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ORIGINAL ARTICLE

Assessment of Polycyclic Aromatic Hydrocarbons in Three Selected Auto-Mechanic Sites Soil within Ijebu Igbo, Ogun State.

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ABSTRACT
Polycyclic aromatic hydrocarbons (PAHs) are organic pollutants which can end up in the soil due to anthropogenic activities in vehicle repair shops. There is an indirect rise in environmental contamination as population and technology grow which results in a persistent and rapid deterioration of the environment's quality with capacity to support life. Among other environmental components, soils are often where PAHs are deposited. The concentrations of PAHs accumulated in a three auto-mechanic workshops were examined in this study. For the purpose of this study, soil samples were taken seven days in a row from three busy auto-mechanic workshops: Opeyemi Automobile Workshop (O.P.W.S), Ayoola Automobile Workshop (A.Y.W.S) and Ajobiewe Automobile Workshop (A.J.W.S). The examinations of PAHs were performed utilizing conventional analytical techniques.). For A.J.W.S naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthalene, fluorene, anthracene, benzo(a)anthracene, chrysene and benzo(b)fluoranthene had 0.18, 0.17, 0.03, 0.05,0.16, 0.14, 0.12, 0.14 and 0.19 mg/kg respectively The concentrations of phenanthrene, anthracene, pyrene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and indeno (1,2,3-cd) pyrene were confirmed to be higher than 1.00 mg/kg in O.P.W.S which confirmed that O.P.W.S is seriously polluted.
***Keywords**: Auto-mobiles, PAHs, Soil, Workshop.*

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INTRODUCTION

Polycyclic Aromatic Hydrocarbons (PAHs) are group of organic chemicals that occur naturally in coal, petroleum and petroleum products like gasoline which can also occur artificially through anthropogenic activities like combustion of oil, garbage, coal.[1] The major sources of PAHs are the anthropogenic sources resulting from vehicular emissions, fossil fuel combustion, as well as incineration of diesel oil, wood, and coal.[2] Auto-mobile workshops are establishments where skilled technicians and other tradespeople fix automobiles. When mechanics and other craftsmen work on cars, they often discard or accidentally release used motor oils, lubricants and organic solvents, which can contaminate their workspaces and nearby areas with toxic substances. Waste oils and organic solvents used in most workshops constitute a major part of the hazardous contaminants usually released from automobile mechanic workshops in most Nigerian cities [3]. Spent engine oils migrate with ease into the soil and filtration of leachates from materials contained in waste engine oil may pose serious threats to groundwater quality and the ecosystem. [4] PAHs have been proven to be a major source of environmental contamination, particularly from vehicular sources. This is because their existence has an impact on health because neither plants nor animals need them for any purpose. In Nigeria, there are few regulations governing the development of auto-mechanic workshops, which has led to a surge in the number of mechanical engineers turning residential areas into auto-mechanic workshops and raising the risk of pollution. The purpose of this study is to assess the PAH concentrations in soil of the town's three busiest chosen auto-mechanic site.

MATERIAL AND METHODS

Study Area

Ijebu igbo is a town in Ijebu North Local government Area of Ogun state, Nigeria. Its geographical coordinates are latitude 6° 58' 0" North and longitude 4° 0' 0" east.

