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EFFECTS OF PESTICIDES RECIDUES ON *TILAPIA ZILLII*, SEDIMENT AND SURFACE WATER OF ERINLE DAM AND RIVER OSUN IN OSUN STATE

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Abstract

This study investigates the effects of selected pesticides on the health of aquatic ecosystems and humans in Erinle Dam and River Osun, Osun State, Nigeria. Focusing on *Tilapia zillii*, a commonly consumed fish in the region, the research assesses the potential health risks posed by pesticides found in the water, sediments, and fish tissues. Samples were collected following APHA guidelines and tested for pesticides like DDT, Heptachlor, Dieldrin, Aldrin, and Chlorpyrifos. The findings revealed high levels of DDT and Chlorpyrifos in both the water and fish, with Erinle Dam showing higher concentrations than River Osun. Specifically, DDT levels in River Osun's water averaged 199.08mg/kg, while Erinle Dam had 271.58mg/kg. Dieldrin and Chlorpyrifos also showed high concentrations, with Heptachlor and Aldrin absent in the water samples from both sites. Fish tissue analysis indicated higher pesticide levels in specimens from Erinle Dam compared to River Osun. DDT and Chlorpyrifos concentrations were notably high, while Dieldrin, Aldrin, and Heptachlor were present in lower amounts. Similarly, sediment analysis showed Erinle Dam with higher pesticide concentrations, particularly for DDT, Dieldrin, and Chlorpyrifos, while Heptachlor and Aldrin were absent.Overall, the study highlights significant pesticide contamination in Erinle Dam and River Osun, posing health risks to local fish consumers and indicating a need for stringent pesticide regulation and monitoring in the region.

Keywords: water, Pesticide, surface water, sediments, tilapia fish, Erinle Dam, River Osun

Introduction

Reduction of the proliferation of pest and increase in food production, has made pesticides application in agriculture inevitable (Akoto *et al.* 2013). Pesticides constitute one of the most hazardous groups of contaminants (Vega et al. 2005), posing potential risk to humans and other life forms (Jeyakumar et al. 2014). Commonly used pesticides include DDT, Aldrin, Dieldrin, Heptachlor, and Chlorpyrifos, among others. Initially, pesticides were seen as essential for achieving food self-sufficiency and boosting export economies. However, despite their extensive use, crop loss due to pests has not significantly decreased over the past 50 years (Pimentel, 1991). Pesticides, while targeting pests, are toxic to a wide range of life forms and can contaminate water bodies, affecting aquatic life and eventually humans through the food chain (NEST, 1991).

Pesticides often end up as environmental contaminants, with less than 0.1% of insecticides reaching their intended targets (Pimentel and Lios, 1988). They can vaporize, runoff into water bodies, or leach into groundwater, leading to widespread pollution. Atrazine, a commonly used herbicide, exemplifies this issue, contaminating water and harming aquatic ecosystems. Pesticides can disrupt endocrine and immune systems in aquatic organisms, and they bioaccumulation in tissues, extending their harmful effects. Predatory birds, such as eagles and falcons, experienced population declines in the 1960s and 1970s due to the bioaccumulation of organochlorine pesticides.

Despite bans in developed countries due to their stability, lipid solubility, and toxicity, organochlorine pesticides are still used in Nigeria. Their persistent nature and indiscriminate potency continue to raise concerns among governments and researchers regarding their environmental presence (Bouwman *et al.*, 1990; Caldas *et al.*, 1999).

Materials and Methods

Methodology and Research Design This study utilized an experimental research design to investigate the effects of pesticides on aquatic ecosystems. A comprehensive survey of the study area and its environment was conducted through direct observation, using a checklist to gather information on water pollution, odor, E. coli levels, and other factors. This method helped determine how organisms in the stream adapt to various conditions.

The experimental work was carried out at the Institute of Agricultural Research and Training in Ibadan. Water and sediment samples from Erinle Dam and Osun River were collected in clean kegs rinsed with distilled water. Various fish species, including *Oreochromis niloticus,*

Tilapia zillii, Auchenogianis occidentalis, and *Clarias anguilaris,* were found, but *Tilapia zillii* was selected for the experiment due to its high consumption and affordability. Fish were purchased from local fishermen.

