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# Organochlorine Pesticide Residues in five Fish Speciesin the Vicinity of Lake Chad, Baga, Nigerian Sector

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**Abstract:** This study was carried out to determine the concentration levels of some Organochlorine Pesticides (OCPs), dichlorodiphenyltrichloroethane (DDT), isomers of hexachlorocyclohexane (HCH) (alpha, beta, and delta HCH), lindane, Endosulfan I, Endosulfan II, Endosulfansulphate, dieldrin, Permethrin , Heptachlor, Lambda-cyhalothrinand aldrin, in five fish species (*Clariasgariepinus, Clariasanguillaris, Heterotisniloticus, Oreochromisniloticm, and Tilapia zillii*) in the vicinity of Lake Chad, Baga, Nigerian sector. The OCP residues were analyzed using Gas Chromatography. The concentrations of OCP residues in fish species ranged between Endrin (0.0003 mg/kg) in *T.zillii* at Dunmba I. to delta HCH (4.677 ± 0.05 mg/kg) observed in *T.zilli* at Dumba 2 The dominant pattern of OCP residues accumulated by fishes followed this order, delta HCH>Endrin>Endosulfan I>Permethrin> Endosulfan II. The accumulation pattern of OCP residues by the fishes was as follows *T.zillii*>*C.gariepinus*> *H. niloticus*>*C.*anguillari>*O.niloticus*s. The mean concentration levels of OCP residues in the fishes were within the permissible limits of FAO/WHO (2005).
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**Keywords:** Organochlorine Pesticides, Pollutants, Water, Fish.

## Introduction

Organochlorine pesticides (OCPs) are chlorinated hydrocarbon chemicals used widely to improve agricultural production and also to control or prevent pests.OCPs are characterized by low aqueous solubility and high lipid solubility, they are persistent in the environment and move long distances in surface water and ground water, and air. They have a potential for bioaccumulation in the food chain, the environment and in fish, posing a great threat to human health and the environment globally. (Afful *et al.*, 2010; Guo *et al*., 2008; Matsumura, 1985) .Fish absorbs OCPs by drinking water or by ingesting contaminated food. The excessive usage of OCPs is harmful to the ecosystem and that they contaminate soil, surface and underground water. OCPs are persistent organic pollutants, a class of chemicals known to break down very slowly and bioaccumulate in lipid rich fatty tissues of the body (Swackhammmer and Hites, 1988). The adverse health effects of OCPs in humans, includes liver toxicity, neurological, reproductive and developmental effects. High doses can cause symptoms like vomiting, diarrhea, muscle weakness, blood disorders and immune deficiencies. The Lake Chad basin is polluted by textiles and tanneries effluents in the upstream parts of the Basin and wastewater discharged from settlements along the Chari-Logone and Komadugu-Yobe River. The cotton industry in the Republic of Chad also uses large quantities of OCPs within the Republic of Chad and therefore contributes to the pollution of the Lake (Akan *et al*., 2014). The study area is Baga, the Nigerian sector of Lake Chad located in Kukawa Local Government area of Borno State, Nigeria. Baga lies on latitude 12° 55' N, and longitude 13° 35' E. The major economic activities of the population in Baga are agriculture, stock breeding and fishing. Fish species were collected between the months of March 2012, March 2013 and March 2014.

The objective of this research work was to determine the concentration levels of OCP residues in Five Fish species in Lake Chad, Baga, Nigerian Sector.

## Materials and Methods: Sampling Sites and Sample Collection

Fish samples were collected from two sampling sites, Dumba 1 and Dumba 2, Lake Chad, Baga, Nigerian Sector. Five species of fish Clariasanguillaris, *Clariasgariepinus, Hetrotisniloticus, Tilapia zilliiand Oreochromisniloticus* were randomly caught by the local fishermen using gill nets and Malian traps, and they were transported to the laboratory in a plastic bag for further analysis. (Ozturk *et al*., 2009). Approximately10 samples of each fish species were caught.

**Sample Preparations**

Fish samples were washed with distilled water in the laboratory and, scales of *H.niloticus, T.zilli* and *O. Niloticus* were removed. The muscle tissues of the fish samples were removed and were oven-dried at 105ºC to a constant weight and were ground to powder in a mortar to obtain a homogenous composite. OCP residues in fish samples were extracted using Soxhlet Extraction (ÖztÜrik *et al*., 2009).