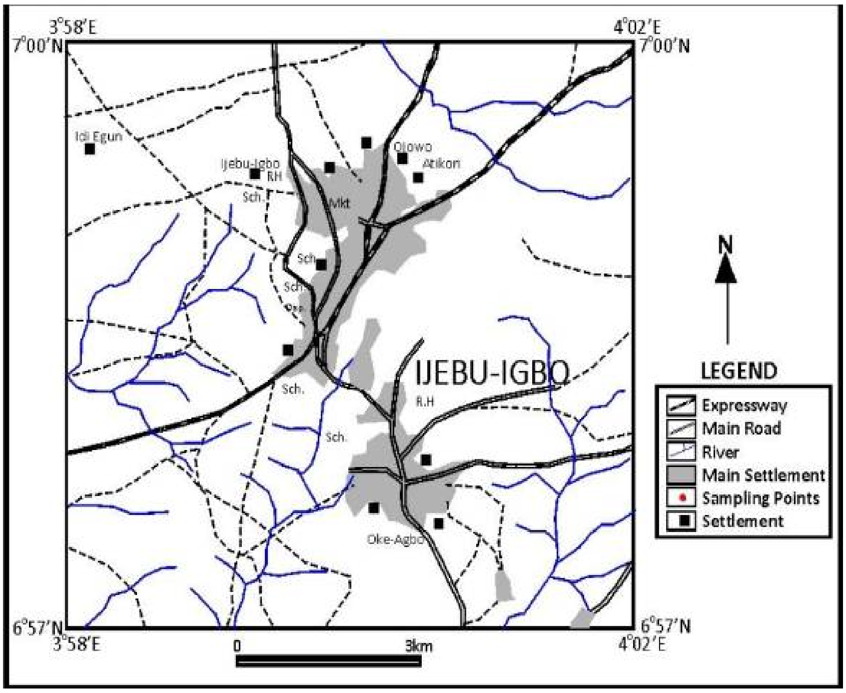

Figure 1: Location Map of the Study Area [5]

Sample preparations and PAHs Extractions

Soil samples were collected for seven consecutive days from three busy auto-mechanic workshops: Opeyemi Automobile Workshop (O.P.W.S), Ayoola Automobile Workshop (A.Y.W.S) and Ajobiewe Automobile Workshop (A.J.W.S). The extraction of the active ingredient was carried out by dissolving 5 g of the dried sample in 10 ml 99.999% pure dichloromethane in well corked reagent bottle. This was thoroughly mixed using an ultra sonicator for 5 hrs. The mixture was allowed to stand for 72 hrs and filtered into a beaker, the mixture was rewashed with 20 ml dichloromethane for two more consecutive times. The combined aliquots was evaporated on a steam berth to 5ml and filtered through a pastures pipette stocked with glass wool (membrane) with packed anhydrous sodium sulfate silica gel to remove the left over moisture and other impurities. The filtrate was concentrated to 1 ml in the vial bottle and was taken to analyze on Gas chromatography for the chemical composition (PAH) The gas chromatography model: 7890 A(GC) analysis was performed on an agilent technologies interfaced with mass selective detector model: 5975 (MSD). The electron Ionization was at 70 v with an ion source temperature at 250 ^{o}C, highly pure helium gas (99.99 % purity) was used as carrier gas. Hp.5ms (30mmx0.2mmx0.320 μm) was used as stationary phase. The oven temperature program initial temperature was 40 oC hold for 2 mins at 4 ^{o}C per minutes to the temperature of 240 ^{o}C at 5 ^{o}C per minutes to the temperature of 300 ^{o}C to hold for 11 mins. 1 μ/l was auto injected.