Pesticides such as DDT, Heptachlor, Dieldrin, Aldrin, and Chlorpyrifos were applied in different doses over two months to test their effects on the samples. The results were recorded, analyzed, and compared to a control setup.

Extraction of Pesticide Residues from Fish Flesh and Tissues

Procedure: One gram of fish flesh or tissue was blended with 20 ml of acetonitrile saturated with petroleum ether. The mixture was homogenized, filtered into a 100 ml flask, and diluted. The solution was transferred to a separating funnel, shaken with sodium chloride solution and distilled water, and the aqueous layer was discarded. The organic layer containing pesticide residues was washed, transferred to a flask, and used for quantitative analysis of pesticide residues.

Determination of Pesticides

DDT:

10 ml of extract was mixed with hexane-acetone and Na_2SO_4, filtered, and treated with tetrabromophenolphthalein dye. Absorbance was read at 315 nm, and DDT was calculated using the formula: Absorbance of sample X Gradient factor X Dilution factor

1000

Heptachlor:

10 ml of extract was mixed with ethanol, HCl, and magnesium turnings to develop a magenta red color. Absorbance was read at 520 nm, and Heptachlor was calculated using the formula:

Absorbance of sample X average gradient factor X dilution factor

1,000

Dieldrin:

10 ml of extract was refluxed with alcoholic KOH, cooled, and extracted with chloroform. Absorbance was read at 328 nm, and Dieldrin was calculated using the formula:

(µg/kg)=Absorbance of sample x gradient factor x dilution factor

1000

Aldrin:

10 ml of extract was dissolved in chloroform, treated with sodium bicarbonate, and filtered. Absorbance was read at 415 nm, and Aldrin was calculated using the formula:

(µg/kg) = Absorbance of sample x gradient factor x dilution factor

1000

Chlorpyrifos:

10 ml of extract was mixed with benzene, zinc dust, and NaOH. Absorbance was read at 640

nm, and Chlorpyrifos was calculated using the formula:

Absorbance of sample X gradient factor X dilution factor

1,000

Results

While pesticides have historically been considered essential for achieving food self-sufficiency and boosting export-oriented agriculture, their proper application and usage are crucial. Our study, which examined samples from Erinle Dam and Osun River, highlights the significant impact of pesticides on fish (*Tilapia zillii*), surface water, and bottom sediments. These findings emphasize the necessity of careful chemical handling.

Analysis of Pesticide Levels in Fish Samples

The study revealed notably high levels of DDT and Chlorpyriphos in fish heads from both Osun River and Erinle Dam. In Osun River, the mean values were 0.296 mg/kg and 0.48 mg/kg, respectively, while in Erinle Dam, they were 0.4583 mg/kg and 0.5433 mg/kg. Conversely, Dieldrin, Aldrin, and Heptachlor levels were significantly lower, with Heptachlor being the lowest detected (Figure 1 and 2; Table 1 and 2). According to Colburn (1992), pesticides can have less obvious but potentially devastating effects by interfering with the endocrine and immune systems of animals, including humans. The endocrine system regulates hormone production and function, controlling everything from reproduction to development. The small quantities of pesticides required to cause damage raise concerns that current contamination levels could have widespread effects on wildlife populations (Howard, 1991). This situation could be particularly relevant for Erinle Dam.

Pesticide Concentration in Gills

The study revealed higher pesticide concentrations in the gills of fish from Erinle Dam compared to those from Osun River (Figure 2). The mean values for DDT and Chlorpyriphos in Osun River were 0.1617 mg/kg and 0.2183 mg/kg, respectively, whereas in Erinle Dam, they were 0.1683 mg/kg and 0.3450 mg/kg. Dieldrin, Aldrin, and Heptachlor levels were lower, with Heptachlor being the lowest. The high concentration in gills may be attributed to their role in respiration, which exposes them directly to contaminated water. This observation is supported by Carl and Shelley (1990) and Howard (1991).

