ASSESSMENT OF PESTICIDE RESIDUES IN WATER AND SEDIMENTS OBTAINED FROM RIVER TARABA IN TELLA TARABA STATE, NIGERIA

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ABSTRACT: The contamination of pesticides in water and sediments from River Taraba was investigated to evaluate/determine the contamination status and potential hazard in the river. A total of twelve samples were collected and analyzed using GC 7890B, MSD 5977A. Statistical analysis revealed that the mean concentrations of pesticide residues in water samples ranged from 0.182 ± 0.031 - 2.48 ± 0.098 mg/L, while in sediments ranged from 1.17 ± 1.3 - 47.7 ± 29.4 mg/kg. The pesticides risk assessment in water recorded 80.0 % high risk, 6.70 % medium and 13.3 low risks respectively, while the pesticides risk assessment in sediments recorded 88.9% high risk and 11.1 % medium risk. The results of the RQ revealed that the RQ values in sediments were generally higher than the RQ values obtained in water. This could be attributed to the fact that sediments serve as natural sink to chemical substances. Therefore, there should be periodic assessment of water and sediments along the river to provide a baseline data and critical information to encourage effective monitoring for maximum utilization of the water resources.
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INTRODUCTION

1.1 Background of the Study

Contaminants are unwanted substances that are present in a particular material such as food, water, soft drinks and render it unsuitable or unsafe. Examples; chemicals like acids, bases and pesticides including dead bodies of living organisms found in water are contaminants. These contaminants can be physical, chemical, or biological (Schymanski *et al.,* 2022).

Pesticide residues are extremely essential in agriculture. They are found in dairy products, food and water causing serious health hazards with regards to environmental pollution and accidental poisoning (Erkmen *et al.*, 2013). Pesticides can reach surface water through runoff from treated plants and soil. Further, the surface water contamination may have an eco-toxicological effect on aquatic flora and fauna as well as on human health, if used for public consumption (Essumang *et al.*, 2009; FAO, 2005).

Highly polluted sediments adversely affect the ecological functioning of rivers due to their persistence in the environment and long-range transport. In India, the concentrations of these pesticides have been detected in almost all segments of the environment due to their extensive use in the past which have shown potential to bio-magnify or accumulate in animal tissues, human blood, and breast milk. Fish take up contaminants directly from the water through their food chain. Generally, the ability of the fishes to metabolize the organochlorine is moderate; therefore, contaminant load in fish is reflective of the state of the pollution in the surrounding environment. The presence of persistent and hydrophobic pesticides in water even at low concentrations, poses a risk to the health of the biota because such residues have a higher affinity for partitioning into sediment and aquatic organisms. Chemicals with long half-life and high solubility in lipids (fats, oils, waxes) will tend to accumulate in fatty tissues. Such lipophilic chemicals easily move into the cells and are sequestered in fat, where they become more persistent (Essumang *et al.*, 2009). The application of pesticides may lead to contamination of aquatic environments through several ways such as spray drift, surface runoff and leaching. Besides habitat loss, overexploitation of species, aquatic organisms are affected by the pollution of surface waters with pesticides from agriculture in particular (IUCN, 2019).

Research has also revealed that atmospheric transport also represents an important source of pesticides residue accumulation in water bodies (Schmiit and Linder, 2010). Alternatively, the herbicide glyphosate for example, grew in popularity and has long been considered to be more environmentally benign than other pesticides. Nevertheless, in 2015 a report from the International Agency for Research on Cancer (IARC) concluded that glyphosate is probably carcinogenic to humans especially non-Hodgkin's lymphoma (Erickson, 2015). A class of pesticides known as neonicotinoids has received the most attention from the public in recent years. The use of neonicotinoids pesticides rose higher as a result of restrictions implemented on the use of carbamates and organophosphates for the raised concerns over their effects on aquatic organisms and human health respectively (Erickson, 2015).

Runoff and erosion have the potential to move more pesticides off site than leaching due to the fact that they are surface phenomenon (Halstead *et al.,* 2014). Hence, surface runoff and erosion move pesticides and other pollutants laterally from points of higher concentrations to collection points such as Rivers, Streams, ponds and lakes at lower elevations. Climatic factors such as rainfall timing, duration and intensity as well as surface features such as slope length and grade, soil permeability and soil cover all together greatly influence the degree to which pesticides are mobilized by runoff and erosion into water bodies (Halstead *et al.*, 2014).

The role of pesticides is to kill the target pest, but this property of pesticides makes them a poison to other organisms including aquatic organisms, birds, animals and humans. These pesticides are not target specific. The constant exposure of pesticides to non-target species may lead to induce toxicity once it crosses the threshold limit in the system. It is known that the major portion of the pesticide applied in an area reaches into healthy environmental components such as aquatic reserves (ponds, lakes, rivers and oceans), where they gradually get accumulated into other organisms (Azab *et al.,* 2013).

In a quest to increase agricultural productivity there has been an increase in the use of pesticides. Pesticides include insecticides, herbicides, rodenticides, and fungicides (Chopra *et al.*, 2010). These persistent organic pollutants (POPs) have become an integral part of the Nigerian society and are being used for diverse activities ranging from crop protection from insect pests, weeds, rodents and fungal diseases to animal husbandry and public health applications (Zhou *et al.*, 2006). Despite these overwhelming benefits, pesticides are usually not target-specific and may cause harm to non-target organisms. Most pesticides are very persistent, remaining in the environment for long periods (Chopra *et al.*, 2010). Due to their stable structure and lipophilic character, pesticides, especially organochlorine pesticides (OCPs), tend to bioconcentrate and biomagnify in the food chains particularly those associated with fatty tissues, leading to vertebrate and non-vertebrate toxicity in non-target organisms and even humans (Okoya *et al.*, 2013; Masia *et al.*, 2013). Studies have been carried out concerning pesticide residues contaminations in various environmental compartments in Nigeria (Ogah *et al.,* 2015; Upadhi and Wokoma, 2012; Ezemonye *et al.,* 2009; Ize-Iyamu *et al.,* 2007). Protecting Nigeria's fresh water bodies from pesticides and other pollutants is of utmost importance due to their prevailing toxicity even at trace levels. Thus, data pertaining to pesticide concentration in rivers are very critical (Adeboyejo *et al.*, 2011).

2.4 Pesticide Residues

Pesticide is a part of agrochemicals used in farming to enhance crops production (Leong *et al.,* 2020). However, they have been reported to have negative effects on soil and water quality (Sun *et al.,* 2019; Corcoran *et al.,* 2020). In addition to the obvious effects on plants and food chains, they are widely used. Because of these many uses, they move into the surrounding water, which has a wide range of effects on physical, chemical, and biological processes within aquatic ecosystems (Lakhani, 2015; Bassi *et al.,* 2016; Joko *et al.,* 2017; Kaur *et al.,* 2019).

Modern agriculture depends heavily on the use of chemicals (Sánchez-Bayo and Tennekes, 2017; Sarker *et al.,* 2020). It has been estimated that every year, 150 million tons of fertilizers and millions of tons of pesticides are applied to crop fields globally with the only objective of increasing agricultural production (Bernhardt *et al.,* 2017; Gilbertson, 2020). While there is evidence that the use of herbicides can increase yields in many crops (Gianessi, 2013; Karim *et al.,* 2020), there is also evidence that most fungicides and insecticides do not help increase such yields (Lechenet *et al.,* 2017).