RESULTS AND DISCUSSION

Table 1 revealed the concentrations of PAHs present in selected auto-mechanic site soil of O.P.W.S, A.Y.W.S and A.J.W.S within Ijebu Igbo, Ogun State. Eighteen PAHs were confirmed in the three auto-mechanic sites. According to Ailijiang *et al*., 2022, [6] PAH contaminated soil can be divided into four levels: no pollution (< 0.200 mg/kg), slight pollution (0.200–0.600 mg/kg), medium pollution (0.600–1.000 mg/kg) and serious pollution (>1.000 mg/kg). Naphthalene, 1-methylnaphthalene, 2-methylnaphthalene and acenaphthene were found below calibration in O.P.W.S but were present in A.Y.W.S and A.J.W.S respectively. 0.02, 0.15 and 0.11 mg/kg were recorded for acenaphthylene, fluorene and benzo (g, h, i) perylene in O.P.W.S. Concentrations of fluoranthene, chrysene and dibenz (a, h) anthracene were 0.84, 0.91 0.45 mg/kg and were within the slightly polluted region (0.200-0.600 mg/kg). The concentrations of phenanthrene, anthracene, pyrene, benzo(a) anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and indeno (1,2,3-cd) pyrene were confirmed to be higher than 1.00 mg/kg (seriously polluted region). Concentrations of naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthalene, fluorene, phenanthrene, anthracene, fluoranthene, chrysene and benzo(a)anthracene recorded for A.Y.W.S were less than 0.200 mg/kg (classified as non-pollution region) while pyrene, benzo(b)fluoranthene, benzo(k) fluoranthene, benzo(a)pyrene, Benzo (g, h, i) perylene, dibenz (a, h)anthracene and indeno (1,2,3-cd) pyrene fell within the slightly polluted range (0.200-0.600 mg/kg). For A.J.W.S naphthalene, 2-methylnaphthalene, acenaphthylene, acenaphthalene, fluorene, anthracene, benzo(a) anthracene, chrysene and benzo(b)fluoranthene had 0.18, 0.17, 0.03, 0.05,0.16, 0.14, 0.12, 0.14 and 0.19 mg/kg respectively and were classified to be in the non-polluted region. 1-methylnaphthalene, phenanthrene, fluoranthene, benzo(k)fluoranthene, Benzo (g, h, i) perylene, dibenz (a, h) anthracene and indeno (1,2,3-cd) pyrene concentrations fell within the slightly polluted region but the concentrations of pyrene and benzo(a)pyrene concentrations fell within the medium polluted region. The concentration of benzo(a) anthracene in all the three auto-mechanic workshop soil were higher than 0.02 mg/kg reported by [7] for PAHs in soil around mechanic workshop in Abakaliki, Nigeria. Chrysene is produced as smoke during incomplete combustion of coal, gasoline and when inhaled, it can cause liver tumors in male and female.

The USEPA suggests that benzo(a)anthracene, chrysene, benzo(b)fluoranthene and benzo(k) fluoranthene are carcinogens [8].