Pesticide Levels in Fish Tissues

The levels of DDT, Dieldrin, and Chlorpyriphos in fish tissues were higher in Erinle Dam than in Osun River, while Heptachlor and Aldrin levels were higher in Osun River (Figure 3). Specifically, the mean values for DDT and Chlorpyriphos in Osun River were 0.3883

mg/kg and 0.6317 mg/kg, respectively, whereas in Erinle Dam, they were 0.5600 mg/kg and 0.6933 mg/kg.

Pesticide Concentration in Water and Sediment

Erinle Dam showed higher concentrations of pesticides in water and sediment compared to Osun River (Figure 3 and Figure 4). DDT had the highest concentration, followed by Dieldrin and Chlorpyriphos. Heptachlor and Aldrin were not detected. This high concentration could be due to extensive farming in the area, leading to pesticide runoff into water bodies, which in turn affects aquatic life and potentially accumulates through the food chain (NEST, 1991).

The higher concentration of pesticides in Erinle Dam sediments compared to Osun River is likely due to weed colonization and sediment deposition from surrounding areas. Additionally, activities such as fishing and farming near the riverbanks contribute to runoff loaded with sediments and pesticides.

Table 1: Result of Fish Samples in Osun River (Mean Value)

Fish Samples Erinle	DDT (µg/kg)	Heptachlor (µg/kg)	Dieldrin (µg/kg)	Aldrin (µg/kg)	Chlorpyriphos (µg/kg)
Head	0.4583	0.0117	0.1267	0.0550	0.5433
Gill	0.1683	0.0100	0.0683	0.0200	0.3450
Tissue	0.5600	0.0200	0.2533	0.0317	0.6933

Table 2: Result of Fish Samples in Erinle Dam (Mean Value)

Fish Samples Osun	DDT (µg/kg)	Heptachlor (µg/kg)	Dieldrin (µg/kg)	Aldrin (µg/kg)	Chlorpyriphos (µg/kg)
Head	0.2967	0.0067	0.0667	0.0067	0.4800
Gill	0.1617	0.0017	0.0200	0.0050	0.2183
Tissue	0.3883	0.0250	0.1217	0.0450	0.6317

Table 3: Result of Water and Sediment in Osun River (Mean Value)

Samples Osun	DDT (µg/kg)	Heptachlor (µg/kg)	Dieldrin (µg/kg)	Aldrin (µg/kg)	Chlorpyriphos (µg/kg)
Sediment	322.20	0.0480	191.48	1.0975	176.98

Samples Osun	DDT (µg/kg)	Heptachlor (µg/kg)	Dieldrin (µg/kg)	Aldrin (µg/kg)	Chlorpyriphos (µg/kg)
Water	199.08	0.0250	116.08	0.8450	124.33

Table 4: Result of Water and Sediment in Erinle Dam (Mean Value)

Samples Erinle	DDT (µg/kg)	Heptachlor (µg/kg)	Dieldrin (µg/kg)	Aldrin (µg/kg)	Chlorpyriphos (µg/kg)
Sediment	380.75	0.0630	216.70	1.3775	186.23
Water	271.58	0.1880	128.78	1.1350	135.13

Key Observations

Water and Sediment in Osun River vs. Erinle Dam

DDT:
Higher concentrations in Erinle Dam for both sediment and water.

Heptachlor:
Significantly higher in Erinle Dam water.

Dieldrin:
Higher in Erinle Dam for both sediment and water.

Aldrin:
Higher concentrations in Erinle Dam.

Chlorpyriphos:
Higher in Erinle Dam for both sediment and water.

Fish Samples in Osun River vs. Erinle Dam

DDT: In both locations, the tissue of fish contains the highest concentration of DDT.
The concentrations are generally higher in the Osun River compared to Erinle Dam.

Heptachlor: Concentrations are relatively low in both locations, but slightly higher in Osun River.

Dieldrin: Osun River has higher concentrations across all fish sample types.

Aldrin: Similar trend to Dieldrin, with higher concentrations in Osun River.

Chlorpyriphos: Higher in Osun River fish samples.

