IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 5, Issue 3, January 2025

# Evaluating Water Quality and Organo-Pesticide Contamination in *Oreochromis niloticus* (Nile Tilapia) in Wawan Rafi and Dambo Dam, Kazaure, Jigawa State:

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**Abstract***: The study investigated the presence of freshwater pollutants and their effects on Oreochromis niloticus(nile tilapia) in the Wawan Rafi and Dambo Dams of Kazaure, Jigawa State. The water samples were found to be within the World Health Organization's permissible guideline for temperature and dissolved oxygen levels. The mean value of temperature, dissolved oxygen (DO), and conductivity (EC) ranged between 23.13±0.8 and 28.25±0.7, 6.5-8.5mg/l, 7.347±0.3, 145.6±16 and 158.3±6.1. The mean turbidity obtained from all stations was far higher than the 5 NTU (Nephelometric turbidity unit) value recommended by the WHO, indicating that the water samples were more turbid than needed. Total dissolved solids content (TDS) levels in the water samples were above the WHO's recommended level, but TSS's mean values fell below the WHO's recommended limits of 450-2000mg/L. Mean hemoglobin levels varied between 6.230 g/dL and 7.570 g/dL, with low levels likely due to heavy metals altering hemoglobin's properties. The study found that Oreochromis niloticus had mean red blood cells (RBC) ranging from 1.180x1012/mL to 1.45x1012/mL, and mean white blood cells (WBC) ranging from 153.100 x 109/mL to 167.67 x 109/mL. The mean corpuscular hemoglobin concentration was unaffected by blood volume and the number of blood cells. The data suggests that Oreochromis niloticus has a unique cellular structure and composition. Heavy metals in water can significantly impact the life and lifespan of aquatic organisms, including fish and aquatic invertebrates. The average mean value of Lead (Pb) in the water sample falls above the World Health Organization (WHO) recommended level of 0.01mg/l in all stations. Chromium levels are higher than the WHO permitted chromium level of 0.05mg/L, which can affect fish organs like gills and liver. Zn levels are lower than the WHO permissible level of 3 mg/L. The fish concentration of heavy metals analyzed in both Wawan Rafi and Dambo Dam had a highest value of Pb (mg/L) 0.1550±0.0, Cr (mg/L) 0.14205±0.0, Zn (mg/L) 1.7750±0.0, Cu (mg/L) 0.5400±0.,Cd (mg/L) 0.07850±0.0, and Ni (mg/L) 0.0475±0.0which are within permissible limit except for Pb, which is slightly higher than the recommended level. Various organo-pesticide were also detected in fish and water samples of both Wawan Rafi and Dambo Dam of which long-term exposure may lead to bioaccumulation in food chains, posing a threat to human health through dietary exposure. Recommendations include proper waste treatment, strict enactment of government policies on pesticide use, waste disposal, and proper sanitation around water sources. Further studies should focus on oxidative stress enzymes on Oreochromis niloticus in the study area.*

**Keywords:** Heavy Metals, *Oreochromis niloticus*, freshwater pollutants, Physicochemical Parameters and Toxic Effects.

## I. INTRODUCTION

Water is extremely essential for the survival of all living organisms. Therefore its quality is crucial tomankind as it is directly linked with his welfare (Kabiru and Abdullahi 2022). The pollution of waterwith pollutants especially heavy metals (Zamora-Ledezma et al. 2021)and organo-pesticides(Semu, Tindwa, and Singh 2019)has become a worrisome problem worldwide due to their toxicity, persistence and non-degradability in the environment (Ozturk et al. 2009). Heavy metals in the aquatic environment canexist in low concentrations but over time they can bioaccumulate, persist and attain considerable concentration level in sediments and biota(Censi et al. 2006). Some of the metals like Zn, Cu, Fe and Mn, are essential for their role in organism metabolism, but they are only required in low concentrations. At concentrations exceeding certain threshold limit, they can manifest their toxicity to the organisms(Hänsch and Mendel 2009). On the other hand,heavy metals, like arsenic (As), cadmium (Cd), lead (Pb), and chromium (Cr), can pose significant health risks even at low concentrations (Sagagi et al. 2022) due to their high toxic effect and persistence (Balali-Mood et al. 2021).

Pesticides which are used to improve agricultural yield to support the rapidly expanding population,are also recognized as other agents of environmental pollution (Wilson and Tisdell 2001). They are chemicals or biological substances meant for attracting, destroying or mitigating any pest (Kaur et al. 2019). In the course of their usage, they can leach through run-offs from agricultural land by gravity and pollute surface and ground water reservoirs downstream (Nyaundi 2023). Approximately 4.6 million tons of 500 different types of pesticides are applied on crops annually according toMills-Knapp et al. (2012)However, only about 1% is effectively utilized (Jayaraj, Megha, and Sreedev 2016). Consequently, the biggest percentage of the applied pesticides end up in different environmental compartments, causing serious pollution to the ecosystem and biota. Among the pesticides, organo-pesticides compounds significantly impact on aquatic ecosystems, causing serious damage to the organism community (AbuQamar et al. 2024). Organochlorine pesticides (OCPs) in especially are of particular concern because of their serious global threat (Keswani et al. 2022) due to their persistence, toxicity, bioaccumulation, and detrimental effects on the environment(Zaynab et al.).