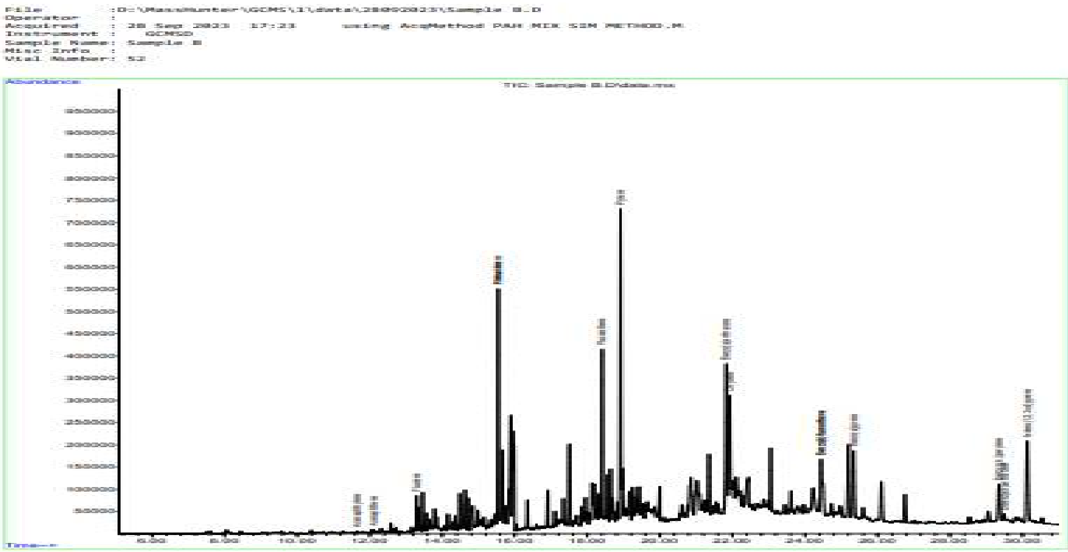

Figure1: Chromatogram of PAHs in O.P.W.S

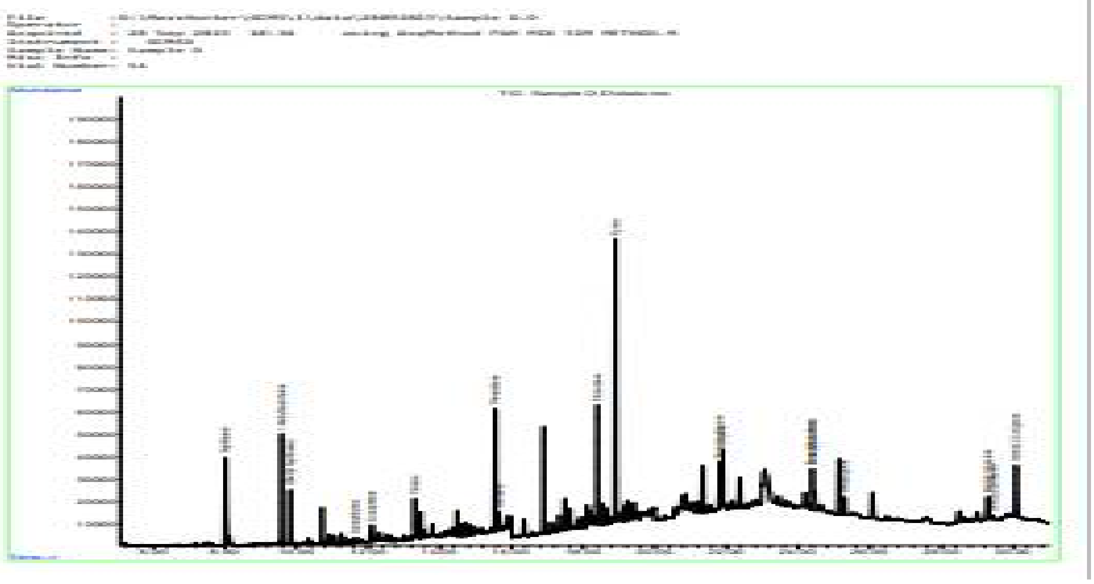

Figure2: Chromatogram of PAHs in A.Y.W.S

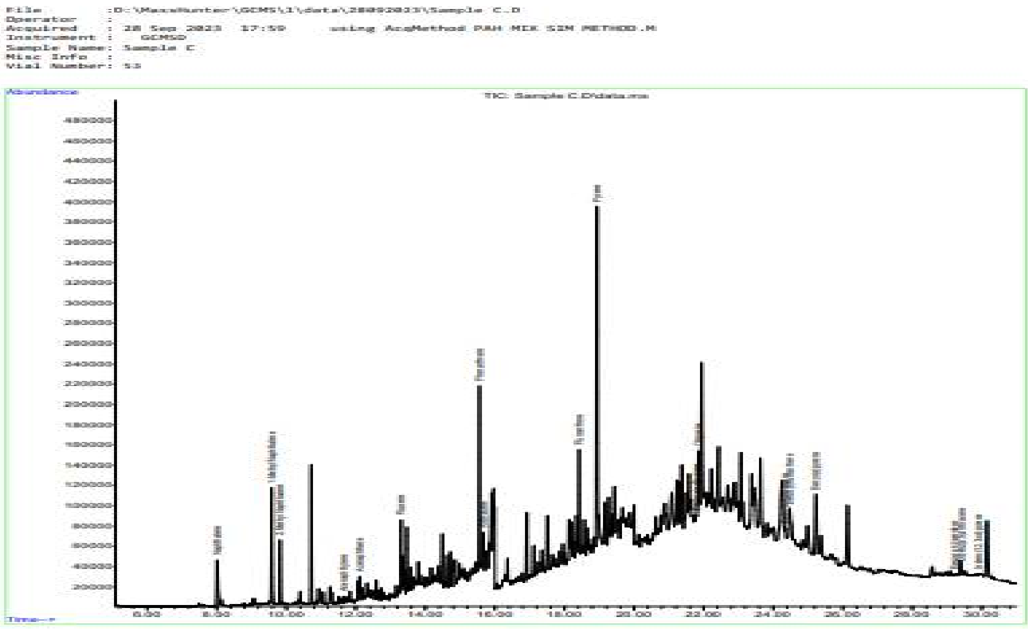

Figure3: Chromatogram of PAHs in A.J.W.S

TABLE1: CONCENTRATIONS OF POLYCYCLIC AROMATIC HYROCARBONS OF SELECTED AUTO-MECHANIC SITE SOIL.