Summary

Fish Samples: The contamination levels for most pesticides are higher in the Osun River than in the Erinle Dam.

Water and Sediment: The Erinle Dam shows higher contamination levels than the Osun River for all pesticides except Chlorpyriphos, which is slightly higher in Osun River sediment.

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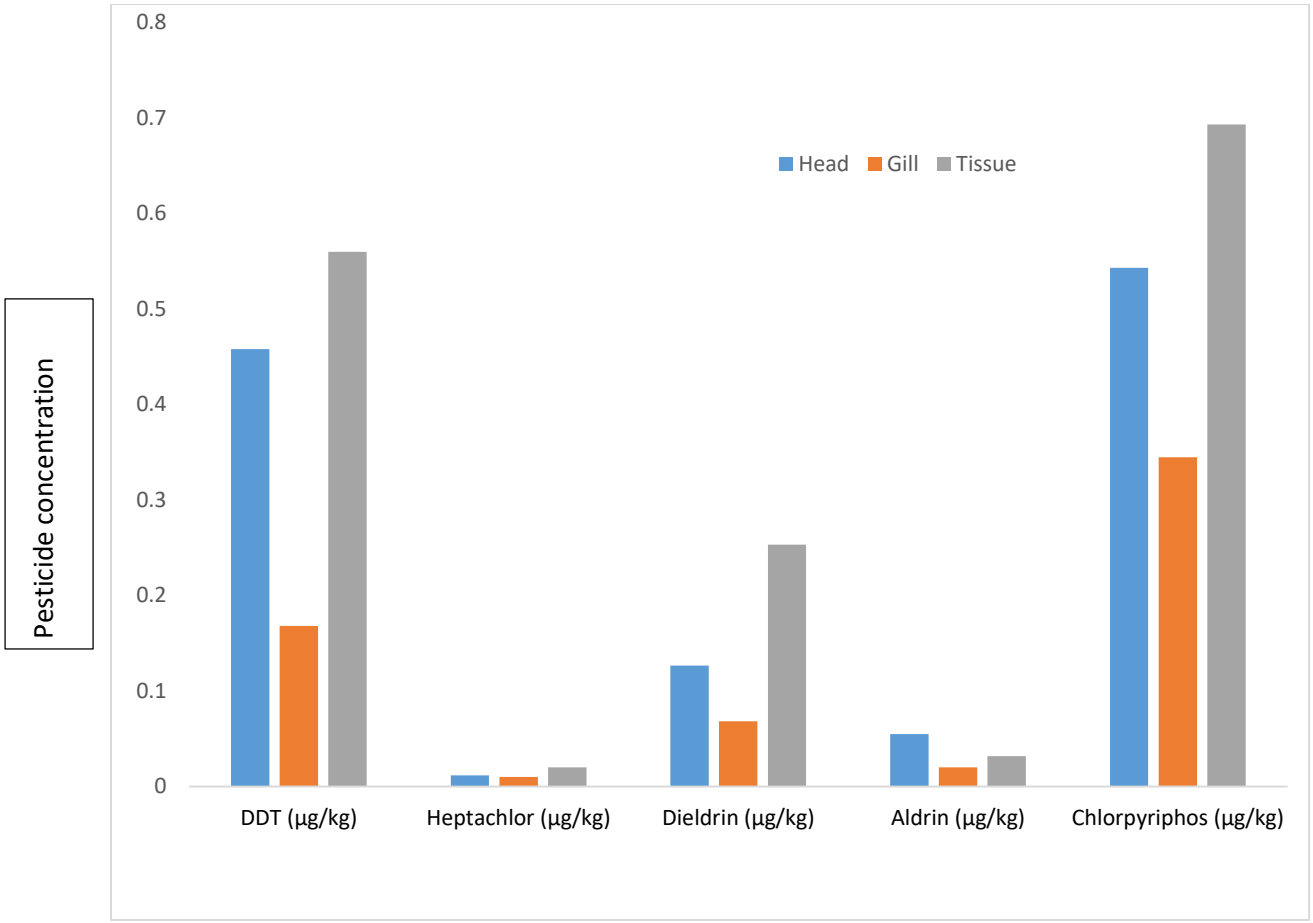