In the aquatic environment, contaminants including toxic metals and organo-pesticides often bind to the sediment particles via physicochemical processes such as adsorption and coagulation and settle to the bottom (Mazrui et al., 2017). Eventually, bioaccumulation and magnification of the contaminats reach toxic level in organisms, even atlow exposure (Garai et al. 2021). Gradually, the presence of the pollutants seriously disturbs the delicate equilibrium of the aquatic systems affecting the aquatic organisms due to exposure to higher levels of the metals since they live and feed on the sediments. Fishes in particular are notorious for their ability to bioaccumulate and biomagnify the pollutants in their muscles and since they play important role in human nutrition, they can cause toxic health effect to humans and even other consumers at higher trophic level(Ray and Vashishth 2024).Among the factors that have worsened the continuous growth of environmental contaminants in aquatic environment are anthropogenic activities (Chen et al.,2015). These activities threaten the fish populations and commercial fishing due to contaminants loads in the aquatic ecosystem.Therefore, the need to conduct intensive research into the negative effects of water pollution and the potential danger it poses to aquatic organisms including fish (*Oreochromis niloticus*)and their ecosystems becomes highly imperative. In addition, analysis of these major pollutants will provide vital information on how to mitigate their impact on freshwater ecosystems, especially fish communities like *Oreochromis niloticus*(Nile tilapia), and contribute to the existing body of knowledge in this field(Munguti et al. 2022; Naseer et al. 2024).

The study is aimed to detect the presence of some freshwater pollutants, their level of occurrence as well as their toxic effects on *Oreochromis niloticus*(Nile tilapia) in Wawan Rafi and Dambo Dams of Kazaure, Jigawa State

## II. STUDY AREA

The research was conducted in Kazaure Local Government Area in Jigawa State Nigeria The selected stations are Wawan Rafi and Dambo Dams geographically located at: 12$^{o}$ 27’ 59" N and 10$^{o}$ 3' 40" E which is 361 meters above sea level, spanning 1,780 km² (Figure 1). The area is home to sand dunes and uneven terrain. The region's extensive loamy soil supports agricultural practices, and waste water from homes and markets is often sent to drainage systems for domestic purposes like irrigation, fishing, and leisure activities (Sagagi et al. 2022).

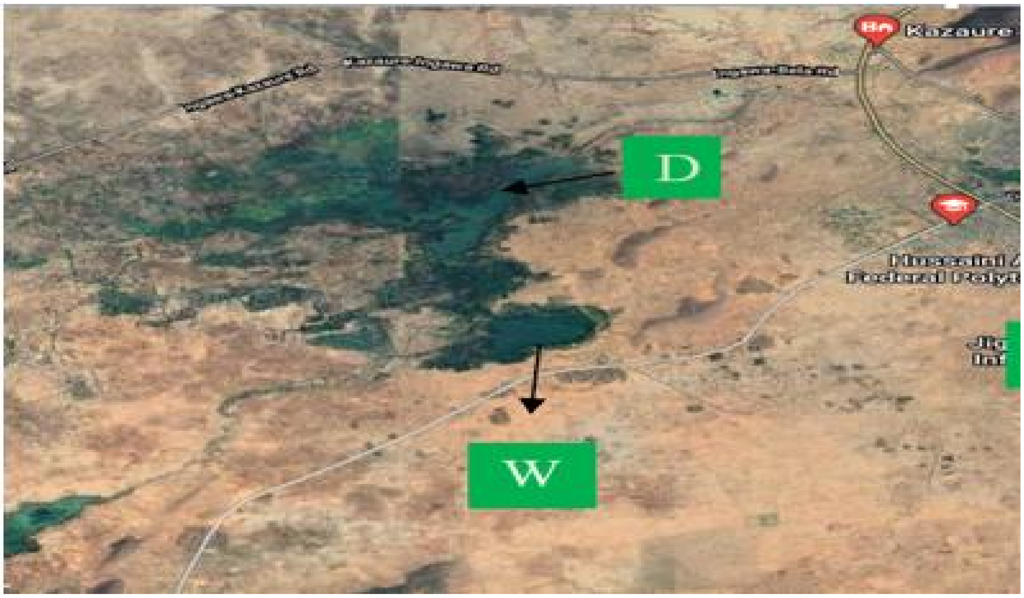


Figure 1: Google earth view of Kazaure Local Government (key: W= Wawan Rafi, D= Dambo)

## III. MATERIALS AND METHOD

**Sample collection**

Four sampling locations within each of the selected dam were identified for water collection. These sampling stations are labeled as station A, B, C, and D following a technique described in (Ahmed, Mumtaz, and Hassan Zaidi 2021). Water samples were collected in duplicates at each sampling location from each dam using a plastic bottle. The samples were then taken in sterilized containers to the laboratory for physicochemical parameter evaluation. Additionally, five fresh matured adult *Oreochromis niloticus*(Nile tilapia) were collected from each station and stored at optimum temperature to avoid spoilage.

**Determination of Physico-chemical characteristics**

Physico-chemical characteristics including temperature, pH, electrical conductivity, transparency, and dissolved oxygenwere evaluated in accordance with AOAC standard as described in (Opaluwa et al. 2022). Briefly, the temperature was measured using a glass thermometer filled with mercury, and the pH was determined using a digital pH meter. With the aid of a digital conductivity meter,ranging of between0-1999µS and 0-19.99µS, electrical conductivity was measured. A Sechi disc with a 25 cm diameter was used to measure transparency, and the average was computed and noted. Using a modified prefigure digital dissolved oxygen meter, the amount of dissolved oxygen was measured.

Glass fiber filter disk, membrane filter paper, glass beaker, and vacuum pump were used in a filtration system to measure total dissolved solids (TDS). The filtered samples were placed in evaporating dishes, heated to 550°C for an hour, and then allowed to cool in desiccators.