S/N	COMPOUNDS	O.P.W.S (mg/kg)	A.Y.W.S (mg/kg)	A.J.W.S (mg/kg)
1	Naphthalene	0.00	0.14	0.18
2	1-methylnaphthalene	0.00	0.12	0.30
3	2-methylnaphthalene	0.00	0.05	0.17
4	Acenaphthylene	0.02	0.02	0.03
5	Acenaphthene	0.00	0.01	0.05
6	Fluorene	0.15	0.04	0.16
7	Phenanthrene	1.31	0.13	0.44
8	Anthracene	1.55	0.06	0.14
9	Fluoranthene	0.84	0.14	0.29
10	Pyrene	1.61	0.32	0.89
11	Benzo (a) anthracene	1.01	0.16	0.12
12	Chrysene	0.91	0.15	0.14
13	Benzo (b) fluoranthene	1.12	0.29	0.19
14	Benzo (k) fluoranthene	1.07	0.27	0.50
15	Benzo (a) pyren	1.22	0.26	0.64
16	Benzo (g, h, i) perylene	0.11	0.40	0.31
17	Di benz (a, h)anthracene	0.45	0.30	0.30
18	Indeno (1,2,3-cd) pyrene	1.85	0.46	0.27

NOTE: O.P.W.S= OPEYEMI AUTO-MECHANIC WORKSHOP SOIL, A.Y.W.S=AYOOLA AUTO-MECHANIC WORKSHOP SOIL, A.J.W.S=AJOBIEWE AUTO-MECHANIC WORKSHOP SOIL.

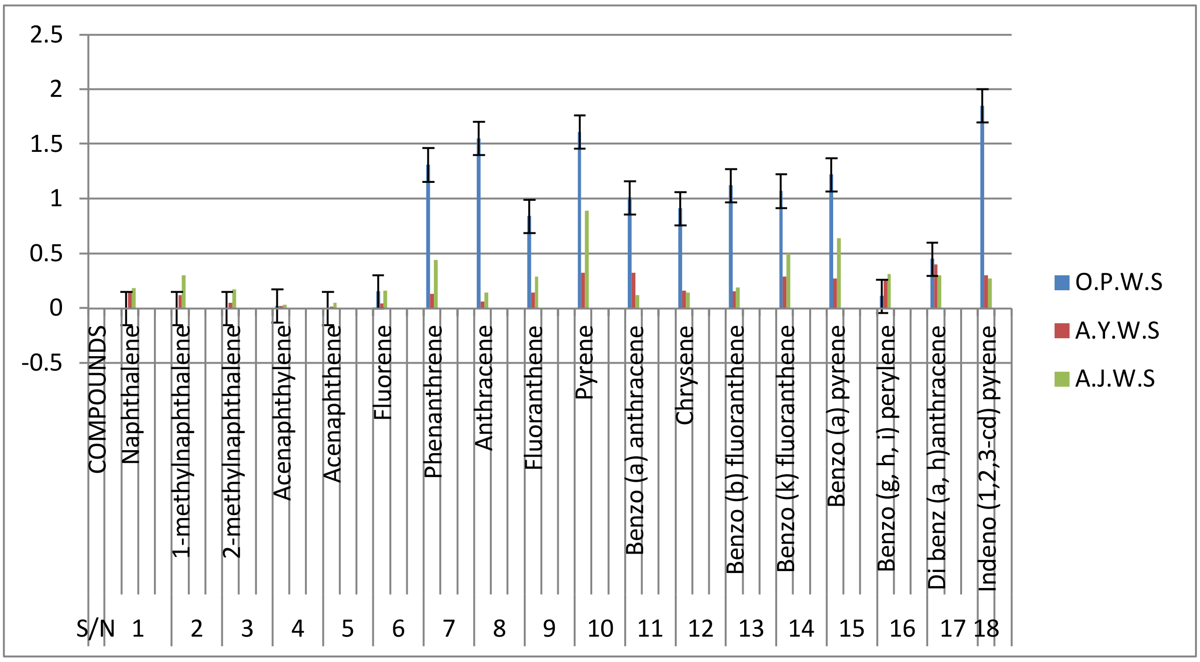

FIGURE4: BAR CHART OF POLYCYCLIC AROMATIC HYROCARBONS OF SELECTED AUTO-MECHANIC SITE SOIL.

