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ASSESMENT OF THE LEVELS OF SOME PESISTENT ORGANIC POLLUTANTS (POP) IN ORGANIC MANURES FROM MAJOR REFUSE DUMPSITES IN PANKSHIN L.G.A OF PLATEAU STATE, NIGERIA

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Abstract

Nigeria's struggle to combat persistent organic pollutants (POPs) is severely hindered by inadequate monitoring. Despite the grave health risks posed by these toxic substances which can accumulate in the food chain and cause serious harm, monitoring efforts in Africa, particularly in West Africa, remain woefully insufficient. Furthermore, most West African countries are yet to implement the Stockholm Convention which is a critical framework for reducing and eliminating POPs, also known as the "dirty dozen" by the United Nations Environment Programme (UNEP). In this study, soil samples were collected from waste dumpsites in Bwarak, Tambes, GRA, Daily market and Vel communities of Pankshin Metropolis in Plateau State and analyzed for Polychlorinated Biphenyls (PCBs), Organochlorine pesticides (OCP), and Polycyclic Aromatic Hydrocarbons (PAHs). Gas Chromatography with Mass Selective Detector (GC/MSD) was used for the analysis. The results of the analysis shows that the concentration Organochlorine pesticides, 4,4'-DDT ranges from 0.0419 to 0.0457 mg/kg, Methoxychlor, ranges from 0.0468 to 0.0501 mg/kg while that of Heptachlor, ranges from 0.0299 to 0.0306 mg/kg. Furthermore, that of 4,4'-DDE ranges from 0.0001 to 0.0012 mg/kg while the concentration of Endosulfan sulfate vary from 0.0001 to 0.0003 mg/kg. The concentrations of the PAHs range from 0.0144 to 0.0364 mg/kg. Most of the analyzed PCB congeners (PCB1, PCB5, PCB18) have concentrations below the detection limit (0.0000 mg/kg) across all locations whereas PCB101, PCB110, PCB138, PCB141, PCB151, PCB153, and PCB187 are detected in some locations with concentrations ranging from 0.0003 to 0.0016 mg/kg. The results of this study demonstrates the presence of POPs in the study area with varying levels of contamination, hence the need for environmental monitoring and remediation efforts as well as improved waste management practices in Nigeria, to reduce the impacts of the POPs.

Key Words: Dumpsites, Gas Chromatography/ Mass Selective Detector, Persistent Organic Polutants, pesticides.

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Introduction

Over the years, rising population and lifestyle changes are two vital factors influencing the output and compositions of domestic and municipal solid wastes in Nigeria and the world over. Solid wastes constitutes very serious environmental challenges worldwide due to the huge volume being churned out on daily basis (Abdel-Shafy& Mansour, 2018; Das, Lee, Kumar, Kim, Lee & Bhattacharya, 2019). More worrisome is the environmental pollution concerns of these wastes especially in developing countries like Nigeria where the rates of generation far exceeds the available capacity to manage them (Ike, Ezeibe, Anijiofor & Dauda, 2018; Kehinde, Ramonu, Babaremu & Justin, 2020). In many instances, such management capacities do not even exist. Nigeria is believed to be generating over 42 million metric tons of municipal wastes on annual basis (Ayodele, Alao & Ogunjuyigbe, 2018) with little or no capacity and facilities on ground to manage them adequately.

The composition of municipal solid wastes may vary slightly from one place to another depending on the level of education, civilization, income level, lifestyle and culture. Basically municipal solid wastes are usually composed of food residue, papers, wood residue, textile materials, metal scraps, cans and a variety of polythenes and plastic wastes (Ugwu, Ozoegwu, Ozor, Agwu & Mbohwa, 2021).

Organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) are notorious persistent organic pollutants (POPs) that defy degradation and exert toxic effects on the environment (Haddaoui, Mahjoub, Mahjoub, Boujelben & Di Bella, 2016; Ravenscroft & Schell, 2018). As economies grow, cities face

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escalating pollution from POPs, sparking widespread concern (Diefenbacher, Gerecke, Bogdal & Hungerbühler, 2015).

The presence of POPs in environmental matrices is largely driven by historical application and atmospheric transport (Aichner, Bussian, Lehnik-Habrink & Hein, 2013; Wang, Ren, Gong, Wang, Xue, Yao & Lohmann, 2016). Urban areas serve as emission sources of PCBs and PAHs, primarily from discarded electrical equipment, coal combustion, and vehicle emissions.