Further, the ecological risks of these chemical inputs to the environment are often ignored by the public, when not dismissed by those who assert that a growing human population needs to be fed at all costs (Popp *et al.,* 2013). Concerns about the massive use of agricultural pesticides, in particular insecticides, herbicides in agriculture were raised half a century ago (Sánchez-Bayo and Tennekes, 2017) sparking an environmental movement that has lasted to this day. Regulations about the safety of individual pesticides were enacted in the developed countries in the 1970s, while most developing and underdeveloped countries remained oblivious to their negative effects until their routine misuse impacted on human health) and brought about

other negative environmental consequences (Scholz, *et al.,* 2012 ; Khan *et al.,* 2015; Alinejad *et al.,* 2017; Valcke *et al.,* 2017; Ha *et al.,* 2018)

An environment that is free of pollutants is essential for ideal environmental safety, fitness of human health and economic development (Ja'agi and Baba, 2015). Polluted water due to microbial infections causes visible diarrheal diseases. Chemical and toxic contaminations result into acute or chronic sicknesses in humans and kill insidiously (Wimalawansa and Wimalawansa, 2014). Contamination of water by agrochemicals are a worldwide problem and a serious issue in developing countries, where the difficulties are associated in part to slack environmental laws. Subsequently, water pollution creates an avenue for contamination of the human food chain. Numerous transmissible and non-transmissible human diseases are often correlated to water, soil geochemistry, and environmental pollution (Kolpakova, 2004; Wimalawansa and Wimalawansa, 2014).

MATERIALS AND METHODS

3.1 Sampling site

A preliminary hydrographical survey of the study area was conducted in Tella, Gassol Local Government Area of Taraba state, during which the sampling locations were selected. Here, six sampling points were marked at an interval of 1km apart. The sampling points were assigned locations as T_1, T_2, T_3, T_4, T_5, and T_6, for water samples and T_A, T_B, T_C, T_D, T_E, and T_F for sediments samples. These locations were selected on the basis of agricultural activities undergoing around the river bank including hospitals, industrial and commercial activities. All data collection as samples for the study were strictly restricted within the six selected points as shown in figure 2 and Table 6.

Table 1: The Coordinates of the Sampling Points

Sampling Points	Latitude (N)	Longitude (E)	Distance
T_1 T_A	8^0 14^1	10. 5^0 15^1	1km
T_2 T_B	8^0 20^1	10. 7^0 12^1	1km
T_3 T_C	8^0 10^1	11^0 00^1	1km
T_4 T_D	8^0 00^1	11. $2^0$$10^1$	1km
T_5 T_E	8.7^0 28^1	10. 2^0 24^1	1km
T_6 T_F	8^o30^1	10^0 30^1	1km

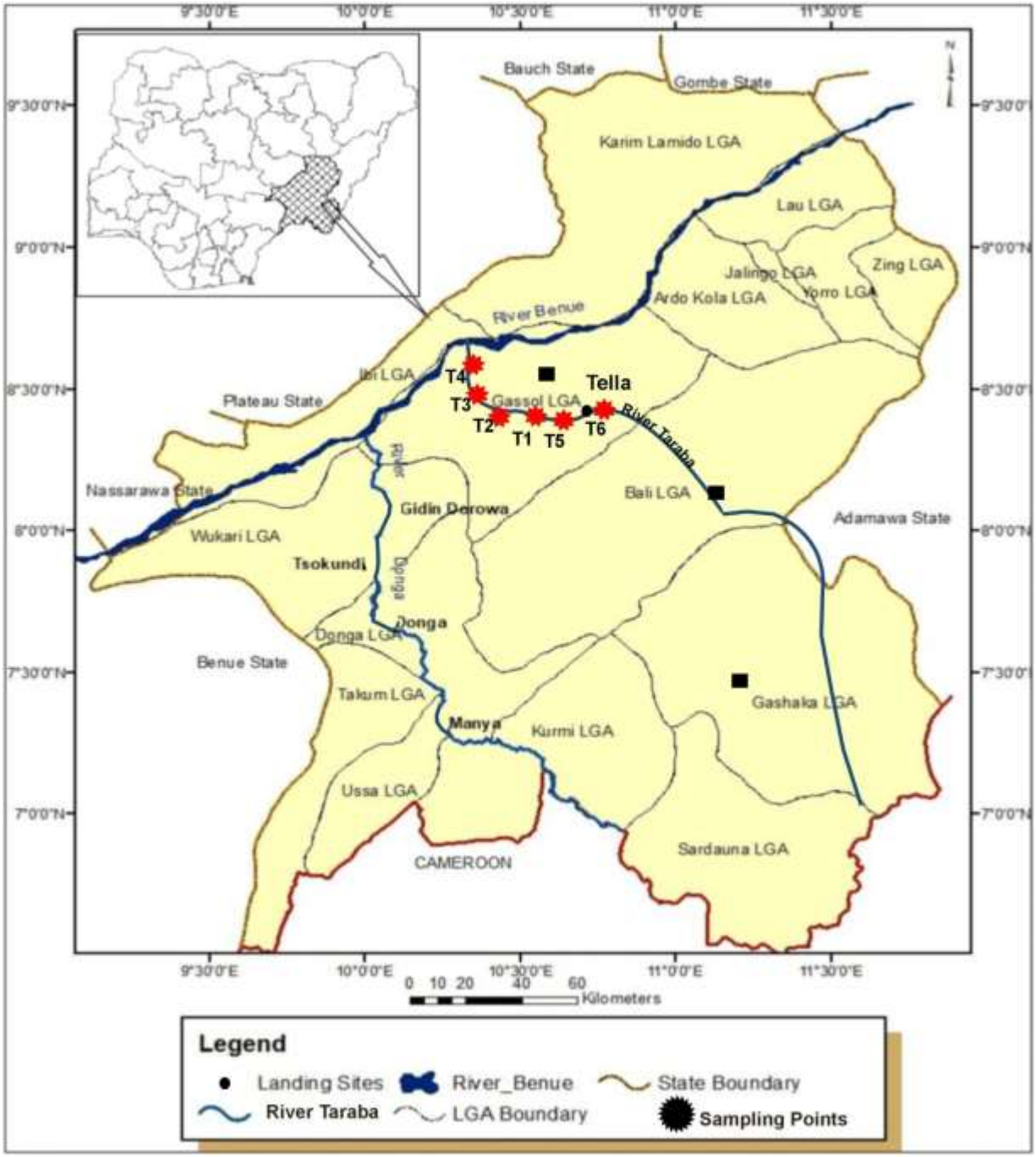

Figure 2: Map of Taraba showing the study area
Source: Extracted and Modified from Google Map

3.2 Methods of data collection

The data samples of water and sediments were collected using standard method by APHA (1998) and the procedures described and adapted by (Akan *et al.*, 2015).

3.3 Water samples collection

Water samples were collected between September and November 2024. Water samples were collected using plastic bottles. The sampling bottles were rinsed with the same water at the points of collection. At each of the sampling points/locations (T_1-T_6), water samples were collected at a distance of 1kilometer apart from

each other. In order to avoid pesticides break down before the analysis, the samples were stored in a refrigerator at a lowest temperature of 4ºC.

The samples were clearly labelled and transported to the laboratory, Department of Chemistry, Joseph Sarwuan Tarka University, Makurdi for the determination of physico-chemical parameters.Further,extraction of pesticide residues, in water were carried out (Akan *et al.,* 2015; Mustapha, 2020).

