 3.1200(mg/100g) found at Ile-ife South Western Nigeria (Adewole and Aboyeji, 2014) and lower than 649mg/kg found in Okigwe Mechanic Village South Eastern Nigeria (Nwachukwu *et al* 2014). The range of valve 100 – 400mg/kg for lead by the US EPA above which toxicity is considered to be possible was slightly exceeded in the spent oil. The result in table II indicates wide range variation between Pb contaminated soil sample and control soil sample with frequently range recorded as 4.078 ± 0.007 and 0.82 ± 0.003. This variation indicates that certain places in Abak Road Mechanic Village, Uyo are receiving more waste oil than others.

The high concentration of lead in the polluted soil may be as a result of Tetra Ethyl Lead (TEL), a Pb compound normally found in SEO. The TEL easily moves down the soil profile, facilitated by the coarse textured (high permeable) loamy soil of Abak Road mechanic village, Uyo. The high concentration of Pb in the sub soil may also be as a result of the conversion of non-polar Pb compounds to aqueous Pb as it passes through clay soil or liners in the soil profile. The main compartments for Pb in the soil are the soil solution, the absorption surfaces of the clay-humus exchange complex, precipitated forms, secondary iron and manganese oxide and Alkaline earth carbonates, the soil humus are silicate lattices. The pH of the soil, which is subject to short-term variation, has an effect on the absorption of lead by the soil particles. At near neutral pH values, proved the highest absorption of lead. In general, heavy metal cation such as that of Pb are most mobile under acidic conditions and increasing the pH by liming (addition of Ca and Mg compound) usually reduces their bioavailability. The concentration of Pb in soil in dry season is significantly higher than concentration of metals in wet season. This is in agreement with the findings of Johnson *et al.* (2021). This might be due to the run off effect that is capable of removing heavy metals from the site and

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the effect of rainfall which may facilitate the dilution of soil solution during the wet season and intense evaporation in the dry season makes soil solution more concentrated.

Soil pH, Particle Size Distribution and CEC

As shown in table III, the soil samples contain percentages of sand ranging between 88.40% to 92.61% as shown in table 1; the high proportion of sand in the soil sample can be attributed to the parent materials. The soil is derived from coastal plain sands of southern Nigeria and as such has high sand content. The pH of the soil samples is predominantly acidic. The highest value was observed was (6.83) and lowest value was (5.67). This could be as a result of the leaching away by rainwater of the basic cation (Ca2+, Mg2+, K+, Na+) and replacement of many of these basic cations by hydrogen ion, H+ from carbonic acid (H_2C03) formed from water and dissolved carbon dioxide. Soil pH usually increases with depth in humid areas where bases are leached down the soil profile and decrease with depth in arid environments where evaporation causes salts to accumulate in the surface horizon. The CEC which is an indication of the relative ability of K, Na, Ca and Mg to displace other cation was observed to be low, the highest value was observed at CF and CG (3.48cmol/kg) respectively while the lowest value was observed to be (2.18cmol/kg). Sand generally has low CEC values of 1–5cmol/kg, compared to other soil. This is because the coarse textured soil (sand) is commonly lower in both clay and humus content. Likewise, a clay soil dominated by the 1.1 type silicate clay and iron and aluminum oxide will have a much lower cation exchange capacity than will one with a similar humus content dominated by smectite clay. The CEC of most soil increases with pH. At very low pH values, the CEC is generally low. The low value of CEC in the soil samples implies low fertility of the contaminated soil.

Spatial Variation on the Distribution of physic-chemical properties of soil at the study area.

Table III:

			Particle Size (%)			
Treatment	**Soil PH**	**CEC(cmoL/kg)**	**Sand**	**Silk**	**Clay**	**Texture**
SEC a	5.67	2.18	90.12	5.88	4.00	Loamy
b	6.69	2.32	92.61	4.33	3.82	Loamy
c	5.91	3.00	89.35	6.93	3.17	Loamy
Control i	5.69	2.91	91.31	5.38	4.52	Loamy
ii	6.83	3.00	90.48	4.52	3.00	Loamy
iii	6.71	3.48	88.41	7.69	2.00	Loamy

Were
CEC = Cation Exchange Capacity
TEB = total Exchangeable Basses, (K^+, Na^+, Ca^{2+}, Mg^{2+})

TEA = Total Exchangeable Acidity.
Continuing from Table II on the elemental concentration of the soil sample continuing chromium, Mercury, Nitrogen, Phosphorus and PAHs.