Figure 1: **Mean concentration of pesticide in head, gills and tissues of *Tilapia zilli in* Osun River**

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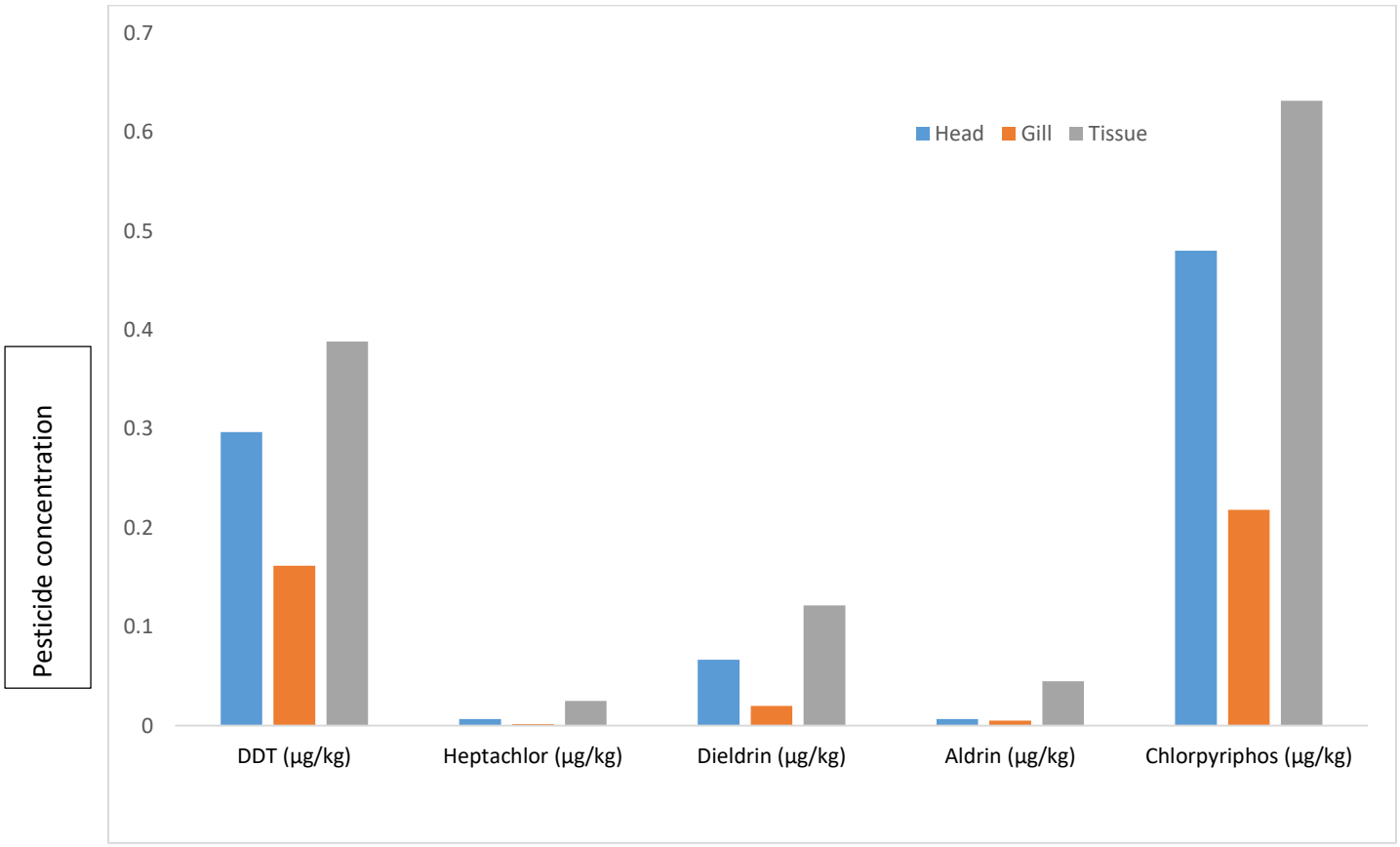