**Fish Samples Extraction for OCP Residues Analysis**

A 10 g sample of each fish species were placed into a beaker containing 50 g anhydrous sodium sulfate and mixed thoroughly. The sample mixture for each fish species was transferred into an extraction thimble and placed in a Soxhlet extractor. The mixture for each fish species were extracted with 150 ml of acetone: n-hexane (20:80 v/v) at 50°C for 4 hours. (Therdteppitak and Yammeng, 2003). The extracts for each fish species were filtered, concentrated to 1 ml using vacuum rotary evaporator. Each of the raw extracts was then dissolved in 10 ml hexane and passed through pre-conditioned octadecyl C-18 columns at a rate of 2 ml min$^{-}$1 to clean up. The column was washed with 1 ml, 30% methanol followed by 1 ml ultrapure water and was allowed to dry. The sample (analyte) which was trapped in the column was eluted 5 times with 0.5 ml aliquots of hexane to recover the OCP residues. Hexane in the sample was then allowed to evaporate off leaving the residue alone in the vial. The dried sample was dissolved in 1cm$^3$ portion of n-hexane containing 1mg/L aldrin as internal standard mixed thoroughly with a whirl mixer.1µl of each final residue solution were injected onto the Gas Chromatography (GC) at flow rate of 1cm$^3$/min (Darko *et al*., 2008).

**Results**

The mean concentration of OCPs, in the muscular tissues of fishes ranged between alpha HCH 0.763 ± 0.02 to 0.775 ± 0.02 mg/kg; beta HCH 0.0273 to 0.578± 0.01 mg/kg; delta HCH 0.0017 to 4.667 ± 0.05 mg/kg; Lindane 1.011 ± 0.05 mg/kg; Heptachlor 0.0005 to 0.657 ± 0.05 mg/kg; Aldrin 0.0033 mg/kg; Endosulfan I 0.0051 to 2.13.5 ± 0.05 mg/kg; Dieldrin 0.105 ± 0.01 mg/kg; Endrin 0.0003 to 3.079 ± 0.05 mg/kg; Endosulfan II 0.019 to 1.117 ± 0.05 mg/kg; P' DDD 0.0077 mg/kg; Endosulfansulphate 0.104± 0.01 to 0.735 ± 0.02 mg/kg; P'DDT 0.0225 to 0.300 ± 0.01 mg/kg; Permethrin 0.1787 ± 0.02 to 1.27.5 ± 0.05 mg/kg (Tables 1 and 2). Delta HCH showed a maximum concentration of 4.677 ± 0.05 mg/kg, observed in *T.zillii,* at Dumba 2, Endrin (3.079 ± 0.05) in *C. gariepinus* at Dumba 2 (Table 2) and a minimum concentration, Endrin 0.0003 mg/kg in *T.zillii* at Dunmba I (Table 1).

In Tables 1 and 2, lindane, Aldrin, Dieldrin, P' DDD, Endosulfan II and Permethrin, and beta HCH in Table 2 only, are less than the detection limit (<5x10$^{-5}$).

Table 1: Mean Concentration of OCPs (mg/kg) in Muscle Tissues of Five Fishes from Dumba 1, Lake Chad, Nigerian Sector

| *Organochlorine Pesticides* | *Fish Species* | | | | |
|---|---|---|---|---|---|
| | *C. anguillaris* | *C. gariepinus* | *H. niloticus* | *O. niloticus* | *T. zillii* |
| beta HCH | 0.0579 | <5x10$^{-5}$ | 0.0273 | 0.578 ± 0.01 | 0.0618 |
| Lindane | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ | 1.011 ± 0.05 | <5x10$^{-5}$ |
| delta HCH | 0.0017 | 2.0660 ± 0.02 | <5x10$^{-5}$ | 0.0360 | 0.0031 |
| Heptachlor | 0.0005 | 0.657 ± 0.05 | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ |
| Aldrin | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ | 0.0033 |
| Endosulfan I | 0.0166 | <5x10$^{-5}$ | 0.007 | 0.114 ± 0.02 | 0.0051 |
| Dieldrin | <5x10$^{-5}$ | 0.105 ± 0.01 | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ |
| Endrin | <5x10$^{-5}$ | 2.910 ± 0.05 | 0.0173 | 0.835 ± 0.02 | 0.0003 |
| Endosulfan II | 0.0555 | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ |
| P'DDD | 0.0077 | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ | <5x10$^{-5}$ |
| Endosulfan Sulphate | 0.0478 | 0.182 ± 0.02 | <5x10$^{-5}$ | <5x10$^{-5}$ | 0.0088 |
| P'DDT | 0.0746 | 0.0510 | 0.0225 | 0.30 ± 0.01 | <5x10$^{-5}$ |
| Lambda-cyhalothrin | 0.0310 | <5x10$^{-5}$ | 0.0061 | 0.134 ± 0.01 | 0.0033 |
| Permethrin | 1.2715 ± 0.05 | <5x10$^{-5}$ | 0.1787 ±0.02 | <5x10$^{-5}$ | <5x10$^{-5}$ |