3.4 Collection of sediment samples

The sediment samples were collected at each sampling point (T_A-T_F) using a Teflon coated spoon. Sediments were taken from positions where the water samples were taken and where a fine texture deposition takes place. The samples were wrapped in an aluminium foil and kept in refrigerator at a low temperature of 4ºC and transported to the Chemisttry Laboratory.

3.5 Extraction of Pesticide Residues from water Samples

This involves Liquid-liquid Extraction (LLE) method earlier described by Helena *et al.,* (2002) was adopted with slight modifications. Exactly 100 mL of dichloromethane was added to 100 mL of unfiltered water sample placed in a 250 mL separating funnel and shaken for about 5 minutes to enhance thorough mixing and allowed to stand for 20 minutes on retort stand. Then the aqueous phase was drained into a conical flask. The extraction was repeated twice using fresh portion of the solvent. The resulting two portions of the extracts were combined and evaporated to near dryness using rotary evaporator after which possible residual water was removed with anhydrous sodium sulphate. The extract was dissolved with 1.0 mL of acetone and transferred into the sample vial for GC-MS analysis using GC- 7890B, MSD 5977A. (Ogah *et al.,* 2015; Abong'o, 2018; Carmona and Pico`, 2018).

3.6 Extraction of pesticide Residues from Sediment samples

Extraction of sediment samples were carried out according to a standard method described by Ize-Iyamu *et al* (2007). A mass of 10 g of each sample and 20 g of anhydrous sodium sulphate (Na_2SO_4) were ground into dry powder. The ground powder sample were extracted with 150 mL of a mixture of acetone or acetonitrile and n-hexane (2:1).using soxhlet extrtaction method. After extraction, the extract was transferred into a round bottom flask connected to a pre-weighed receiver through a Liebig condenser and concentrated to about 20 mL on a water bath maintained between 50 and 55 ºC. The remaining solvent in the concentrated extract was evaporated using a rotary evaporator. The almost–dry extracts was cleaned up in a micro-column as described in ASTM (1979). A mass of, 2 g of activated silica gel was packed into a chromatographic micro-column of 10 mm internal diameter and approximately 10 cm long. The silica gel was conditioned with 10 mL n-hexane while the sample extracts was dissolved in 5 mL n-hexane before they were loaded on to the micro-column. Elution of each of the sample was done with 50 mL of ethyl acetate: n-hexane mixture (9:1). The eluents were then heated on a rotary evaporator at about 45 ºC. The heated sample extract was dissolved in 2 mL acetone, and then transferred into a vial.These were transported to Chemistry Department,University of Ibadan for GC - MS analysis of the Model,GC – 7890B,MSD5977A

3.7 Chemicals and reagents

The chemicals and reagents used were acetone, nitric acid, ammonium hydroxide, and Dichloromethane, anhydrous sodium sulphate, conc.sulphuric acid,n-hexane, silver sulphate, conc.hydrochloric acid,hydrogen peroxide,conc.nitric acid,acetonitrile, magnesium chloride, mercury sulphate. Others were ferrous ammonium sulphate, EDTA, methyl orange, pure silica gel, deionized water and many others. All the solvents and reagents used were of analytical standard.

3.8 Statistical Analysis

All data obtained were analyzed using analysis of variance (MANOVA). A significant level of $p<0.05$ was adopted for the analysis of variance (ANOVA) which was done using statistical package for social sciences (SPSS) software version 24 including Risk Quotient which involves the ratio of MEC/PNEC.

Results

4.1 Pesticide Residues Analysis

The results of pesticide residues obtained from the analysis

of water and the risk assessment of the pesticides in water samples collected from River Taraba in Tella were presented in Tables 2 and 3. Similarly,the results of pesticides residues and the pesticides risk assessment in sediments from the same river were presented in Tables 4 and 5.

Table 2: Pesticide Residues in Water Samples (mg/L) obtained from River Taraba in Tella

Name of Pesticides		Sampling Stations						
	RT (mins)	T1`	T2	T3	T4	T5	T6	mean$\pm SD$
Endrin ketone	6.69	0.14	0.20	0.22	1.00	0.50	0.25	0.385±0.33
Methoxychlor	`16.37	0.12	0.50	0.20	0.20	0.15	0.25	0.237±0,14
Endosulfan sulfate	7.13	0.22	0.20	0.25	0.25	0.10	0.25	0.212±0.059
P,p′ – D D T	13.02	0.10	1.25	0.22	0.22	0.12	0.22	0.355±0.43
Heptachlor	6.31	0.11	1.00	1.25	0.22	1.25	0.50	0.722±0.51
P,p′– D D E	10.67	0.14	BDL	0.20	0.22	0.15	0.20	0.182±0.031
Endrin aldehyde	5.31	0.25	BDL	0.45	0.22	0.22	0.45	0.318±0.11
Chlorodane	8.12	0.50	2.50	0.20	0.22	0.50	0.20	0.687±0.88
Heptachlor epoxide	24.74	0.20	BDL	0.20	BDL	0.20	0.20	0.200±0.00
Endrin	18.88	1.50	0.35	0.25	0.55	1.50	0.25	0.733±0.57
Endosulfan	15.90	1.00	1.80	2.00	2.00	1.00	2.00	1.63±0.50
Aldrin	25.03	2.50	2.30	2.50	2.50	2.60	2.50	2.48±0.098
β –BHC	26.51	0.20	2.00	0.20	2.22	2.30	1.20	1.35±0.96
Dieldrin	15.65	0.22	0.50	BDL	BDL	0.65	BDL	0.457±0.217
P,p′ – D D D	2.55	BDL	0.40	BDL	BDL	BDL	BDL	0.400±0.00

Table 3: Pesticides Risk Assessment in Water Samples obtained from River Taraba in Tella

Pesticide Residues	**MEC**	**PNEC**	**RQ/HQ**	**Remark**
Endrin ketone	0.385	0.0420	9.17	High risk
Methoxychlor	0.237	20.0	0.0120	Low risk
Endosulfan sulfate	0.212	0.100	2.12	High risk
P,P'-DDT	0.355	2.00	0.178	Medium risk
Heptachlor	0.722	0.0300	24.1	High risk
P,P'-DDE	0.182	2.00	0.091	Low risk
Endrin aldehyde	0.318	0.0420	7.57	High risk
Chlordane	0.687	0.150	4.58	High risk
Heptachlor epoxide	0.200	0.0300	6.67	High risk
Endrin	0.733	0.00320	244	High risk
Endosulfan	1.63	0.500	3.27	High risk
Aldrin	2.48	0.0300	82.8	High risk
B-BHC	1.35	1.00	1.35	High risk
Dieldrin	0.457	0.0300	15.2	High risk
P,P'-DDD	0.400	0.300	1.3	High risk

LR= 13.3 % MR = 6.70 % HR = 80.0 %

Table 4: Pesticide Residues in Sediment Samples (mg/kg) obtained from River Taraba in Tella

Name of Pesticides	RT (mins)	T_A	T_B	T_C	T_D	T_E	T_F	mean$\pm SD$
Lindane	13.05	0.90	0.55	0.90	9.20	0.90	0.88	2.22±3.4
Heptachlor	14.90	27.80	23.10	27.80	73.40	27.80	27.76	34.6±19.
Chloropyrifos	15.71	0.50	50.05	0.50	6.55	9.20	9.22	5.19±4.4
Endosulfan I	16.38	45.55	20.30	45.55	7.50	0.50	0.48	29.7±18
Endosulfan II	16.94	19.70	2.40	24.30	2.20	73.40	73.30	47.7±29.4
Endosulfan sulfate	18.26	3.80	1.45	12.60	40.55	45.55	45.48	29.6±20
Tetradifon	19.02	1.05	2.12	1.05	24.30	24.30	24.27	12.9±13
Cyhalothrin	20.40	0.65	0.52	0.65	12.60	12.60	12.50	6.59±6.9
Acrinathrin	21.13	3.80	0.30	0.50	1.05	1.05	0.30	1.17±1.3

Table 5: Pesticides Risk Assessment in Sediment Samples obtained from River Taraba in Tella.