Figure 2: **Mean concentration of pesticide in head, gills and tissues of *Tilapia zilli in* Erinle Dam**

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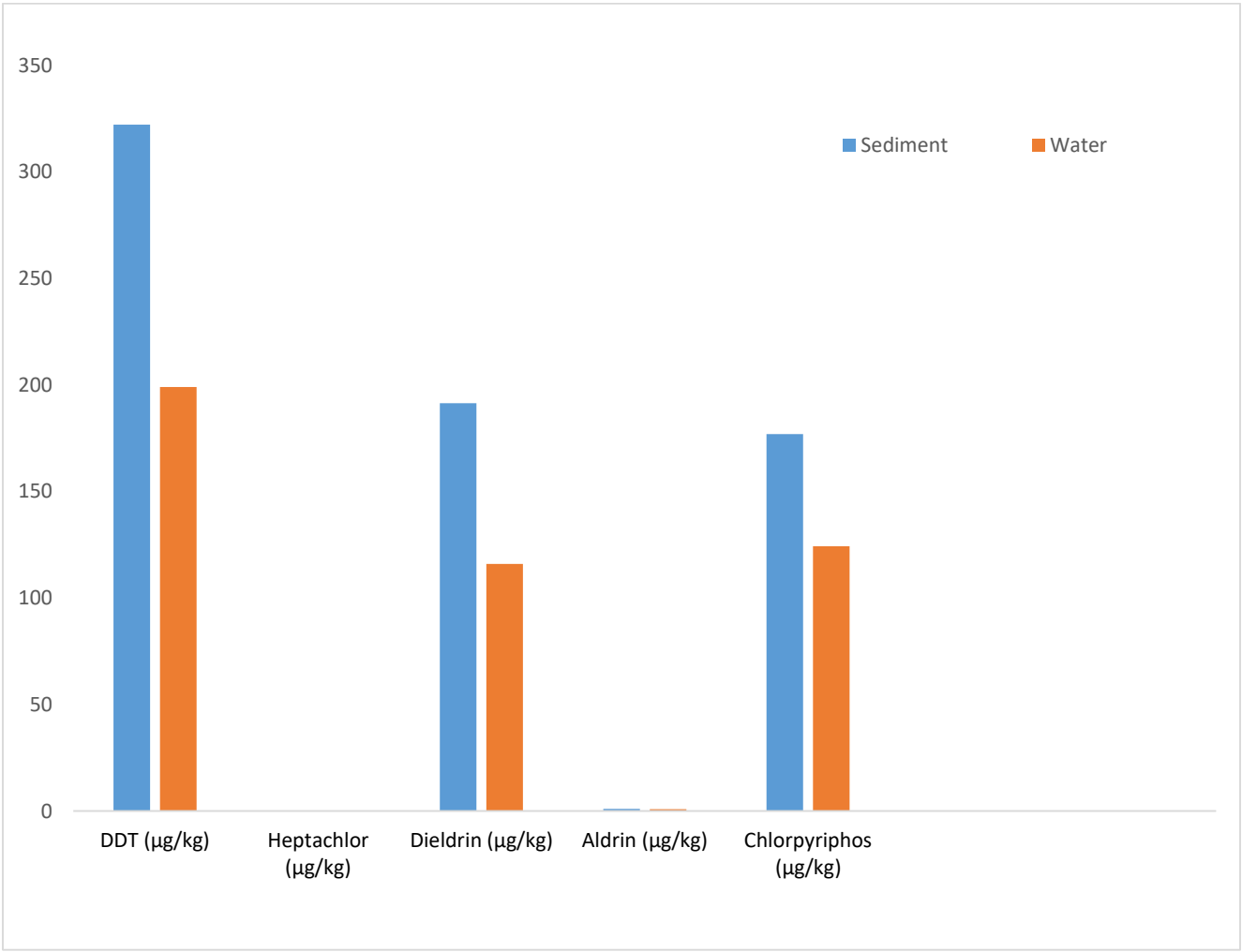