<5x10$^{-5}$: less than detection limit Values are Mean ± Standard Deviation

Table 2. Mean Concentrations of OCPs (mg/kg) in Muscle tissues of five fishes from Dumba 2, Lake Chad, and Nigerian Sector

| Organochlorine Pesticides | Fish Species *C.anguillaris* | *C. gariepinus* | *H. niloticus* | *O. niloticus* | *T. zillii* |
|---|---|---|---|---|---|
| alpha HCH | 0.763 ± 0.02 | $<5x10^{-5}$ | 0.775 ± 0.02 | $<5x10^{-5}$ | $<5x10^{-5}$ |
| beta HCH | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ |
| Lindane | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ |
| delta HCH | 1.865 ± 0.05 | 1.997 ± 0.05 | 1.478 ± 0.05 | $<10^{-5}$ | 4.677 ± 0.05 |
| Heptachlor | 0.018 | 0.466 | 0.274 ± 0.01 | $<10^{-5}$ | 0.264 ± 0.02 |
| Aldrin | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ |
| Endosulfan I | $<5x10^{-5}$ | 0.120 | 2.135 ± 0.05 | 0.422 ±0.02 | 0.725 ± 0.05 |
| Dieldrin | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ |
| Endrin | $<5x10^{-5}$ | 3.079 ± 0.05 | 0.394 ± 0.02 | $<5x10^{-5}$ | 2.318 ± 0.20 |
| Endosulfan II | 0.150 ± 0.01 | $<5x10^{-5}$ | 0.019 | $<5x10^{-5}$ | 1.117 ± 0.05 |
| P'DDD | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ |
| Endosulfan Sulphate | 0.104 ± 0.01 | $<5x10^{-5}$ | 0.518 ± 0.02 | 0.270 ± 0.02 | 0.735 ± 0.02 |
| P'DDT | $<5x10^{-5}$ | 0.057 | 0.082 | 0.044 | 0.042 |
| Lambda-cyhalothrin | $<5x10^{-5}$ | $<5x10^{-5}$ | 0.272 ± 0.02 | 0.329 ± 0.02 | 0.026 |
| Permethrin | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ | $<5x10^{-5}$ |

$<5x10^{-5}$: less than detection limit Values are Mean ± Standard Deviation

**Discussion**

In this study, delta HCH was indicated the most abundant OCP residues in fish sample. delta HCH accumulation was the highest and that it was observed in *T.zillii,* at Dumba 2, while the lowest value was Endrinobserved in *T.zillii* at Dunmba I. Isomers of HCH are used commercially as an insecticide on fruits, vegetables, forest crops, and animals (ATSDR, 2005a). The differences in feeding habits, metabolic capacity and trophic position explains most of the variations in OCPs levels between the different fish species. The possible reasons for the presence of high level of delta HCHs in the fish samples may be due to its current usage in vector control. In spite of the adverse side effect of pesticides, OCPs constitute a necessary part of modern agriculture due to its increase in food supply, low cost and versatility in industry, agriculture and public health (Tanabe *et al.*, 1994). Organochlorine pesticides tend to accumulate in living organisms especially in aquatic organisms such as fish species and they substantially settle on the sediments. The dominant pattern of OCP residues accumulated by fishes followed this order, delta HCH>Endosulfansulphate>Aldrin. The accumulation pattern of OCP residues by the fishes was as follows *T.zillii>C.gariepinus> H. niloticus>O.niloticus>C.anguillaris.*

The presence of higher levels of OCP residues in fishes could be attributed to the sprays of pesticides from the large farm lands around Lake Chad which have sharp slopes toward the sampling sites of the Lake, so, OCP residues can enter into them more easily. It could also be due to the fact that OCPs are highly soluble in fatty tissues of fishes. The results of this research work are in agreement with Akan *et al.*, 2014. The concentration levels of OCP residues in the fishes were within the permissible limits of FAO/WHO, 2005.

**Conclusion**

Delta HCH was the most abundant OCP residue in the muscular tissues of the fish species studied. The concentration levels of OCP residues in the fishes were within the permissible limits of FAO/WHO, 2005.The presence of OCPs in the fish samples indicates that farmers within the study area use OCPs for pest control. Therefore, there is the need to check the use of OCPs to control pest by farmers with little or no knowledge of the adverse effects of pesticides.

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