The TDS was determined using the following equation:

$$\text{TDS (mg/L)} = (A - B) \times 1000) \div \text{Volume of sample}$$

Where, A = Weight of evaporating dish and dried residue

B = Weight of evaporating dish

**Gas Chromatography – Mass Spectrophotometry Analysis of Samples**

**Extraction of Fish Organs and Clean-Up of Samples Extract**

The fish samples were prepared according to procedure described by (Serrano et al. 2003) although with slight modification. After cleaning the bench, the samples were thawed at room temperature, descaled and subsequently dissected to isolate the desired tissues for the analysis. The tissues were macerated and homogenized using a mortar and pestle and mixed with anhydrous sodium sulphate necessary to remove water.After deactivationwith silica gel and anhydrous sodium sulfate for cleaning-up the extracts, a 1:1 (v/v) ethyl acetic acid derivatied/dichloromethane mixture was added to moisten and flush the extract. The sample extract was moved to the column and the residue was eluted with 80 mL of ethyl acetate/dichloromethane and diluted with an additional 50 mL. A rotary evaporator was used to dry the fractions at 40°C. Each residue was dissolved and collected in 2 mL ethyl acetate for gas chromatography examination.

**De-Fattening of Organ Extracts**

In a 100-mLseparator funnel, 2 mL of pesticide recovered from the fish samples were combined with 50 mL of a 1:1 (v/v) hexane/acetonitrile solution for the de-fattening procedure. The separator funnels were gently shaken for three minutes while the gas pressure was discharged. The separator funnels were let to stand for twenty minutes in order to ensure the organic solvents' phase separation. While the fat holding the hexane, dissolvable stage was disposed of, the acetonitrile divisions containing the pesticides were collected into a 50 mL measuring glass. The acetonitrile solvent extract was cleaned using 25 mLof pure hexane. A rotatry evaporator was used to condense the acetonitrile fraction at 40 °C. The contents of the flask were then dissolved by adding 2 mL of ethyl acetate to a 2-mL vial. The pesticide extracts in the vial were stored in the refrigerator at 4 °C prior to GCMS analysis.This was done in accordance with the procedure described by Rahman et al. (2021)

**Determination of Organic Pollutants (Pesticide Residue) Using GC/MS**

The study analyzed fish and water samples for pesticide contaminants using GC/MS. A 35% diphenyl, 65% dimethyl polysiloxane column and a fluorescence-detector-equipped SHIMADZU JAPAN (GC-MS-QP2010 PLUS) was used for chromatographic separation. The oven program was set at various temperatures and flow rates. The GC-ion trap MS with an optional MSn mode was used to detect pesticides. The scanning mode offered greater selectivity compared to full scan or selected ion monitoring. However, the ratio of matrix ions to pesticide ions increased exponentially as the concentration approached the detection limit. The GC-ion trap MS performed the tandem MS function, separating only pesticide ions. The sample's retention time, peak area, and peak height were compared to the standards. This was done in accordance with (Rahman et al. 2021)

**Fish Morphometric Analysis, Condition Factor Estimation and Haematological Analysis**

Fish morphometric analysis involves measuring total length (TL) and standard length (SL) from the fish's mouth or snout, and using a digital weighing balance to measure fish weight (g). Hematological analysis is performed using a computerized hematology analyzer, Sysmex (KX-21N), which uses EDTA against coagulated new fish blood test as in (El-Degwy et al. 2023). The system analyzer uses electronic resistance detection to identify, count, and size leukocytes, erythrocytes, and platelets. Results are displayed on an LCD with a histogram printed on thermal paper. Haematometric variables such as red blood cells (RBC), Haematocrit (PCV), hemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), absolute neutrophils count (ANC), and absolute lymphocytes count (ALC) are determined for each blood sample.

**Heavy Metal Analysis of water and Fish Samples**

Sample Digestion was a crucial step in analyzing heavy metals in water and fish samples using the Atomic Absorption Spectrophotometer (AAS) machine model BUCK SCIENTIFIC 210 VGP. The water samples were filtered andevaporatedand heatedto 85°C, followed by theadditionof concentrated $HNO_3$. The digested sample was then transferred to a 100 mLvolumetric flask, and the AAS was used to analyze the solution for heavy metals. The concentrations of heavy metals in fish gills were estimated, and the heavy metals, such as Cd, Cu, Cr, Ni and Pb were resolved using the Nuclear Retention Spectrophotometer (BUCK Logical 210 VGP) using a standard bend for each metal as described in (Mutiah et al. 2022).

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**Statistical Analysis**

The Pearson correlation coefficient was utilized to ascertain the statistical relationships between the different parameters, and the results were examined using Analysis of Variance (ANOVA) at $p \leq 0.05$ among the measured parameters.

## IV. RESULTS AND DISCUSSIONS

**Physicochemical Parameters of the Water Sample**

From the result (Figure 2.) the physicochemical parameters in water samples from Wawan Rafiincluding temperature and dissolved oxygen levelsof the water samples from both sampling stations were found to be within the World Health Organization's (WHO) permissible guideline. The mean temperature ranged between 23.13±0.8 and 28.25±0.7, which does not directly impact fish growth as it is within the WHO's permissible guideline. The mean values of dissolved oxygen (DO) in the water samples met the WHO's threshold of 6.5-8.5mg/l, which is consistent with previous studies. The mean pH values of the water samples was 7.347±0.3, which is higher than the 6.20–6.88 range for physicochemical parameters reported in water from Ikwu River, Umuahia, Abia State, Nigeria.