CONCLUSION

This study confirmed that A.Y.W.S and A.J.W.S are slightly polluted while O.P.W.S is seriously polluted. There is concern that the workers in these auto-mechanic hamlets particularly (O.P.W.S) and its environs may be at increased risk of developing cancer because exposure to PAH chemicals for an extended period of time via contaminated soils.

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is 19.66 KJ/mol, which is near to experimental value [17]. For bagasse, values of activation energy vary between 16-35 KJ/mol. In literature, values of activation energy are in the range of 3-37 KJ/mol, which is quite near to the values of activation energy in this experiment. Activation energy for 50:50 by weight mixture of sludge with bagasse is varies between 30-35 KJ/mol. Overall activation energy of mixture is 30.780 KJ/mol. Overall activation energy for mixture is higher than that of sludge, because bagasse requires high energy to decompose organic compounds [18]. This could be understood by comparing activation energy data for zone-2. Activation energy for mixture in zone-2 is high. Overall activation energy required for sludge is less than overall activation energy of bagasse because bagasse has significant number of degradable components. As concentration of bagasse is increased in sludge the activation energy required is also increased.

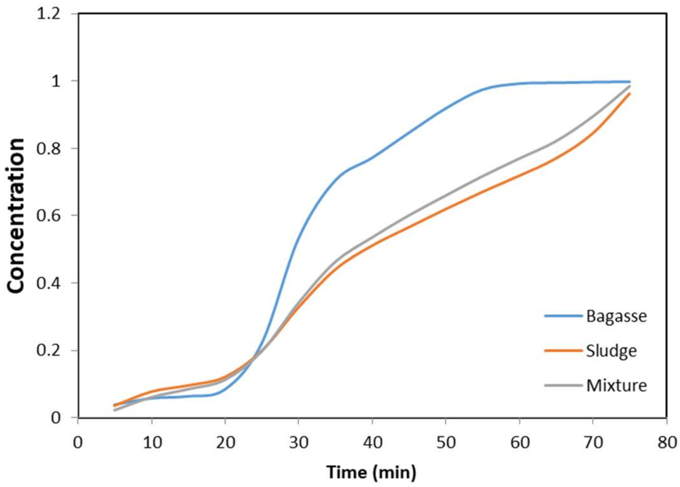

Figure 1 Conversion vs Time graph for Bagasse, sludge and their 50-50% Blend

For bagasse, conversion rate increases in temperature range of 250-400ºC because major organic degradable volatile matter decomposing in this temperature range. Bagasse has a high number of volatile matters. For sludge, conversion rate increases slowly due to sludge has low number of organic matters.

CONCLUSION

Proximate and ultimate analysis reveals that sludge has a lower amount of carbon, hydrogen and volatile matter as compared to that of bagasse. Also, sludge contained significant amount of ash and bagasse contained very low amount of ash. Biomass has a significant amount of energy. Biomass can be used as a raw material along with sewage sludge in pyrolysis. The present study concludes that sugarcane bagasse is a good source of renewable energy, which can be used in co-pyrolysis along with municipal sewage sludge. Pyrolysis characteristics of materials were studied by thermo-gravimetric analysis. Activation energy was calculated by using TGA data. During pyrolysis, major de-volatilization step occurs between 250-500ºC, 240-450ºC and 250-450ºC for sludge, bagasse and their mixture respectively. In this study, Arrhenius equation method is used to calculate activation energy. Activation energy for sludge varies between 21-54 KJ/mol. For bagasse, values of activation energy vary between 16-35 KJ/mol. Activation energy for blend of sludge and bagasse (50:50) varies between 30-35 KJ/mol.

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