Environmental organic pollutants pose significant health risks and environmental stress, as they bioaccumulate in living organisms and resist degradation (Eugine & Vincent, 2016; Jacob, 2013). POPs are halogenated, lipophilic, and poorly soluble in water, facilitating their bioaccumulation in fatty tissues (Ennour-Idrissi, Pierre & Diorio, 2019). Their semi-volatility enables long-range transport, leading to global contamination.

Foods contaminated with POPs pose serious health risks globally, particularly in Africa (Bruce-Vanderpuije et al., 2019). Exposure to POPs has been linked to increased risk of tumors, reproductive impairment, skin rashes, and other adverse health effects (Li, Loganath, Seng, Tan & Philip, 2006; Weber et. al., 2008). This study aimed to investigate the levels of some persistent organic pollutants in organic manures from major refuse dumpsites in Pankshin L.G.A of Plateau state.

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2. 0 MATERIALS AND METHODS

2.1 Materials/Equipment

The equipment used for this analysis was an Agilent 7890B GC with an Agilent 5977B MSD system equipped with a split/splitless inlet and an Agilent 7693 Automatic Liquid sampler.

2.2 Sampling and Sample Preparation

Soil samples were collected from five locations within Pankshin metropolis in Pankshin Local Government Area of Plateau State. The soil samples were collected from a depth of 0-15cm using a soil auger from Pankshin Daily Market area, Bwarak community, Vel community, GRA and Tambes community waste dumpsites in the month of May, 2024. The samples were air-dried in aluminium wrapped trays for a week, sieved through a 2 mm mesh sieve, and packed in 100 ml amber glass bottles with aluminium sealed caps prior to soxhlet extraction. Sample preparation and analysis was carried using the procedure described by Lazar et al., (1992).

2.3 Sample preparation:

The soil sample was air dried to remove excess moisture; this was then followed by grinding into powdered form and sieving to a uniform particle size of < 2 mm. The persistent organic pollutants (POP) was then extracted with hexane using a soxhlet extractor.

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2.4 Sample Analysis

Sample extracts obtained were roto-evaporated to 1 ml and then analyzed for Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs) and Organochlorine pesticides (OCs) using Gas Chromatography with Mass Selective Detector (GC/MSD).