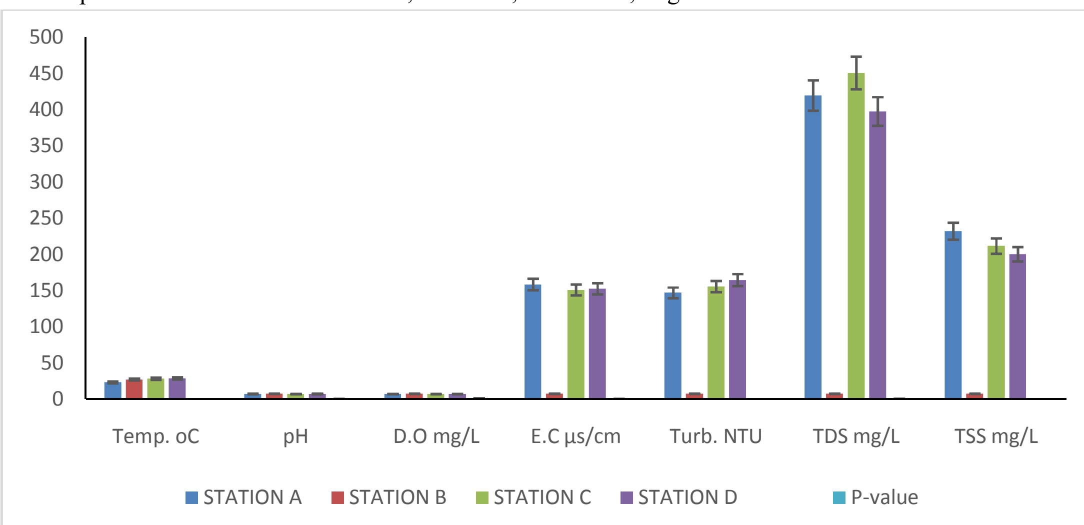


**Figure 2. Monthly Mean ± standard deviation of the physicochemical parameters recorded in Wawan Rafi water**

This indicates that the WHO's acceptable guideline value of 6.5-8.5 was not exceeded in all study stations. The mean conductivity of the surface water ranged between 145.6±16 and 158.3±6.1µs/cm, which is lower than the WHO standard. This suggests that the pH of Wawan Rafi and Dambo Dam needs to be adjusted for proper Tilapia growth in the river.

The turbidity obtained from all stations was far higher than the 5 NTU (Nephelometric turbidity unit) value recommended by the WHO, indicating that the water samples revealed higher turbidity than the recommended allowable limit. This might be due to the open structure of the water sources, which makes it susceptible for atmospheric deposition of pollutants. This high turbidity could interfere with light transmission. (Luttamaguzi et al. 2023) reported that the turbidity mean valueis slightly greater than the WHO's recommended limits.

Total dissolved solids (TDS) levels in the water samples from the two locations were found to be above the WHO's recommended level, but TSS's mean values fell below the WHO's recommended limits of 450-2000mg/L. These findings suggest that the water sources in the Wawan Rafi and Dambo Dams, respectively are safe for Tilapia growth.

Figure3 depictsthe result of physicochemical parameters from Dambo Dam. The results revealed that the mean temperatures were of almost similar across the four stations A, B, C, and D with the slight increase recorded in station D (26.75 ± 2.8$^{O}$C). Similarly, the result revealed that there are no significant variations in the pH mean values for all the stations, the highest being recorded is in station C (7.35 ± 0.3) and D (7.35 ± 0.3). The mean value of dissolved oxygen concentration at station B, C, and D (7.13 ± 0.1, 7.25 ± 0.1 and 7.1 ± 0.0 mg/L) were found to be within the same range, the lowest being recorded in station A (6.85±0.2 mg/L). Station B recorded the highest electric conductivity mean value

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(156.15 ± 5.3 µS/cm).On the other hand, the turbidity value at station A, B, and D did notshow significant variations except at station C where the lowest value was recorded (148.43 ± 8.1 NTU)

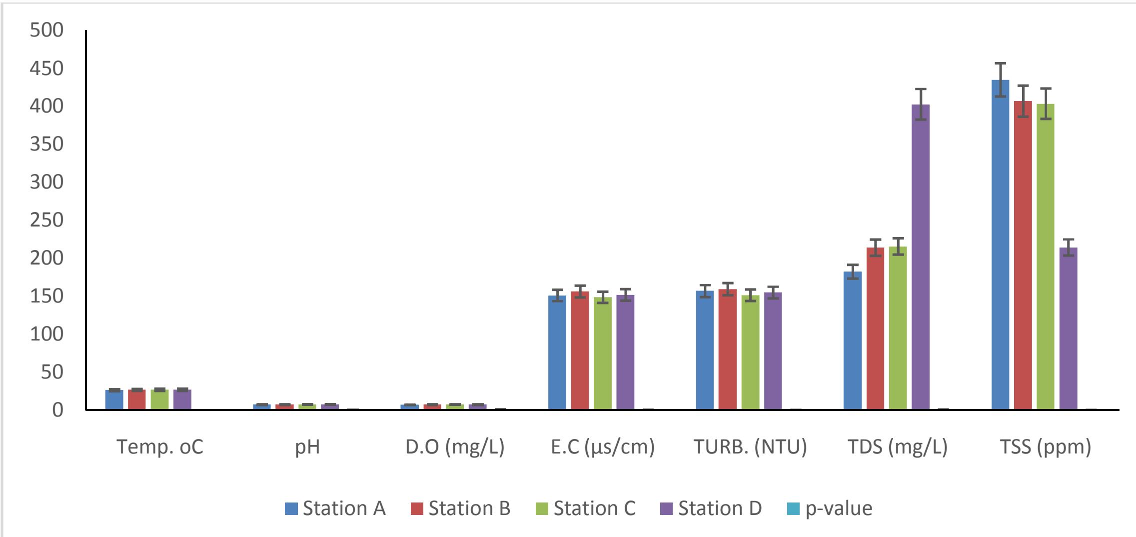


**Figure 3. Mean ± standard deviation of Physico-chemical parameters for all Stations recorded in Dambo Dam Jigawa state**

The Pearson correlation of the study at both 0.05 level and 0.001 level (1-tailed), showed a negative correlation between temperature, pH, electrical conductivity, total dissolved solid TDS, and total suspended solid TSS. pH was positively correlated with dissolved oxygen and total suspended solid TSS. Electric conductivity was strongly negative with turbidity, while TDS and TSS showed strong negative correlations.