Pesticides	MEC	PNEC	RQ/HQ	Remark
Lindane	2.22	0.580	3.831	High risk
Heptachlor	34.6	0.03	1153.	High risk
Chlorpyrifos	5.19	0.01	519.0	High risk
Endosulfan 1	29.7	0.003	9900	High risk
Endosulfan 11	47.7	0.069	691.3	High risk
Endosulfan sulfate	24.9	9.030	3.280	High risk
Tetradifon	12.8	23.300	0.5510	Medium risk
Cyhalothrin	6.59	0.03	219.7	High risk
Acrinathrin	1.17	0.50	2.340	High risk

MR = 11.1 % HR = 88.9 %

DISCUSSION

5.1 Pesticide Residues Analysis

Pesticides are chemical contaminants which in high concentrations result into acute or chronic sicknesses in animals and humans. Contamination of water by pesticides are a worldwide problem and a serious issue in developing countries due to slacks in environmental laws. Numerous transmissible and non-transmissible human diseases are often caused by water, soil, geochemistry and environmental pollution (Wimalawansa and wimalawansa, 2014).

5.2 Pesticide residues in Water

High concentrationsl of pesticides in water cause pollution to drinking water, degrade fisheries and potentially increase food risks.

Endrin ketone in water:The concentrations of endrin ketone in water samples of this study range from 0.14–1.00 mg/L. These values have a mean value of 0.385 ± 0.33 mg/L The highest concentration of Endrin ketone was recorded at sampling point T_4 while the lowest value was obtained at point T_1

The Endrin ketone values reported by FAO/ WHO,(2016) maximum residue limits were not specified (NS) which did not agree with the result of this study. .Idris (2017) reported Endrin ketone concentrations ranging from 0.02 – 0.1 mg/L in W1 – W8, water samples obtained from the analysis of rivers Niger and Kaduna, North-central Nigeria. These Endrin ketone values reported by Idris, fall within the range values of this study.

Methoxychlor in water: The concentration of methoxychlor in water samples of this study ranged fromn 0.12 – 0.50 mg/L. These methoxychlor value have a mean value of $0.237 \pm o.14$ mg/L. The highest value of methoxychlor was recorded at sampling point T_2 while the lowest value was obtained at sampling point T_1. The low values of this methoxychlor implies that the pesticide residue undergo degradation and distribution patterns in water and sediments (kilulya and Mhinzi, 2012).

FAO/WHO (2016) reported the methoxychlor maximum permissible limit value of 20.0 mg/L which was far greater than the methoxychlor mean value of 0.237 ± 0.14 mg/L of this study.

Moses et al., (2022) reported the methoxychlor concentrations in sampling stations S1 and S2 from the analysis of water samples obtained from Nwaniba River, Akwa Ibom State, were all below detection limits (BDL). These results did not agree with the result of this study whose concentrations ranged from 0.12 – 0.50 mg/L.

Alani et al.,(2022) reported the methoxychlor concentrations range in sampling stations A and B from the analysis of Ogun River at Kara abattoir recorded 0.111 – 1.099 mg/L for station A and BDL for station B, respectively. The concentrations range values of 0.12-0.50 mg/L in this study fall within the range reported by Alani et al.,(2022).

Endosulfan sulfate: The endosulfan sulfate concentrations in this study range from 0.10-0.25 mg/L.These values have a mean value of 0.212 ± 0.059 mg/L. The highest concentration of endosulfan sulfate was recorded at sampling points T_3, T_4 and T_6 respectively, while the lowest value was obtained at point T_5. The low values of endosulfan sulfate residues in water indicated that the pesticide residues underwent degradation and distribution in water.

Ezemonye *et al*. (2015) reported the mean value of 0.01±0.01 mg/L, endosulfan sulfate in water obtained from Ogbese River of Edo State. This value was lower than the mean value 0.212±0.059.mg/L of endosulfan sulfate recorded in this study.
Ogah *et al*.(2015) reported the endosulfan sulfate values ranging from 0.00 - 0.14909 mg/L in twelve samples obtained from River Benue in Makurdi agreed with the endosulfan sulfate concentrations ranged of 0.10 - 0.25 mg/L in this study area.
Alani *et al* (2022) reported the endosulfan sulfate concentrations in two water samples obtained from River Ogun ranging from 14.663 - 41.521 mg/L for sample A and BDL for sample B respectively. These endosulfan sulfate values obtained by Alani *et al* were far greater than the endosulfan sulfate results obtained in this study.
The Endosulfan sulfate concentrations range of this study were 0.10 - 0.25 mg/L did not agree with the WHO maximum permissible limits of (NS), meaning not specified.
Endosulfan sulfate in sediments: The endosulfan sulfate values in this study ranged from 3.80 - 45.55 mg/kg. These endosulfan sulfate values have a mean value of 29.6±20 mg/kg. The highest value of Endosulfan sulfate was recorded at sampling point T_E, while the lowest value was obtained at point T_A.
The concentrations of Endosulfan sulfate in this study area were generally high in all the sampling points. This may implies that the endosulfan sulfate having the density of 1.745 g/cm^3 greater than that of water and less soluble with the solubility of 0.22 mg/L at 72°f would go under the water and be adsorbed onto the sediments, on analysis might results to an elevated concentrations.
Alani *et al*.(2022) reported Endosulfan sulfate concentrations obtained from two sampling point range of ND - 42.749 mg/kg and ND - 0.210 mg/kg from River Ogun at Kara abattoir. These Endosulfan sulfate values reported by Alani *et al* agreed with the results of Endosulfan sulfate recorded in this study.
Idris (2017) reported Endosulfan sulfate concentrations in S1-S8 sediments samples obtained from Rivers Niger and Kaduna ranging from 0.01 - 0.06 mg/kg,were lower than endosulfan sulfate concentrations range of 3.80 - 45.55 mg/kg obtained in this study.
Ezemonye *et al*.(2015) reported the mean Endosulfan sulfate values of 0.25±0.12 mg/kg in sediments obtained from River Ogbese in Edo State were lower than the mean value of Endosulfan sulfate of 29.6±20 mg/kg recorded in this study.
P,P′ - DDT. in water: The concentrations of P,P′-DDT in water samples of this study range from 0.10-1.25 mg/L. These values have a mean value of 0.355±0.44 mg/L. The highest concentration of P,P′ -DDT was recorded at sampling point T_2, while the lowest value was obtained at point T_1.
Moses *et al*.(2022) reported the P,P′ -DDT concentrations of BDL in stations S1 and S2 obtained from analysis of water samples from River Nwaniba in Akwa Ibom State. These value disagreed with the P,P′-DDT mean value of 0.355±0.44 mg/L obtained in this study.
Ogah *et al*.,(2015) reported P,P′ - DDT concentrations range of 0.01243 - 0.04123 mg/L. from the analysis of water samples obtained from River Benue at Makurdi. These range values were below the P,P′-DDT range values recorded in this study.
Ezemonye *et al*.(2015) reported the mean P,P′ -DDT concentrations of 0.12±0.06 mg/L in samples obtained from River Ogbese in Edo State. This mean value of P,P′-DDT was below the mean value 0.355±0.44 mg/L obtained in this study.
Idris, (2017) reported the P,P′-DDT concentrations range values of ND - 0.02 mg/L in eight water samples obtained from Rivers Niger and Kaduna, north-central Nigeria. These range value were lower than the range values of 0.10 - 1.25 mg/L P,P-DDT obtained in this study. These concentrations range fall within the WHO MRL of 2.00mg/L.
Heptachlor in water: The concentrations heptachlor in water samples obtained from River Taraba ranged from 0.11-1.25 mg/L. These values have the mean value of 0.722±0.51 mg/kg. The highest concentrations of heptachlor was recorded at sampling point T_3 and T_5, while the lowest value of this residue was obtained at sampling point T_1. These values did not exceed the WHO maximum residues limit of 0.03 mg/L.
Alani *et al*.(2022) reported the heptachlor mean value of 0.146±0.068 mg/L. and 0.010±0.001 mg/L in two sampling points A and B obtained from River Ogun at Kara abattoir. These values were below the heptachlor mean value recorded this work.
Moses *et al*.(2022) reported the concentrations of heptachlor ranging from BDL - 0.199 mg/L in two sampling points obtained from River Nwaniba in Akwa Ibom State. These range values agreed with the heptachlor range values of this work.