Figure 3: **Mean concentration of pesticide in Water and Sediment in Osun River (Mean Value)**

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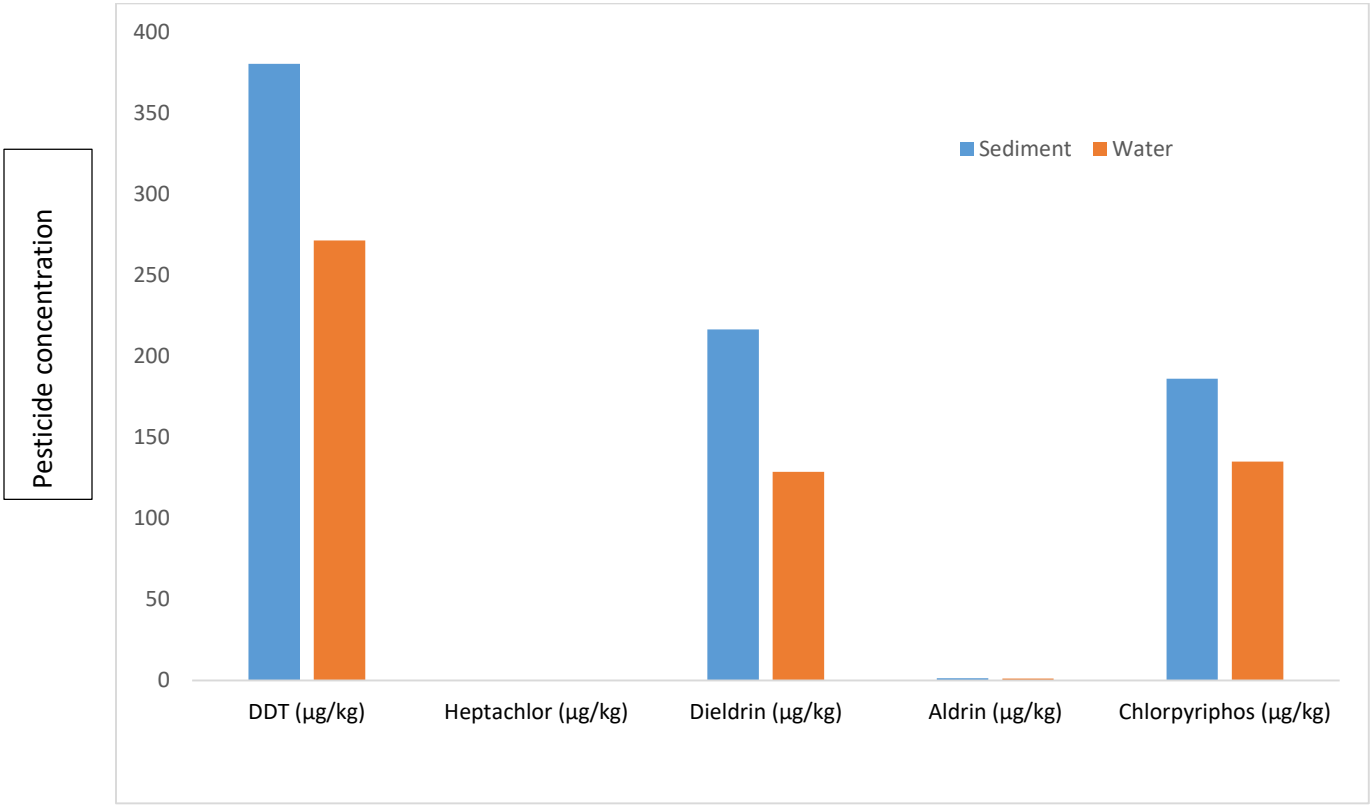

Figure 4: Mean concentration of pesticide in Water and Sediment in Erinle Dam

Discussion

Pesticides have long been considered essential for achieving food self-sufficiency and boosting export-oriented agriculture. However, their application must be managed carefully. Our experiment, which involved collecting samples from Erinle Dam and River Osun, aimed to assess the effects of pesticides on fish (Tilapia zillii), surface water, and bottom sediments, highlighting the need for proper handling of these chemicals.