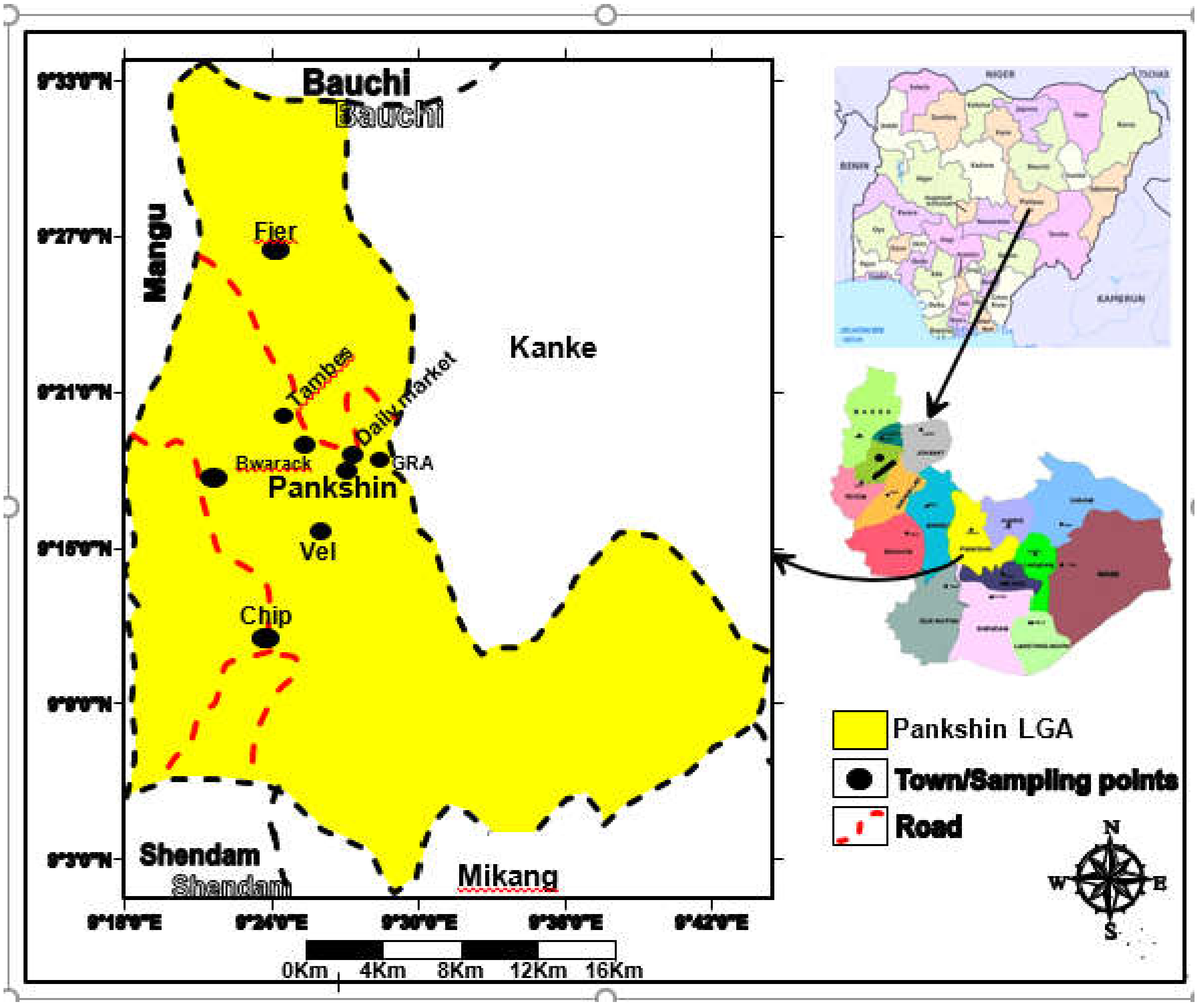

Figure 1: Map of Pankshin LGA

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3.0 RESULTS AND DISCUSSION

3.1 Results

Tables' 1-3 shows the results of the concentrations of all the POPs analysed.

Table 1

Results of Organochlorine Pesticides concentration (OCs) from different locations in Pankshin metropolis

Organochlorine Pesticides	BWARAK	DAILY	GRA	VEL	TAMBES
a-BHC [mg/kg]	0.0209	0.0165	0.0096	0.0087	0.0106
b-BHC [mg/kg]	0.0277	0.0248	0.0191	0.0244	0.0173
d-BHC [mg/kg]	0.0225	0.0168	0.0107	0.0201	0.0123
g-BHC [mg/kg]	0.0134	0.0103	0.0098	0.0130	0.0104
Heptachlor [mg/kg]	0.0299	0.0299	0.0306	0.0302	0.0219
Aldrin [mg/kg]	0.0093	0.0074	0.0078	0.0080	0.0053
Heptachlor epoxide [mg/kg]	0.0024	0.0024	0.0024	0.0023	0.0014
Endosulfan I [mg/kg]	0.0230	0.0046	0.0245	0.0093	0.0200
Dieldrin [mg/kg]	0.0154	0.0185	0.0230	0.0348	0.0134
4,4'-DDE [mg/kg]	0.0001	0.0005	0.0012	0.0005	0.0001
Endosulfan II [mg/kg]	0.0015	0.0054	0.0073	0.0013	0.0012
Endrin aldehyde [mg/kg]	0.0021	0.0026	0.0020	0.0025	0.0011
Endosulfansulfate [mg/kg]	0.0002	0.0001	0.0002	0.0003	0.0012
4,4'-DDT [mg/kg]	0.0433	0.0419	N.D	0.0457	0.0333
Methoxychlor [mg/kg]	0.0468	0.0488	0.0501	0.0468	0.0258

Table 1 shows the residual levels of various organochlorine pesticides (OCs) in the samples. The results reveal that 4,4'-DDT, has the highest residual concentration with values ranging from 0.0419 to 0.0457 mg/kg. This was followed by methoxychlor with concentration ranging from

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0.0468 to 0.0501 mg/kg. Heptachlor Residue levels in the samples were consistently high across all samples, ranging from 0.0299 to 0.0306 mg/kg. On the other hand, the levels of 4, 4'-DDE were low (0.0001 to 0.0012 mg/kg). Also, the levels of Endosulfan sulfate residue were also relatively low, ranging from 0.0001 to 0.0003 mg/kg. The residue levels of some pesticides, such as Heptachlor and 4,4'-DDT, were relatively consistent across all samples. In contrast, the residue levels of other pesticides, such as Endosulfan I and Dieldrin, widely across the samples. On the whole, the results in table 1 suggests that some organochlorine pesticides, such as 4,4'-DDT and Methoxychlor are present at relatively high levels in some samples, while that of other pesticides, such as 4,4'-DDE and Endosulfan sulfate, were generally much lower.