Heptachlor in sediments: The concentrations of heptachlor in sediments samples obtained from River Taraba ranged from 23.10-73.40 mg/kg. These values have a mean value of 34.6±19 mg/kg. The highest concentrations was recorded at sampling point T_D, while the lowest value was obtained at sampling point T_B. The heptachlor mean concentration of 34.61±19.10mg/kg obtained in this study was far greater than WHO maximum residues limits (MRL).

Ezemonye *et al.*(2015) reported the heptachlor mean concentration of 1.35±0.47mg/kg in sediments samples obtained from River Ogbese in Edo State. These values were lower than the heptachlor mean value recorded in this study.

Another study was carried out by Alani et al.(2022) reported the heptachlor mean concentrations of 0.064±0.124 mg/kg in sediments samples obtained from Ogun river at Lara abattoir, Ogun State, which were lower than the heptachlor mean concentrations recorded this study.

Statistical analysis results revealed that the mean concentration of heptachlor in sediments samples was higher, therefore there was a significant difference $p>0.05$ between the mean concentration of heptachlor obtained from the Water samples and the sediments samples.

P,P′_DDE in water: The concentrations of P,P′_DDE in water samples obtained from River Taraba at Tella, ranged from BDL - 0.22 mg/L. These concentrations have a mean value of 0.182±0.031 mg/L. The highest value was recorded at point T_4 and the lowest value of P,P′_DDE was obtained at point T_2. The mean concentration of P,P′_DDE in water samples did not exceed the WHO maximum residue limit of 2.00 mg/L.

Mustapha *et al.*(2020) reported the P,P′_DDE concentration of 4.44±1.44 mg/L in water samples obtained from downstream of River Benue, Jemita Adamawa State. This mean value of 4.44±1.44 mg/L was greater than the mean value of P,P′_DDE in this study.

Idris, (2017) reported P,P′_DDE concentrations in water samples obtained from Rivers Niger and Kaduna North-central Nigeria were below detection limit which disagreed with the results of PP′_DDE recorded in this study.

Alani *et al*.,(2022) recorded the P,P′_DDE concentrations range of 0.112 - 0.559 mg/L in water samples obtained from River Ogun, agreed with the concentrations of P,P′_DDE recorded in this study.

Statistical analysis results revealed that the concentrations of P,P′_DDE recorded in the various sampling points were generally low. There was no significant difference $P<0.05$ between the concentrations of P,P′_DDE recorded in various sampling points and the mean value.

Endrin aldehyde in water: The concentrations of endrin aldehyde recorded in sediment samples from River Taraba at Tella ranged from BDL - 0.145 mg/L. These values have a mean value of 0.318±0.11 mg/L. The highest value was recorded at sampling points T_3 and T_6, while the lowest concentration was obtained at point T_2.

Alani *et al.*(2022) reported the concentrations of endrin aldehyde in water samples obtained from River Ogun at Kara abattoir which ranged from 5.480 - 17.693 mg/L. These values were higher than the concentrations of endrin aldehyde recorded in this study. The low values of endrin aldehyde might be due to degradation and distribution of pesticide residue in water. And high values of endrin aldehyde might be due to increased in agricultural activities in the area that bring about the introduction of the residue into the river .

Moses *et al.*(2022) reported the concentrations of endrin aldehyde in water samples obtained from River Nwaniba in Akwa Ibom State were below detection limit(BDL). These values fall within the concentration range of endrin aldehyde recorded in this study.

Statistical analysis results revealed that there were no significant difference in the concentrations of endrin aldehyde recorded in the various sampling points $P<0.05$, between the scores and the mean value.

Chlordane in water: The concentrations of chlordane recorded in water samples obtained from River Taraba range from 0.20 - 2.50 mg/L. These values have a mean value of 0.687±0.88 mg/L. The highest concentration of chlordane was recorded at sampling point T_2, while the lowest values were obtained at sampling points T_3 and T_6 respectively.

Idris, (2017) reported the concentrations of chlordane obtained in water samples from Rivers Niger and Kaduna North-central Nigeria, were below detection limits (BDL) in all the eight sampling points in the area. These results did not agreed with the values of chlordane recorded in the analysis of water samples obtained from River Taraba at Tella. The concentrations of chlordane in water samples of the study area disagreed with the world health Organisation (WHO) value whose maximum residues limits (MRL) was not specified (NS) for chlordane residue. The concentrations of chlordane in water samples recorded in this study were in the order of T6<T4<T5<T2 respectively.

Heptachlor epoxide in water: the concentrations of heptachlor epoxide recorded in water samples obtained from River Taraba ranged from BDL - 0.20 mg/L. These values have a mean value of0.200±0.00 mg/L. Here, T_1, T_3, T_5 and T_6 recorded the highest heptachlor epoxide concentrations in the sampling points while T_2 and T_4 recorded the lowest values.

Ezemonye *et al*.(2015) reported the heptachlor epoxide mean concentrations of 0.43±0.22 mg/L in surface water from sampling points obtained from Ogbese River. The mean concentration of heptachlor epoxide recorded in this study fall within the mean concentration of heptachlor epoxide recorded by Ezemonye *et al.* (2015).

Ogah *et al*.(2015) reported the concentrations of heptachlor epoxide in water samples obtained from River Benue at Makurdi ranging from 0.00278 - 0.15109 mg/L. These values agreed with the concentrations range of heptachlor epoxide recorded in this study. The concentrations ranged of heptachlor epoxide in this study agreed with the WHO maximum residue limit (MRL) of 0.03 mg/L for heptachlor epoxide.