Our analysis revealed significant pesticide levels, particularly DDT and Chlor, in the fish samples. In River Osun, the concentrations of DDT and Chlor in fish heads were 0.296 mg/kg and 0.48 mg/kg, respectively, while in Erinle Dam, the levels were higher, at 0.4583 mg/kg and 0.5433 mg/kg. Conversely, Dieldrin, Aldrin, and Heptachlor levels were much lower, with River Osun fish showing values of 0.0667 mg/kg, 0.0067 mg/kg, and 0.0067 mg/kg, and Erinle Dam fish showing 0.1267 mg/kg, 0.055 mg/kg, and 0.0117 mg/kg. Colburn (1992) noted that pesticides could disrupt the endocrine and immune systems in animals, including humans. The endocrine system regulates hormone production and function, influencing everything from reproduction to development. Suzawa & Ingraham, 2008, reported that, “Endocrine disrupting chemicals (EDCs) affect the reproductive health of fish and amphibious wildlife but their impact on mammals and particularly humans is less clear. This issue may be particularly relevant for Erinle Dam. Further analysis indicated that fish gills from Erinle Dam had higher pesticide concentrations than those from River Osun. DDT and Chlor levels were higher in Erinle Dam gills, at 0.1683 mg/kg and 0.3450 mg/kg, compared to 0.1617 mg/kg and 0.2183 mg/kg in River Osun gills. Dieldrin, Aldrin, and Heptachlor levels in the gills were also noteworthy, with Erinle Dam showing 0.0683 mg/kg, 0.20 mg/kg, and 0.010 mg/kg, and River Osun showing 0.20 mg/kg, 0.0050 mg/kg, and 0.0017 mg/kg. The gills' exposure to the environment likely explains these high concentrations (Carl and Shelley, 1990; Howard, 1991).

In fish tissues, DDT, Dieldrin, and Chlor levels were higher in Erinle Dam than in River Osun. Erinle Dam fish tissues had DDT and Chlor levels of 0.6933 mg/kg and 0.560 mg/kg, while River Osun had 0.6317 mg/kg and 0.3883 mg/kg. Conversely, Heptachlor and Aldrin levels were higher in River Osun fish tissues, at 0.2533 mg/kg and 0.0450 mg/kg, compared to Erinle Dam’s 0.1217 mg/kg and 0.020 mg/kg. Erinle Dam also showed higher pesticide concentrations in water than River Osun,

particularly for DDT, Dieldrin, and Chlor. This discrepancy may result from extensive farming in the area, leading to pesticide runoff into water bodies, which can harm aquatic life and enter the food chain (NEST, 1991). Additionally, Erinle Dam's sediment showed higher pesticide levels due to weed colonization and sediment deposition from surrounding areas, exacerbated by footpaths used by local fishermen and farmers cultivating crops like cassava and maize. Studies have shown that OC pesticides tend to accumulate more in aquatic organisms and they substantially settle on the sediments (Akan et al. 2014). The result of this study indicates that OC pesticide residues were present in varying amounts in different organs of fish and sediments sampled from Oshun Riverr. Indeed, the study has revealed that any pesticide present in water will preferably be adsorbed to sediment or bioaccumulate in fish due to low water solubility of OC pesticides (Caldas *et al.* 1999).

These findings underscore the need for proper pesticide management to mitigate environmental and health risks.

Conclusion and Recommendations

This study confirmed higher concentrations of pesticides in Erinle Dam compared to Osun River, with DDT and Chlorpyriphos being predominant. Despite the ban on DDT, its presence indicates continued use in the area. Fish, particularly *Tilapia zillii*, serve as primary indicators of stream and lake contamination. This finding is significant not only because this fish species is commonly consumed in Ede town, Osun State, but also because fishing is a primary occupation in the region. Given that fish sold in local markets are sourced from these rivers, there is a pressing need for monitoring pesticide residues in water, food, and the environment. Such monitoring can prevent environmental and public health hazards, protecting communities reliant on these water bodies for their livelihoods.

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