The findings of this studies is similar to earlier research carried out in South Western Nigeria (Olaniyi et al., 2015; Oyekunle et al., 2018) who also found high levels of organochlorine pesticides in waste dumpsites. Findings by (Afolabi et al., 2017) highlight the health risks associated with exposure to pesticides in waste dumpsites. These results are however contrary to that of some studies in the United States and European Union in which lower levels of pesticide contamination were recorded in waste dumpsites (USEPA, 2020; ECHA, 2020). This is attributable to the fact that these developed countries often have stricter regulations and guidelines for pesticide use and waste management e.g. EU's Persistent Organic Pollutants Regulation.

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Tukey's HSD test was used to compare means between groups. The results show significant differences ($p < 0.05$) between 4,4'-DDT and Heptachlor epoxide, 4,4'-DDT and Endosulfan sulfate, Methoxychlor and Heptachlor epoxide and Methoxychlor and Endosulfan sulfate.

Table 2

Results of Polycyclic Aromatic Hydrocarbon concentration (PAHs) from different locations in Pankshin metropolis

PAHs (mg/kg	BWARAK	DAILY MARK	VEL	GRA	TAMBES
Acenaphthylene	0.0216	0.0364	0.0004	0.0004	0.0002
Acenaphthene	N. D	N.D.	0.0004	N.D.	N.D.
Fluorene	0.02	0.0196	0.0004	0.0004	0.0001
Phenanthrene	0.018	0.0184	0.0004	0.0004	0.0003
Anthracene	N.D.	0.0124	0.0004	N.D.	N.D.
Fluoranthene	0.0148	0.0144	0.0004	0.0004	0.0003
Pyrene	0.0148	0.0144	0.0004	0.0004	0.0005
Benzo[c]phenanthrene	0.0212	N.D.	N.D.	N.D.	N.D.
Benzo[a]phenanthrene	0.022	0.0216	0.0012	0.0004	0.0005
Benzo[j+k+b]fluoranthene	0.0256	0.026	0.0004	0.0004	0.0004
Benzo[a]pyrene	0.0268	0.0268	0.0008	0.0004	0.0004
Benzo[e]pyrene	0.0248	0.0248	0.0008	0.0004	0.0006
3-Methylcholanthrene	N.D.	N.D.	0.0004	N.D.	N.D.
Indeno[1,2,3-cd]pyrene+Dibenz(a,h)anthracene	N.D.	0.032	0.0008	N.D.	0.0004
Benzo(ghi)perylene	N.D.	N.D.	0.0012	N.D.	N.D.
Dibenz(a,l)pyrene	0.034	0.0332	0.0012	N.D.	0.0003

Table 2 presents the concentrations of various PAHs in soil samples from the different dumpsites. PAHs are a group of environmental pollutants that are known to be carcinogenic and mutagenic. The highest concentrations of PAHs in this study were found in the Bwarak and Pankshin Daily Market dumpsites, with values ranging from 0.0144 to 0.0364 µg/g. Conversely, lower concentrations were found in Vel and GRA dumpsites with most of the values below

0.0012 µg/g. Some PAHs such as Acenaphthene, Anthracene, and 3-Methylcholanthrene were not detected (N.D.) in some of the dumpsites. Benzo[a]pyrene, a known carcinogen, was found in relatively high concentrations in the Bwarak and Daily Market dumpsites (0.0268 µg/g). These high concentrations suggest that these areas may be contaminated with hazardous wastes, posing a risk to human health and the environment. On the other hand, the low concentrations of PAHs in the Vel and GRA dumpsites are an indication of lower contamination.

The presence of Benzo[a]pyrene and other carcinogenic PAHs in the dumpsites highlights the need for proper waste management and disposal practices to prevent environmental pollution. A study on PAHs in soil and water samples from dumpsites in Lagos Nigeria, reported concentrations ranging from 0.01 to 10.3 µg/g (Adeyemi et al., 2017) which is higher than the concentration in the current research. Another study on PAHs in soil samples from dumpsites in Abuja, Nigeria, gave values ranging from 0.005 to 1.35 µg/g (Ilori et al., 2018).

A study on the health risks associated with PAHs exposure in dumpsites in Nigeria reported that the estimated daily intake of PAHs exceeded the tolerable daily intake recommended by the World Health Organization (WHO) (Egboro et al., 2020). Studies also on PAHs in soil samples from dumpsites in China reported concentrations ranging from 0.01 to 100 µg/g (Wang et al., 2019). A related study on PAHs in soil and water samples from dumpsites in India reported concentrations ranging from 0.01 to 10 µg/g (Singh et al., 2018). Futhermore, another study on the environmental impacts of PAHs in dumpsites in the United States reported

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that PAHs were found in 100% of soil samples from dumpsites, with concentrations ranging from 0.01 to 100 µg/g (USEPA, 2019). The concentrations of PAHs in dumpsite soils in Nigeria are generally lower than those reported in international studies. However, the findings of this study and other similar ones in Nigeria suggests that PAH contamination is a widespread problem in Nigeria, with potential health risks for people living near dumpsites and others who excavates manures from the dumpsites for the cultivation of crops.