Moses *et al*.(2022) also reported the concentrations of 0.0658 mg/L and BDL heptachlor epoxide in two sampling areas obtained from Nwaniba River in Edo State agreed with the concentrations of heptachlor epoxide recorded in this study.

Endrin in water: The endrin concentrations in water in this study ranged from 0.25-1.50 mg/L. These values have a mean value of 0.733±0.57 mg/L. The highest concentrations of endrin was recorded at sampling points T1 and T5 while the lowest values were obtained at point T_3 and T_6. WHO did not specify the maximum residue limit (MRL) for endrin.

Idris, (2017) reported the endrin concentrations ranged of 0.01 - 4.71 mg/L in eight sampling points obtained from Rivers Niger and Kaduna North-Cental Nigeria. The concentrations range of endrin in this study fall within the range values recorded by Idris, (2017).

Alani *et al*.(2022) reported the concentrantions of endrin in water samples of Ogun River at Kara ranging from 0.436 - 1.329 mg/L. Comparatively, the concentrations range of this study agreed with the concentrations range of endrin recorded by Alani *et al.*(2022).

Ogah *et al.* (2015) reported the concentrations of endrin in water samples obtained from River Benue at Makurdi ranging from BDL - 0.33535 mg/L. These values fall within the concentrations range of endrin in this study.

Endosulfan in water: The concentrations of endosulfan in this study ranged from 1.00-2.00 mg/L. These values have a mean value of 1.63±0.50 mg/L. The highest concentrations of endosulfan was recorded at sampling points T_3, T_4, and T_6, while the Lowest values of endosulfan was obtained at sampling points T_1 and T_5.

Upadhi and Wokoma,(2012) reported the concentrations of endosulfan in surface water obtained from Elechi Creek, Niger Delta, Nigeria which range from BDL - 0.01 mg/L. These values were below the range values of endosulfan recorded in this study.

Idris, (2017) reported the concentrations of endosulfan in eight sampling points obtained from Rivers Niger and Kaduna ranged from BDL - 0.02 mg/L. These ranged values were lower than the endosulfan ranged value recorded in this study.

Aldrin in water: the concentrations of Aldrin in this study ranged from 2.30 - 2.60 mg/L. These concentrations have a mean value of 2.48±0.098 mg/L. The highest Aldrin concentrations was recorded at sampling points T_5 and the lowest value was obtained at T_2. The concentrations of Aldrin and the mean value exceeded the WHO maximum residue limit of 0.03 mg/L.

Ezemonye *et al.*(2015) reported the mean concentration of Aldrin in water samples from Ogbesse River was 0.21±0.08 mg/L. This value was lower than the mean value of Aldrin recorded in this study.

Alani *et al*.(2022) recorded the concentrations of Aldrin in water samples obtained from River Ogun in Edo State ranging from BDL - 0.189 mg/L. In comparison, these values were lower than the concentrations range of Aldrin in this study.

Mustapha *et al*.(2020) reported Aldrin mean concentration of 16.06±2.94 mg/L in water samples from River Benue, Jimeta, Adamawa state. The mean value of Aldrin recorded in this study, fall within the mean value recorded by Mustapha *et al*. (2020).

β* -BHC in water**: The concentrations of ***β –BHC in water samples of this study ranged from 0.20-2.30 mg/L. These values have a mean value of 1.35 ±0.96 mg/L. The highest value of ***β*** -BHC was recorded at sampling points T_5 while the lowest values was obtained at sampling points T_1 and T_3.

Ogah *et al*.(2015) reported the concentrations of β-BHC in water samples obtained from River Benue at Makurdi ranging from 0.01190 - 0.06734 mg/L .These values were lower than the range value of β-BHC recorded in this study.

Ezemonye et al.(2015) reported a mean concentration of 0.32 ± 0.05 mg/L.of β -BHC in water samples obtained from Ogbesse River of Edo State. This value was lower than the mean value of β-BHC recorded in this study.

Moses *et al*.(2022) also reported the concentrations BDL of β-BHC in water samples collected from Ufak Effiong and Akani Obio along River Nwaniba in Akwa Ibom State. These values did not agree with the concentrations of β-BHC recorded in this study area.

Dieldrin in water: The concentrations of Dieldrin in this study ranged from BDL-0.65mg/L. These values have a mean value of 0.457 ± 0.217 mg/L. The highest Dieldrin concentrations was recorded at sampling point T_5 and the lowest value was obtained at points T_3, T_4, and T_6. This mean value did not exceed the WHO maximum residue limit of 0.03 mg/L.

Mustapha *et al*.(2020) reported the mean dieldrin concentration of 24.16 ± 4.04 mg/L in water samples obtained from River Benue at Jimeta. This value was greater than the dieldrin mean value recorded in this study.

Alani *et al*.(2022) reported the concentrations of dieldrin in two water samples obtained from Ogun River ranging from 5.792 - 15.862 mg/L and BDL - 0.047 mg/L. Comparatively, the concentration range of dieldrin in this study fall within the range recorded (Alani.,2022).

Moses *et al*.(2022) reported dieldrin concentration of 0.0614 mg/L and 0.0689 mg/L from two sampling stations obtained from River Nwaniba, Akwa Ibom State. These values agreed with the concentration range of dieldrin recorded in this study.

P,p′_DDD in water: The concentrations of p,p′_DDD in this study range from BDL -0.40 mg/L. These values have a mean value of 0.400 ± 0.00 mg/L. The highest p,p′_DDD concentration was recorded at sampling point T_2, while the lowest values were recorded at sampling point T_1, T_3, T_4, T_5 and T_6, were all below detection limit (BDL).

Alani *et al*.(2022) reported P,P′_DDD concentrations in two sampling points obtained from River Ogun in Ogun state, which ranged from 0.597-1.904 mg/L and BDL-0.002mg/L. The concentrations ranged of P,P′_DDD in this study agreed with the concentration range values of p,p′_DDD reported by Alani *et al*. (2022).

Mustapha *et al*.(2020) reported the p,p′_DDD mean concentration of 4.93 ± 1.69 mg/L in water samples obtained from downstream of River Benue in Jimeta, Adamawa state. This mean value was higher than the mean concentration of p,p′_DDD recorded in this study.

Statistical analysis results revealed that the concentrations of p,p′_DDD in various sampling points were very low. Therefore, there was no significant difference $p<0.05$ between the concentrations of p,p′_DDD in the various sampling points and the mean value

5.3 Pesticide residues risk assessment in Water from River Taraba.

The risk assessment of pesticide residues in water samples obtained from River Taraba at Tella were presented in Table 14. The table presented the results of the risk assessment of pesticides based on measured environmental concentration (MEC), predicated no effect concentration(PNEC) and risk quotient (RQ). Fatemeh *et al*. (2012) reported that the risk quotient, $RQ \geq 1$, indicated high risk, $0.1 \leq RQ \leq 1$, indicate medium risk, while, $0.01 \leq RQ \leq 0.1$, indicated low risk respectively.

Endrin ketone: The MEC concentration of Endrin Ketone recorded was 0.385 mg/L, while the PNEC value obtained was 0.042 mg/L. These values have the RQ of 9.17. This value was far greater than the PNEC value. The RQ value of this study agreed with the RQ value reported by Fatemeh *et al*. (2012).Therefore, the results of the RQ value indicated that Endrin ketone recorded high risk indicated by $RQ \geq 1$, and so this compound could likely cause hazards to aquatic life and humans.