**Heavy Metal Concentration in Water**

The results of heavy metals analysis conducted on Wawan Rafi and Dambo Dam are presented in Figure 4. The result revealed that the metals analyzed did not show significant variations across the studyarea with the exception of copper (Cu) which shows significant variability at probability level of $p \leq 0.05$ with p-value of (0.001).Highestconcentration of copper was recorded in station C (0.50±0.40 ppm)

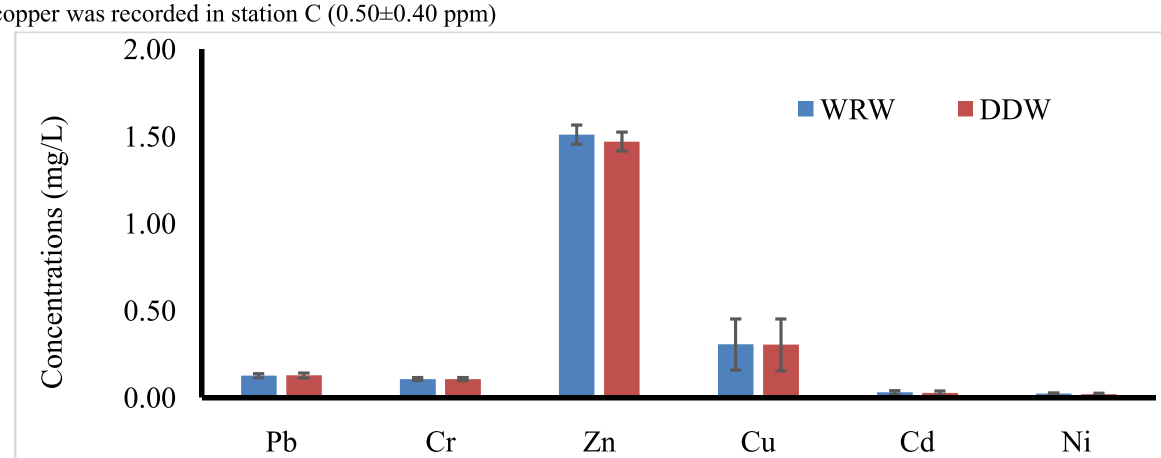


**Figure 4. Station's Mean ± standard deviation of the heavy metals recorded in Wawan Rafi water(WRW) and Dambo Dam water (DDW)**

The result from figure4revealed that the concentration of heavy metals analyzed in stations A, B, C, and Dof both Wawan Rafi and Dambo Dam, with the highest concentration of Lead (Pb) and Chromium (Cr) in Station D (0.1400±0.007 ppm) and (0.1325±0.023ppm) while concentration of Zinc, Copper, Cadmium and Nickel in station D were also found to be above the values recorded in stations A, B, and C, of the two study area respectively.

Heavy metals in water can significantly impact the life and lifespan of aquatic organisms, including fish and aquatic invertebrates. These toxic effects can lead to reduced developmental growth, increased abnormalities, reduced fish survival, or even extinction of the entire fish population. The mean value of Lead (Pb) in the water sample of this study falls above the World Health Organization (WHO) recommended level of 0.01mg/l in all stations, but lower than the highest level of 0.55 mg/L observed in Orjiakor *et al*. (2018). Cr levels are higher than the WHO permitted chromium level of 0.05mg/L, which can affect fish organs like gills and liver. Mean concentration levels for Zn are lower than the WHO permissible level of 3.0 mg/L, which agrees with the findings of Oghenenyoreme Eyankware et al. (2024) that Zn values below the permissible limit have no significant effect on aquatic organisms' life and growth. Cu levels are below the WHO permissible level of 2mg/L, making water sources with less Cupper level safe for aquatic organisms. Cadmium levels are higher than the WHO permissible level (of 2mg/L) only in Station D, putting fish at risk of developing clinical issues in their organs like liver, stomach, and gill. Ni levels are higher than the findings of Adefemi, Awokunmi, and Technology (2010) for water samples taken from the River Ona and a few hand-dug wells in Nigeria's Ondo State. Nickel average levels in Station D fall above the WHO permissible level of 0.02 mg/L, posing health risks to fish's gills.

**Heavy Metal in Fish**

The result from figure 5 revealed that the fish concentration of heavy metals analyzed in stations A, B, C, and D of both Wawan Rafi and Dambo Dam had a highest value of Pb (mg/L) 0.1550±0.0, Cr (mg/L) 0.14205±0.0, Zn (mg/L) 1.7750±0.0, Cu (mg/L) 0.5400±0.,Cd (mg/L) 0.07850±0.0, and Ni (mg/L) 0.0475±0.0both of which are within permissible limit except for Pb, which is slightly higher than the recommended level.