The polycyclic Aromatic Hydrocarbon (PAHs) is 38 times greater in spent oil (38:1) having 38.94 ± 3.507 and 1.65 ± 0.051 respectively. Heavy metals like Chromium in spent oil is approximately twice greater in spent oil than normal or control soil (2:0) recording 1.986 ± 0.020 and $< 0.001 \pm 0.000$ respectively. Mercury also clarified as heavy metal is of three times greater than normal (3.0). The report showed spent oil for mercury to be 0.033 ± 0.006 and the control recorded 0.001 ± 0.000. From there result it is clear that there has been increased PAHs, Pb, Cr and Hg. The increase obviously shows increased pollution. According to Heidelberg, Springer (2017), the presence of heavy metals, pesticides, polychlorinated biphenyls and polycyclic aromatic hydrocarbon (PAHs) affect all form of life since these chemicals has associated toxicity, mutagenicity and carcinogenicity. According to Heidelberb (2017) PAH are typical pollutants of soil which result in alteration in grain size, porosity and water holding capacity of soil and also affect diversity and population of microbes adversely, also it affects significant changes in permeability, volume, plasticity etc. and reduces the quality of soils. However, there is mild increase of mercury in the report which is categorized by world health organization to be slight pollution. Closely followed in the tolerable limit is chromium. There is slightly increase in mercury and chromium we are not sure of any positive impact on plant since they have been reported as carcinogens and hardazous 10m. Barbar Shahad (2020) views these heavy metals as dangerous to plant and animals.

In thin case plants grown in this area of spent oil, is in danger when there is the presence chromium and mercury in the mechanic village of Abak road, Uyo, Akwa Ibom State. In the case of Pb where its level is four times is seen as an outright pollution which negatively affect plants and animals' lives including human are at risk in the area, reports from WHO and UNICEF (2017).

Metals like Nitrogen and phosphorus metals are also affected thus recording a reduction in phosphorus and Nitrogen content as major elements. The reduction of phosphorus is 10:16 against the control soil and in Nitrogen it is approximating 9:12 as against the normal, loss of major elements in mechanic village oil spilled area suffers loss of major soil nutrients.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Considering the parameters researched to include PAHs, Pb, Hg, Chr, N, P, PH, CEC and particle seize; the results from the study analyzed show that at the polycyclic Aromatic Hydrocarbons (PAHs) is 38 times greater in spent oil showing a high level of toxicity, which is capable of damaging the soil structure, toxicity, mutagenicity, carcinogenicity with reduction in soil quality in the area of the study. The study also showed slight reduction of Nitrogen (0.0 ± 0.006 vs 0.11 ± 0.001) phosphorus is also affected with reduction according to the study 9.89 ± 0.003 vs $16{:}36 \pm 0.005$. The deleterious effect on plant growth can be obvious in Mechanic Village vicinity of spent engine oil (SEO). PH values, Uyo are predominantly acidic. The research shows as well that CEC is low which implies low fertility of the soil. Particle size analysis shows that the soil is predominantly loamy. The soil in the area shows lead contamination which exceeded the permissible level (Limits) Chromium is also toxic having 1.966 ± 0.20 against the normal 0.001 ± 0.000. However, mercury is only slightly higher with a lower degree of toxicity in the area at 0.033 ± 0.006. From the analysis it is shown that the soil in spent lubricating oil in soil of mechanic village vicinity, Uyo, Akwa Ibom is comparatively toxic.

RECOMMENDATIONS

Based on the finding the following recommendations are given:

- A well-coordinated waste oil collection program should be initiated by the government in partnership with the private sector, to minimize disposal of waste oil on soil. The collected waste oil should be sent to motor oil manufacturers for recycling and re-injection into the production stream.
- Proper drainage system should be made such that such drain can be sent to designated areas for further processing before disposal.
- Mechanic village is located at Abak road at the heart of the town where traffic congestion and location can encourage environmental degradation. In this case the mechanic village should be recited for proper channeling of waste especially spent lubricating oil to the appropriate area and aesthetics.
- Health, safety and environmental workshops including seminars should be organized for awareness. A lot of the mechanics are not learned, as such should be enlightened to stop polluting the soil through disposal of waste engine oil on the soils in the vicinity. The analysis of this work should be shown to them to show evidence and convinced them about the menace.
- There should be periodic monitoring of the contaminated areas to ascertain that pollution do not exceed permissible limits. Certain plant found in the environments which are capable of decomposing the organic constituents of waste engine oil should be planted with the contaminated areas to help breakdown the complex molecules of waste oil (phytovemediateion).

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