Methoxychlor: The methrochlor MEC concentration recorded was 0.237 mg/L, while the PNEC value obtained was 20.0 mg/L. Tthese values have the RQ of 0.012 mg/L. This RQ value was less than the PNEC value, and so the compound indicated low risk with $0.01 \leq RQ \leq 0.1$.

Endosulfan sulfate: The ratio of MEC/PNEC for endosulfan sulfate recorded was 2.12 . This RQ value was greater than the MEC and PNEC values of 0.212 and 0.100 mg/L. The result of the RQ value indicated that the compound recorded high risk with $RQ \geq 1$.

P,P^1-DDT: The P,P^1-DDT MEC concentration recorded was 0.355 mg/L, while the PNEC value obtained was 2.000 mg/L. These values have the RQ value of 0.178. This value was lower than the PNEC value. The result of the RQ value indicated medium risk with $0.1 \leq RQ \leq 1$.

Ezemonye *et al*. (2015) carried out a study on the distribution and ecological risk assessment of pesticide residues in surface water, sediments and fish from ogbesse river of Edo state, Nigeria and reported the risk quotient value (RQ) of P, P^1-DDT obtained,this was higher than the RQ value recorded in this study.

Heptachlor: The risk quotient (RQ) of heptachlor recorded was 24.1 mg/L, this value was greater than the PNEC value of 0.030 mg/L,having the MEC value of 0.722 mg/L . The RQ of the heptachlor indicated that the compound recorded very high risk with $RQ \geq 1$. This value of RQ in this study agreed with RQ value reported by Ezemonye *et al*.(2015).

P,P^1-DDE: The MEC concentration of P,P^1-DDE recorded was 0.182 mg/L, while the PNEC value obtained was 2.000 mg/L. These value have the RQ value of 0.091 mg/L, and this RQ value indicated that the compound recorded low risk having $0.01 \leq RQ \leq 0.1$.

Endrin aldehyde: The risk quotient (RQ) of endrin aldehyde recorded was 7.57 , while the PNEC value obtained was 0.042 mg/L, having the ME*C* value of 0.042 mg/L, the RQ of this compound indicated that endrin aldehyde recorded high risk, having $RQ \geq 1$

Chlordane: The MEC concentration of chlordane recorded was 0.687 mg/L, while the PNEC value obtained as 0.150 mg/L. These values have the RQ value of 4.58. The high concentration of RQ value indicated that the compound recorded high risk. This means that chlordane could likely cause hazard to aquatic life and humans.

Heptachlor epoxide: The heptachlor epoxide MEC concentration recorded was 0.200 mg/L, while the PNEC value obtained was 0.030 mg/L. These values have the MEC/PNEC value of 6.67, higher than the PNEC value. This means that the compound recorded high risk, indicated by $RQ \geq 1$.

Ezemonye *et al.* (2012) reported that the RQ value of heptachlor epoxid was high, this results agreed with the results of the heptachlor epoxide RQ value recorded in this study.

Endrin: The risk quotient (RQ) of endrin recorded in this study was 244, while the PNEC value obtained was 0.003 mg/L with the MEC value of 0.733 mg/L. The value for the RQ indicated that the compound recorded very high risk with $RQ \geq 1$.

Similarly,Ezemonye *et al*. (2012) reported that the RQ value of endrin was high, this result agreed with the result of the endrin RQ value recorded in this study.

Endosulfan: The MEC concentration of endosulfan recorded in this study was 1.63 mg/L, while the PNEC value obtained was 0.500 mg/L. These values have the RQ value of 3.27. The high level of RQ value indicated that the compound recorded high risk, denoted by $RQ \geq 1$.

Aldrin: The ratio of MEC/PNEC for aldrin recorded in this study was 82.8, while the PNEC value obtained was 0.030 mg/L, with MEC concentration of 2.48 mg/L. The high concentration of RQ value for adrin indicated that the compound recorded very high risk with $RQ \geq 1$,and can likely cause hazards to humans.

β-BHC: The MEC concentration of β-BHC recorded in this study was 1.35 mg/L, while the PNEC value obtained was 1.000 mg/L. These values have the RQ of 1.35. The high level of RQ value indicated that the compound recorded high risk with $RQ \geq 1$.

Dieldrin: The RQ of dieldrin recorded in this study was 15.2 , while PNEC value obtained was 0.030 mg/L with 0.457 mg/L. The high concentration of RQ indicated that dieldrin recorded high risk . This means that the compound could likely cause adverse effects to aquatic life and humans.

P,P^1-DDD: The MEC concentration of P,P^1-DDD recorded in risk assessment of pesticides in water from River Taraba was 0.400 mg/L, while the PNEC value obtained was 0.300 mg/L. These values have the RQ value of 1.33 mg/L. The result of the RQ indicated that the compound recorded high risk, denoted by $RQ \geq 1$.

The risk assessment of pesticides in water samples obtained from River Taraba indicated that Methoxychlor, P,P^1-DDE recorded low risk (LR) with 13.3 %, P,P'-DDT, recorded medium risk (MR) with 6.70 % could unlikely cause adverse effects while endrin ketone, endosulfan sulfate, heptachlor, endrin aldehyde, chlordane, P,P^1-DDD, heptachlor epoxide, endrin, endosulfan, aldrin, β-BHC and Dieldrin recorded high risk with 80.0 % can cause adverse effects to aquatic life and humans.

5.3:Pesticide residues in sediments

Lindane in sediments: The concentrations of lindane in sediment samples obtained from River Taraba in Tella range from 0.55 - 9.20 mg/kg. These values have a mean concentration of 2.22 ± 3.5 mg/kg. The highest

concentration of lindane was recorded at sampling points T_D, while the lowest value of lindane was recorded at sampling points T_B. The WHO maximum residue limit for lindane is 2.0 mg/kg. This value agreed with the lindane mean concentration recorded in this study.
Upadhi and Wokoma.,(2012) reported lindane concentrations in sediment sample obtained from Elechi Creek of Niger Delta ranging from BDL - 0.03 mg/kg. These value were lower than the value of lindane ranged recorded in this study.
USEPA,(2000 a,b) reported that the recommended limit for pesticide residues was 0.01 mg/kg. This value was lower than the lindane mean concentration recorded in this study.
Chlorpyrifos in sediments: the concentrations of chlorpyrifos in this study ranged from 0.50 - 9.22 mg/kg. These values have a mean value of 5.19±4.4 mg/kg. The highest value of chlorpyrifos was recorded at sampling point T_F, while the lowest value was obtained at sampling points T_A and T_C. The difference in the concentrations of the chlorpyrifos were due to anthropogenic activities and agricultural practices in the area (Hamilton *et al*.,2003). Singh *et al.*,(2015) reported the chlorpyrifos mean concentration of 5.0371±1.4236 mg/kg, chlorpyrifos in sediment samples obtained from River Deomoni of Terai region of West Bengal in India, The mean concentration of chlorpyrifos in this study was greater than the mean value of chlorpyrifos reported by Singh *et al*.(2015).
Endosulfan I in sediments: The concentrations of endosulfan I in sediment samples obtained from River Taraba in Tella ranged from 7.50 - 45.55 mg/kg. These values have a mean value of 29.7±18 mg/kg. Therefore, the highest concentration of endosulfan I was recorded at sampling points T_A and T_C, while the lowest value was obtained at sampling point T_D.
Ezemonye *et al*.(2015) reported the mean concentration of 1.06±0.31 mg/kg, endosulfan I in sediment samples obtained from Ogbesse River. This mean value of endosulfan I was lower than the mean value of endosulfan I recorded in this study.
Alani *et al*.(2022) reported Endosulfan I concentration ranged of 0.016-0.460 mg/kg and BDL - 0.016 mg/kg in sediments samples obtained from River Ogun. These values were below the endosulfan I concentration range recorded in this study.
Statistical analysis results revealed that there were significant differences between the concentrations of endosulfan I in sediment samples of various sampling points P>0.05 level of significance and the mean value. Therefore, the concentrations of endosulfan I at various sampling points were in the order of $T_F<T_E<T_D<T_B<T_A$ and T_C, respectively.
Endosulfan II in sediments: The concentrations of endosulfan II in this study ranged from 19.7 - 73.4 mg/kg. These values have a mean endosulfan II value of 47.7±29 mg/kg. Therefore, the highest value of endosulfan II was recorded at sampling points T_E and T_F, while the Lowest value of endosulfan II was obtained at point T_A.
Alani *et al.*(2022) reported the endosulfan II concentrations ranging from BDL - 154.374 mg/kg. and BDL - 0.020 mg/kg in sediments samples obtained from River Ogun. Comparatively the endosulfan II concentrations range recorded in this study, fall within the range value recorded by Alani *et al*,(2022).
Ezemonye *et al*.(2015) reported the mean concentration of 0.81±0.28 mg/kg endosulfan II in sediment samples obtained from Ogbesse River of Edo State. These mean value was lower than the mean concentration of endosulfan II recorded in this study.