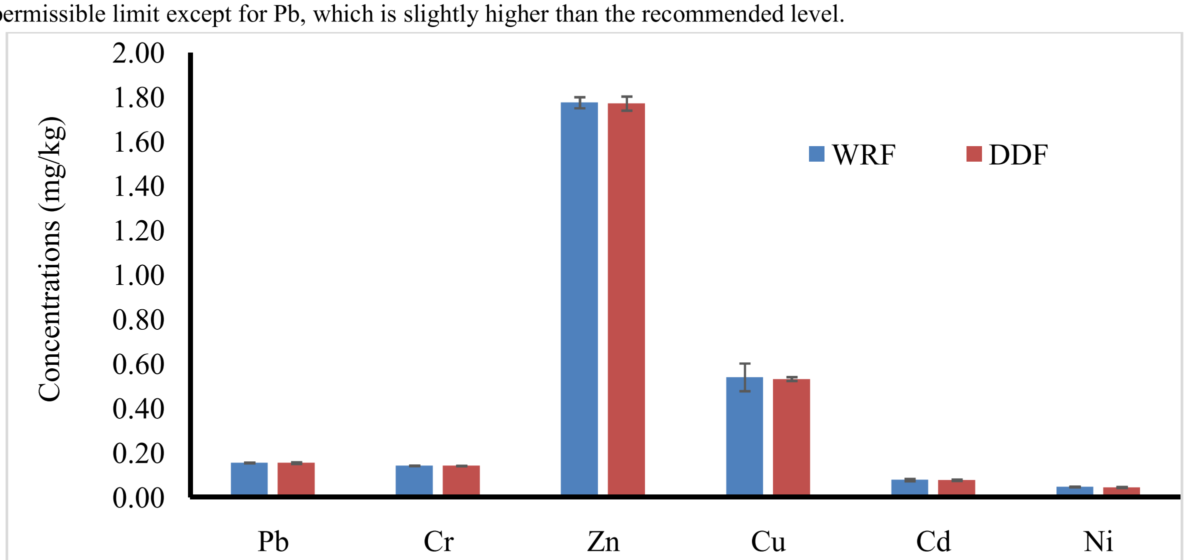


**Figure 5. Station's Mean ± standard of heavy metals in fish of all Stations recorded in Wawan Rafi (WRF) and Dambo Dam (DDF)**

The health effects of organo pesticides (OPs) are a serious concern. Table 1, 2, 3 and 4 are the results of organo-pesticide compound detected in water and fish sample of Wawan Rafi and Dambo Dam respectively.

OPs inhibit the enzyme acetylcholinesterase, which is responsible for breaking down acetylcholine and neurotransmitter, leading to buildup of acetylcholine. Various symptoms include Nausea, vomiting, diarrhea, sweating, salivation, blurred vision, bradycardia, Muscle weakness, fasciculations, paralysis, and respiratory failure.

Long-term exposure to OPs can lead to a range of chronic health problems, including Neuro developmental effects. Studies have linked OP exposure in utero and early childhood to impaired cognitive function, learning disabilities, and attention deficit hyperactivity disorder (ADHD) (Barret al. 2008), ( Eskenaziet al, 2009).While they offer benefits in pest control, their potential to harm human health and the environment necessitates careful consideration of their use.

The presence of these OPs in the study areas could be attributed anthropogenic activities which can contaminate the environment through runoff and leaching, affecting lives, water sources, and soil. It can bioaccumulate in food chains, posing a threat to human health through dietary exposure.

**Table 1. Detected Organic compounds in water samples from Wawan Rafi Dam**

| Peak No | Compound Name | RT | MF | Mw | Peak Area |
|---|---|---|---|---|---|
| 1 | 2,3-dimethyl-3hexanol | 13.291 | $C_8H_{1}8O$ | 130 | 57802 |
| 2 | 2,6,10,14-tetramethylheptadecane | 13.551 | $C_{21}H_{44}$ | 296 | 59377 |
| 3 | 2,3-dihydroxypropyl palmitate | 18.313 | $C_{19}H_{3}8O_4$ | 330 | 1077586 |
| 4 | 9,12-Octedecadienoyl chloride | 19.786 | $C1_8H_{31}CIO$ | 298 | 2543903 |
| 5 | n-Pentadecane | 20.775 | $C_{15}H_{32}$ | 212 | 2110858 |
| 6 | 3,7-dimethyldecane | 21.3 | $C_{12}H_{26}$ | 170 | 2606128 |
| 7 | Hexadecane, n-Cetane | 21.725 | $C_{16}H_{34}$ | 226 | 3547383 |
| 8 | hexadecanoic acid, methyl ester. Palmitic acid | 19.364 | $C_{17}H_{3}4O_2$ | 270 | 910179 |
| 9 | n-Hexadecanoic acid, palmitic acid | 20.09 | $C_{16}H_{3}2O_2$ | 256 | 2545851 |
| 10 | 9,12-Octadecadienoic acid | 21.467 | $C_{19}H_{3}4O_2$ | 294 | 1461248 |
| 11 | 11-Octadecnoic acid | 21.514 | $C_{19}H_{3}6O_2$ | 296 | 2509613 |
| 12 | Docosanoic acid, methyl ester | 21.853 | $C_{23}H_{4}6O_2$ | 354 | 301449 |
| 13 | 9,12- Octerdecadienoic acid | 22.627 | $C_{18}H_{3}2O_2$ | 280 | 14200299 |
| 14 | 9,12-Octadecadienoyl chloride, Linoleoyl chloride | 25.912 | $C_{18}H_{3}1CIO$ | 298 | 1563974 |