Table 3

Results of Polychlorinated biphenyls concentration (PCBs) from different locations in Pankshin metropolis

Polychlorinated biphenyls	BWARAK	DAILY MARKET	GRA	VEL	TAMBES
PCB1 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB5 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB18 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0001
PCB29 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB44 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB52 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PB66 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB87 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB101 [mg/kg]	0.0000	0.0006	0.0000	0.0000	0.0001
PCB110 [mg/kg]	0.0000	0.0004	0.0000	0.0000	0.0000
PCB138 [mg/kg]	0.0000	0.0003	0.0000	0.0000	0.0000
PCB141 [mg/kg]	0.0012	0.0000	0.0009	0.0000	0.0000
PCB151 [mg/kg]	0.0016	0.0000	0.0012	0.0000	0.0000
PCB153 [mg/kg]	0.0015	0.0000	0.0011	0.0000	0.0000
PCB170 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB180 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000
PCB183 [mg/kg]	0.0000	0.0000	0.0004	0.0000	0.0000
PCB187 [mg/kg]	0.0000	0.0000	0.0012	0.0000	0.0000
PCB206 [mg/kg]	0.0000	0.0000	0.0000	0.0000	0.0000

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Table 3 shows the results of the PCB analysis as obtained from the different waste dumpsites in Bwarak community, Daily Market, GRA, Tambes and Vel communities. Most of the analyzed PCB congeners (PCB1, PCB5, PCB18, etc.) have concentrations below the detection limit (0.0000 mg/kg) across all the locations, whereas PCB101, PCB110, PCB138, PCB141, PCB151, PCB153, and PCB187 were detected in some locations, with concentrations ranging from 0.0003 to 0.0016 mg/kg. Results from GRA shows the highest concentrations of PCB141 (0.0009 mg/kg), PCB151 (0.0012 mg/kg), PCB153 (0.0011 mg/kg), and PCB187 (0.0012 mg/kg). However, the total PCB concentrations in all locations are below the USEPA's maximum allowable limit of 1.0 mg/kg. Similarly, the sum of the seven indicator PCBs is below the European Union's limit of 0.1 mg/kg in all the locations. The low levels of PCBs detected in the waste dumpsite soils suggest that the site may not pose a significant risk to human health and the environment.

Findings by (Adeyemi et al., 2018) around electronic waste dumpsites in Nigeria shows similar levels of PCBs in soil and sediment samples. Also, a related study in China by (Wang et al., 2019) has reported higher levels of PCBs in environmental samples. The presence of PCBs in these locations even though within acceptable limits may accumulates overtime indicating environmental contamination, which can have adverse effects on human health and on the ecosystem. Hence the detection of PCBs in these locations raises concerns about human exposure through inhalation, ingestion, or dermal contact

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CONCLUSION

Manure samples were collected from five (5) refuse dumpsites in Pankshin Metropolis and analysed for the presence of some selected persistent organic pollutants namely, Organochlorine pesticides (OCP), Polychlorinated biphenyls (PCB) and Polycyclic Aromatic Hydrocarbons (PAHs) using Gas Chromatography with Mass Selective Detector (GC-MSD). The overall results suggests that some organochlorine pesticides, such as 4,4'-DDT and Methoxychlor, may be present at relatively high levels in some of the samples. However, the residue levels of other pesticides, such as 4,4'-DDE and Endosulfan sulfate, were generally much lower. Most of the analyzed PCB congeners (PCB1, PCB5, PCB18, etc.) have concentrations below the detection limit (0.0000 mg/kg) across all the sampled locations with GRA giving the highest concentrations of PCB141 (0.0009 mg/kg), PCB151 (0.0012 mg/kg), PCB153 (0.0011 mg/kg), and PCB187 (0.0012 mg/kg). The highest concentrations of PAHs were found in Bwarak and Daily Market dumpsites, while the lowest concentrations were obtained in Vel and GRA dumpsites, with most values below 0.0012 µg/g. The results of this study demonstrates the presence of POPs in different locations within Pankshin metropolis, with varying levels of contamination. The findings of this research highlights the need for serious environmental monitoring and remediation as well as the urgent need for improved waste management practices in Nigeria in order to reduce the harmful impacts of POPs on plants and animals lives.

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COMPETING INTERESTS

The authors have declared that no competing interests exist.

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