



**ASSESSMENT OF AGRICULTURAL RUNOFF (OCCURRENCE OF
CHLORPYRIFOS) ON *Clarias gariepinus* IN KOMADUGU YOBE RIVER,-NIGERIA:**

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ABSTRACT

This study assessed the occurrence and spatial variation of Chlorpyrifos contamination in water and *Clarias gariepinus* along three sampling locations (Usur, Mashayar-Bade, and Zango) of Komadugu Yobe River in Gashua. The research was prompted by the increasing agricultural runoff in the region and growing concerns over declining fish stocks and public health risks. Water and fish samples were analyzed using High-Performance Liquid Chromatography (HPLC) at the Yobe State University laboratory following standard procedures. The results revealed that all sampling sites contained detectable concentrations of Chlorpyrifos in both water and fish tissues. Water samples recorded concentrations ranging from 121.70 to 136.20 µg/L, while fish tissues contained 61.06 to 84.26 µg/kg. These values significantly exceeded the WHO permissible limits of 1 µg/L for water and 10 µg/kg for fish, indicating severe contamination. A significant difference exists between sampling sites ($p < 0.05$). Highest water contamination occurred in Usur and Mashayar-Bade, whilst highest fish contamination occurred in Zango. The presence of Chlorpyrifos in water and edible fish tissues raises serious ecological and public health concerns. The study recommends stricter pesticide regulation, improved farming practices, and continuous environmental monitoring.

Keywords: *Clarias gariepinus*, Chlorpyrifos, Komadugu Yobe River, Liquid Chromatography

Introduction

In Nigeria, the need for agricultural amplification arises from the country's flourishing population, which has led to both Land scarcity and increased demand for food.

In response to the mounting need for food, farmers across the nation cultivate high-yielding crop varieties; however, these varieties are highly susceptible to various pests and diseases. Consequently, farmers chose to use pesticides to protect their crops, enhance yields, and improve the quality of their produce (Maton *et al.*, 2016). The Nigerian government, like many other developing states, promotes the widespread use of pesticides to enhance agricultural productivity (Sarkar *et al.*, 2021). Currently, farmers employ various pesticides, with chlorpyrifos being a prominent choice (Shahjahan *et al.*, 2017). Chlorpyrifos (0,0-diethyl 0-3,5,6-trichloro-2-pyridyl phosphorothioate, CAS No. 2921-88-2) is a synthetic organophosphate insecticide and acaricide widely utilized in both agricultural and household settings (Yen *et al.*, 2024). The African catfish, *Clarias gariepinus*, Burchell 1822 (Siluriformes: Clariidae), ranks among the most widely distributed freshwater fish species in Africa, thriving in tropical swamps, lakes and rivers. In 2018, global fish production reached 179 million tonnes, with 156 million tonnes allocated for human consumption, approximately translating to an estimated annual supply of 20.5 kg of fish per capita (FAO, 2020). Developing countries host around 94% of all freshwater fish species, contributing over 6%

to the world's animal protein supply for human consumption (FAO, 2007). However, a significant portion of these fish and other aquatic organisms consumed by humans reside in rivers, which serve as the ultimate repositories for pollutants originating from spray drift, runoff, and leaching. Chlorpyrifos-contaminated soils exacerbate the situation, causing hazardous impacts on the aquatic environment (Agbohessi *et al.*, 2013). Agricultural runoff has emerged as a major environmental concern worldwide, especially in developing countries where unregulated farming practices lead to the contamination of water. In recent years, Fishers in Gashua, Yobe State have reported alarming declines in fish catches, with yields dropping by an estimated 40% between 2015 and 2022 (GFC, 2023). Recent trends indicate a severe reduction in fish sssproductivity in the Komadugu Yobe River. Agricultural runoff, carrying pesticides such as Chlorpyrifos, fertilizers, and sediments, is suspected to degrade water quality and damage aquatic habitats. Despite the severity, scientific evaluation of these impacts in Gashua is limited. Therefore, the need to assess the extent of Chlorpyrifos pollution and its biological implications on *Clarias gariepinus* (one of the most important freshwater commercial fish species) becomes pertinent.

MATERIALS AND METHODS

Study Area

The research was carried out along the Komadugu-Yobe River in Gashua, Bade Local Government Area, Yobe State, Nigeria. The study focused on the River Komadugu, a tributary of Lake Chad, located in Gashua (Latitude: 12.8705° N, Longitude: 11.0464° E). The river forms a small part of the international border between Niger and Nigeria, with a length of 95 miles (150 km) and flows a total of 200

miles (320 km). This area lies within Bade LGA, the Komadugu-Yobe River and Lake Chad-linked wetlands serving as primary fishing grounds. The region experiences a five-month rainy season (June–October) and intensive dry-season farming, making it ideal for studying seasonal variations in runoff impacts. These wetlands are crucial for dry-season agriculture and artisanal fisheries.



Figure 1: Map of a segment of Komadugu Yobe River showing sampling sites (Source: Mustapha, 2019).

Collection of Water Sample

Water samples were collected from the three sites (Usur, Mashayar Bade, and Zango), which are approximately five kilometers apart. Samples were collected in triplicate every month from July to September, 2025 using 1 L sterile plastic bottles at a depth of 0.5 m below the surface between 9 am and 10 am each sampling day. Each bottle was rinsed with river water before filling, leaving minimal headspace, and tightly capped. Samples were transported in an icebox at approximately 4°C to Yobe State University homogenized, and preserved in clean, labeled containers until analysis.