**KEY: RT**. Retention Time. **MF -** Molecular Formula. **MW** - Molecular Weight

**Table 2. Detected Organic compounds in water samples from Station Dambo Dam**

| Peak No | Compound Name | RT | MF | Mw | Peak Area |
|---|---|---|---|---|---|
| 1 | 1-Nitro-bicyclo{6.1.0}nonan-2one | 16.421 | $C_9H_{13}HNO_3$ | 183 | 1350530 |
| 2 | Bicyclo{3.1.0}hexane-6-methanol | 17.596 | $C_{10}H_{18}O_2$ | 170 | 198964 |
| 3 | Octachlorohexahydromethanoindene | 18.334 | $C_{10}H_6CL_8$ | 409 | 5665188 |
| 4 | 2(1H)- Naphthalenone | 19.861 | $C_{11}H_{18}O_2$ | 182 | 807560 |
| 5 | 4-Isopropenyl-4,7-dimethyl-1oxaspiro{2.5}octane | 21.441 | $C_{12}H_{20}O$ | 180 | 1595674 |
| 6 | 9,12, -Octadecadienoyl chloride | 22.664 | $C_{18}H_{31}CIO$ | 298 | 22257155 |
| 7 | 1,19-Eicosadiene | 23.664 | $C_{20}H_{38}$ | 278 | 1041544 |
| 8 | Hexadecanoic acid, 1-(hydroxymethyl) | 24.279 | $C_{35}H_{68}O_5$ | 568 | 437359 |
| 9 | 9-Tetradecenal | 25.919 | $C_{14}H_{26}O$ | 210 | 4069626 |
| 10 | 1,2-Ethanediyl ester | 26.091 | $C_{35}H_{68}O_5$ | 568 | 2153289 |
| 11 | Heptadecyn-1-ol | 26.316 | $C_{17}H_{32}O$ | 252 | 3424590 |
| 12 | Diethyl 2-(4-methylphenyl) malonate | 15.893 | $C_{14}H_{18}O_4$ | 250 | 1628767 |
| 13 | 14-methylpentadecanoate | 19.369 | $C_{17}H_{34}O_2$ | 270 | 492803 |
| 14 | n-Hexadecanoic acid | 20.105 | $C_{16}H_{32}O_2$ | 256 | 6110489 |
| 15 | Hexadecane, n- Cetane | 21.221 | $C_{16}H_{34}$ | 226 | 408746 |
| 16 | 10- Octadecanoate | 21.517 | $C_{19}H_{36}O_2$ | 296 | 810195 |

**KEY: RT**. Retention Time. **MF -** Molecular Formula. **MW** - Molecular Weight

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**Table 3.Detected Organic compounds in fish samples from Wawan Rafi**

| Peak No | Compound Name | RT | MF | Mw | Peak Area |
|---|---|---|---|---|---|
| 1 | Decanoic acid, methyl ester, capric acid methyl ester, metholene | 13.634 | $C_{11}H_{2}2O_{2}$ | 186 | 1448920 |
| 2 | Pentadecanoic aci,14-methyl-, methyl ester | 15.787 | $C_{17}H_{3}4O_{2}$ | 270 | 1.1E+08 |
| 3 | Hexadecanoic acid,palmitic acid | 16.53 | $C_{16}H_{3}2O_{2}$ | 256 | 15625015 |
| 4 | Cyclopropanepentanoic acid, 2-undecyl-, methyl ester | 15.568 | $C_{20}H_{3}8O_{2}$ | 310 | 1322214 |
| 5 | Decanoic acid, methyl ester. Capric acid methyl ester | 15.781 | $C_{11}H_{2}2O_{2}$ | 186 | 85145774 |
| 6 | n-Nonadecanoic acid | 16.581 | $C_{19}H_{3}8O_{2}$ | 298 | 36243635 |
| 7 | 9,12-Octadecadienoyl chloride | 17.482 | $C_{18}H_{3}1CIO$ | 298 | 2.82E+08 |
| 8 | Stearic acid,methyl ester | 17.716 | $C_{19}H_{3}8O_{2}$ | 298 | 58012166 |
| 9 | Oleic Acid, 9-Octadecenoic acid | 18.338 | $C_{18}H_{3}4O_{2}$ | 282 | 2.58E+08 |
| 10 | Eicosanoic acid, Arachic acid | 18.432 | $C_{20}H_{4}0O_{2}$ | 312 | 56397893 |
| 11 | Methyl ricinoleate, Ricinoleic acid | 19.347 | $C_{19}H_{3}6O_{3}$ | 312 | 18411447 |
| 12 | Triacontanoic acid, methyl ester | 19.427 | $C_{31}H_{6}2O_{2}$ | 466 | 6796757 |
| 13 | 11-Octerdecanoic acid,methyl ester | 17.494 | $C_{19}H_{3}6O_{2}$ | 296 | 1.2E+08 |
| 14 | Hexadecanoic acid, 15-methyl-, methyl ester | 17.713 | $C_{18}H_{3}6O_{2}$ | 284 | 54322860 |
| 15 | Oleic acid, 9-octerdecanoic acid | 18.178 | $C_{18}H_{3}4O_{2}$ | 282 | 24744377 |
| 16 | Octerdecanoic acid, 2-(2-hydroxyethoxy) ethyl ester | 18.324 | $C_{22}H_{4}4O_{2}$ | 372 | 8036125 |
| 17 | Heptacosanoic acid, methyl ester | 19.415 | $C_{28}H_{5}6O_{2}$ | 424 | 7492016 |
| 18 | Phenol,3-pentadecyl | 23.04 | $C_{21}H_{3}6O$ | 304 | 18189556 |