Tetradifon in Sediments: The concentrations of tetradifon in this study ranged from 1.05 – 24.3 mg/kg. These values have a mean value of 12.9 ± 12 mg/kg. The highest concentration of tetradifon in sediment samples were recorded at sampling points T_D and T_E while the lowest values were recorded at points T_A and T_C. There were differences in the concentrations of tetradifon in sediment samples of various sampling points. Therefore, there was a significant difference between the concentrations of tetradifon in various sampling points P>0.05 and the mean value.
Cyhalothrin in Sediments: The concentrations of cyhalothrin in sediment samples of this study ranged from 0.52 -12.60 mg/kg. These values have a mean value of 6.59 ± 6.6 mg/kg. The highest concentrations of cyhalothrin were recorded at sampling points T_D and T_E and the lowest value was obtained at point T_B. Statistical results revealed that there were differences in concentrations of cyhalothrin recorded in various sampling points in the study area. There was a significant difference between the concentrations of cyhalothrin in sediment samples obtained from River Taraba P>0.05 and the mean value.
Acrinathrin in Sediments: The concentrations of acrinathrin in sediment samples of this study ranged from 0.30 – 3.80 mg/kg .These concentrations have a mean value of 1.17± 1.3 mg/kg .The highest concentrations

of acrinathrin was recorded at sampling point T_A,while the lowest values were obtained at sampling points T_B and T_E . Statistical analysis results revealed that there were no much differences in the concentrations of acrinathrin in various sampling points in this study $P< 0.05$ and the mean value.

5.5: Pesticide reesidues health risk assessment in sediments from River Taraba.

The risk assessment of pesticide residues in sediments obtained from River Taraba were presented in Table 5. These pesticide residues include Lindane, Heptachlor, chlorpyrifos, endosulfan I, endosulfan II, Endosulfan sulfate, tetradifon, cyhalothrin and acrinathrin.

Lindane: The lindane MEC concentration recorded in this study was 2.22 mg/kg, while, the PNEC value obtained was 0.58 mg/kg. These values have the RQ of 3.831. The high value of RQ for lindane indicated that the compound recorded high risk with RQ≥1 . The RQ value of this study agreed with the RQ value reported by Fianko *et al*.(2011).

Heptachlor: The MEC concentration of heptachlor recorded was 34.6 mg/kg, while the PNEC value obtained was 0.030 mg/kg. These values have the RQ value of 1,153. The high level of RQ for heptachlor indicated that the compound recorded very high risk with RQ≥1. This means that the residues can cause adverse effects to aquatic life and humans.

Chlorpyrifos: The risk quotient (RQ) for chlorpyrifos in this study recorded was 519. while the PNEC value obtained was 0.010 mg/kg and the MEC concentration of 5.19 mg/kg. This indicated that chlorpyrifos recorded high risk. RQ value of this study was high and so this agreed with the RQ value reported by Andoh *et al*.(2013).

Endosuffan I: The ratio of MEC/PNEC value for endosuffan I in this study recorded was 9900. This value was greater than the PNEC value of 0.003 mg/kg and the MEC concentration of 29.7 mg/kg. The high level of RQ indicated that the compound recorded very high risk with RQ≥1.

Endosuffan II: The risk quotient (RQ) of endosuffan II recorded in this study was 691.3 . This value was greater than the PNEC value of 0.069 mg/kg and the MEC value of 47.7 mg/kg. The high level of RQ indicated that endosuffan II recorded high risk .

Fianko *et al*. (2011) and Andoh *et al*. (2013) reported potential risks to humans through consumption of fish, maize and cowpea from River Ghana due to high estimated hazard quotient was greater than one (1). These results agreed with the results of RQ recorded in this study.

Endosulfan sulfate: The MEC concentration of endosulfan sulfate recorded in this study was 29.6 mg/kg, while the PNEC value obtained was 9.030 mg/kg. These values have the RQ of 3.28. The high level of endosulfan sulfate indicated high risk, with RQ≥1.

Tetradifon: The ratio of MEC/PNEC value for tetradifon recorded in this study was 0.551, while the PNEC value obtained was 23.30 mg/kg and the MEC concentration recorded was 12.8 mg/kg. This result indicated that the compound recorded medium risk with 0.1≤RQ≤1. This result of RQ value obtained in this study agreed with the RQ value reported by Andoh *et al*.(2013).

Cyhalothrin: The risk quotient of cyhaqlothrin recorded in this study was 219.7, while the MEC and the PNEC values were obtained as 6.59 mg/kg and 0.030 mg/kg, respectively. The high value of RQ for cyhalothrin recorded in this study indicated that the compound recorded a very high risk shown by RQ≥1. Therefore, the RQ value of Cyhalothrin recorded in this study agreed with the RQ value obtained by Fatemeh *et al*.(2012).

Acrinathrin: The MEC concentration of acrinathrin recorded in this study was 1.17 mg/kg, while the PNEC value obtained was 0.500 mg/kg. These values have RQ value of 2.340. The high value of RQ indicated that acrinathrin recorded high risk with RQ≥1,which agreed with the results of risk quotient reported by Fatemeh *et al*. (2012).

The risk assessment of pesticide residues in sediments from River Taraba indicated that the medium risk (MR) recorded 11.1 % can unlikely cause adverse effects while high risk (HR) recorded 88.9 % can likely cause adverse effects to aquatic life and humans.

Conclusion

This study has shown that water and sediments from River Taraba in Tella were both contaminated with pesticide residues in varying concentrations. The results of the pesticides risk assessment showed that the total pesticide residues in water from Tella were lower than the concentration of the pesticides risk assessment in sediments 80.0% high risk, while that of sediments was 88.9% high risk respectively. Therefore, prolonged consumption of water by aquatic organisms and humans might likely cause hazards to aquatic life and

humans There should be proper orientation exercises for farmers to ensure effective handling and application of pesticides.

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