**KEY: RT**. Retention Time. **MF -** Molecular Formula. **MW** - Molecular Weight and Peak Area

**Table 4. Detected Organic compounds in fish samples from Dambo Dam**

| Peak No | Compound Name | RT | MF | Mw | Peak Area |
|---|---|---|---|---|---|
| 1 | Hexadecanoic acid,2-hydroxy-1(hydroxymethyl) | 20.85 | $C_{19}H_{3}8O_{4}$ | 330 | 8225497 |
| 2 | 10-Undecenoyl chloride | 22.16 | $C_{11}H_{1}9CIO$ | 202 | 5118723 |
| 3 | 2,3-dihydroxypropyl ester | 22.446 | $C_{21}H_{4}0O_{4}$ | 356 | 12556908 |
| 4 | Squalene(2,6,10,14,18,22-Tetracosahexaene) | 23.672 | $C_{30}H_{5}O$ | 410 | 1731186 |
| 5 | Octadecanoic acid, Stearic acid | 17.968 | $C_{18}H_{3}6O_{2}$ | 284 | 21120210 |
| 6 | n-Hexadecanoic acid | 16.08 | $C_{16}H_{3}2O_{2}$ | 256 | 38044690 |
| 7 | 13-Hexyloxacyclotridec-10-en-2-one | 17.005 | $C_{18}H_{3}2O_{2}$ | 280 | 4205369 |
| 8 | Oleic Acid,9-Octadecanoic acid | 17.829 | $C_{18}H_{3}4O_{2}$ | 282 | 84301807 |
| 9 | 9-Octadecynoic acid, Stearolic acid | 18.137 | $C_{18}H_{3}2O_{2}$ | 280 | 8637978 |
| 10 | Octadecenyl aldehyde | 18.545 | $C_{18}H_{3}4O$ | 266 | 8480012 |
| 11 | Hexadecanoic acid, 1-(aminoethoxy)hydroxyphosphinyl | 18.957 | $C_{37}H_{7}4NO_{8}P$ | 691 | 6178178 |
| 12 | Undecylenic Acid | 19.477 | $C_{11}H_{2}0O_{2}$ | 184 | 12298062 |
| 13 | 10-Undecenoyl chloride | 20.212 | $C_{11}H_{1}9CIO$ | 202 | 5999035 |
| 14 | 9-Tetradecenal | 20.458 | $C_{14}H_{2}6O$ | 210 | 13097148 |

**KEY: RT**. Retention Time. **MF -** Molecular Formula. **MW** - Molecular Weight

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 5, Issue 3, January 2025

**Haematological Parameters**

Hematology is a crucial technique for evaluating fish health problems. Packed cell volume (PCV) mean values ranged between 17.19% and 22.32%, higher than the reported range of 15.2 and 10.4%. The hematological index is higher in the early dry season due to a total drop in water volume. Hematological values should be between 20 and 35%, rarely exceeding 50%.The significant decrease in PCV station C may be due to gill damage and poor osmoregulation, leading to anemia and heamodilation (Chris *et al.* 2022).

Hemoglobin is crucial for fish's physiological survival, and mean hemoglobin levels varied between 6.230 g/dL and 7.570 g/dL. Low hemoglobin is likely due to heavy metals altering hemoglobin's properties, making erythrocytes weaker and more porous. (Odioko and Daniel 2016) suggest that the decline in Hb value station C may be caused by slower red blood cell synthesis or higher red blood cell oxidation.

O. niloticus had mean red blood cells (RBC) ranging from 1.180x1012/mL to 1.45x1012/mL, surpassing those reported by Odioko & Daniel (2016). The mean white blood cells (WBC) ranged from 153.100 x 109/mL to 167.67 x 109/mL, higher than the stated values by (Zaghloul, Mohamed, and Khalil 2019) The mean corpuscular hemoglobin concentration, which is the ratio of mean hemoglobin concentration, is unaffected by blood volume and the number of blood cells.

From the results of haematological indices of *Oreochromis niloticus from* Station A to Station D of both study area, the lowest packed cell volume (PCV) was found in Station D and Station A of Dambo Dam and Wawan Rafi respectively, while the highest (6.7±0.8g/dL). Monthly mean red blood cells (RBC) and white blood cell (WBC) values varied significantly between stations. The mean corpuscular volume (MCV) varied significantly across the months. Station B and D recorded the lowest and highest mean corpuscular hemoglobin (MCH) values, respectively. The minimum and maximum monthly mean corpuscular hemoglobin concentration (MCHC) were recorded in Station D and Station C, respectively. Analysis of variance revealed a significant difference in mean corpuscular hemoglobin concentration in *Oreochromis niloticus*. The data suggests that *Oreochromis niloticus* has a unique cellular structure and a unique cellular composition.

## V. CONCLUSIONS AND RECOMMENDATIONS

The study examined the physicochemical parameters of surface water, including temperature, pH, electric conductivity, turbidity, dissolve oxygen, total dissolve solid, and total suspended solid. All parameters were within permissible limits, except for turbidity, which was above the recommended limit of 5 NTU. The study also examined the concentration of organic compounds and heavy metals in water and fish samples. Lead and nickel concentrations levels were above WHO acceptable limits. Haematological indices of fish blood were examined. Fish organ analysis revealed histopathological alterations in the liver, kidney, and gills. The findings in this study suggests that authorities should ensure that proper treatment of waste from industries should be carried before emptying into the river or other surfacewater. There should be strict enactment and enforcement of policies by government on application of pesticidesand its subsequent waste disposal, and management, and observing proper sanitation around water sources to prevent contamination. Further studies should focus on oxidative stress enzymes on *Oreochromis niloticus* Fishin the study area.

## VI. ACKNOWLEDGEMENT

The researchersare deeply grateful to Allah Ta'ala for providing them with the ability and permission to carry out this investigation. They are also grateful to the administration of Hussaini Adamu Federal Polytechnic, Kazaure, for creating a favorable learning environment and conducive atmosphere that enabled this research to be conducted. We would especially like to acknowledgethe Tertiary Education Trust Fund (TETFund) for the financial support for the research.

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