Laboratory Analysis

(YSU) Laboratory, Damaturu, Yobe State for analyses. Chlorpyrifos was extracted using High-Performance Liquid Chromatography (HPLC).

Fish Samples

Samples of *C.gariepinus* were collected from the three sampling sites. At each sampling site, a fish of approximately 600g was collected monthly for three months. Samples were cleaned and rinsed with river water, iceboxed, and transported to the Laboratory. Fish tissues (muscle) were dissected,

Water and fish tissue samples were tested for Chlorpyrifos using High-Performance Liquid Chromatography (HPLC) at the Yobe State

University laboratory, Damaturu. Water samples were analyzed using Liquid – liquid extraction with dichloromethane and homogenization plus solvent extraction (hexane), then cleaned up (solid–phase extraction) following established methods (APHA, 2017; WHO, 2011).

RESULTS

The concentration of Chlorpyrifos in water and fish samples is presented in Table 1. Higher level of Chlorpyrifos was recorded from the water at Usur (136.20 µg/l) and Mashayar-Bade (134.43 µg/l), which vary significantly, with the lowest concentration recorded from Zango with only 121.70 µg/l. The concentrations of Chlorpyrifos from water across the three different locations of significance in levels of contamination.

The proportion (%) of Chlorpyrifos concentration in water is presented in Figure 2, with the highest concentration detected at

Statistical Analysis

Data obtained from water samples were subjected to statistical analysis using One-Way Analysis of Variance (ANOVA). A significance level of $p < 0.05$ was adopted. Where significant differences were observed after post hoc tests, Tukey's HSD was used to separate the means.

show significant differences at $p < 0.05$ level of significance. Chlorpyrifos level in fish muscles was highest in samples from Zango (84.26 µg/kg), followed by Usur (70.70 µg/kg), and the lowest was detected from fish samples at Mashayar-Bade (61.06 µg/kg), indicating a significant difference at ($p < 0.05$) level.

Zango (39%), followed by Usur (32.7%) and the least at Mashayar Bade (28.3 %).

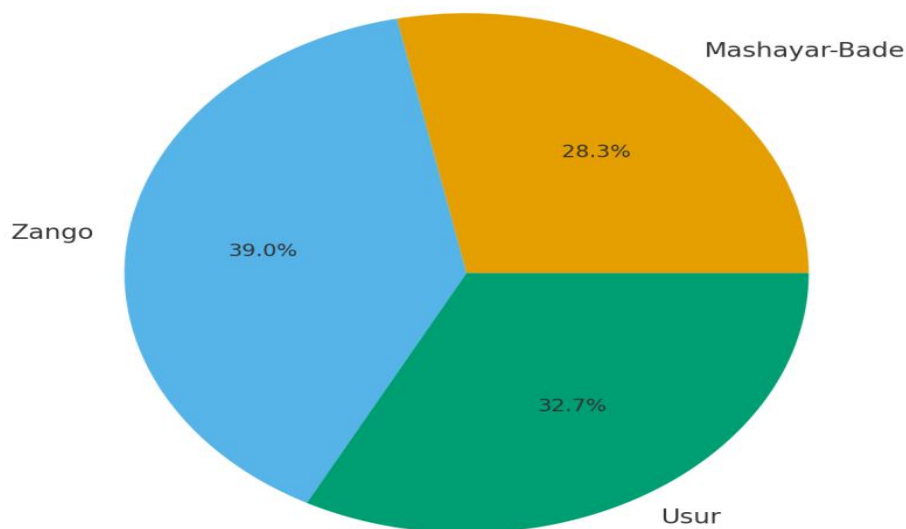


Figure 2: Proportion of Chlorpyrifos in Fish by Location

DISCUSSION

The results of this study demonstrated that water and fish from River Komadugu are contaminated with Chlorpyrifos at varying levels across sampling locations. These findings aligned with recent accounts of pesticide pollution in freshwater systems in Northern Nigeria and other agricultural regions of Africa (Abubakar *et al.*, 2023). The spatial variation in Chlorpyrifos concentrations observed in both water and *C. gariepinus* along the Komadugu Yobe River may reflect the influence of agricultural activities, hydrological dynamics, and habitat differences. Similar patterns have been reported in recent studies showing that

pesticide residues tend to be higher in areas closer to intensive farming (Adebayo *et al.*, 2021). The highest concentrations of Chlorpyrifos in water were recorded in Usur sites; this may be attributed to intensive upstream farming and irrigation. Similarly, Adeola *et al.* (2022) reported elevated Chlorpyrifos levels in rivers close to farmlands due to unregulated pesticide usage. Likewise, Isa *et al.* (2022) documented significant pesticide influx into aquatic ecosystems in Yobe State following rainfall events, supporting the pattern observed in this study. The lower Chlorpyrifos concentrations detected at Zango may possibly be attributed to dilution effects, vegetation buffer presence, or reduced direct

runoff. This is consistent with the findings of Abubakar *et al.* (2023), who reported that river sections with wider floodplains tend to dilute pollutants more effectively. However, Chlorpyrifos concentration was highest in fish from the Zango site despite the lowest concentration detected in water; a pattern that might suggest location-specific bioaccumulation factors, possibly due to feeding ecology, sediment retention, habitat structure, and exposure duration. This agrees with the findings of (Muhammad *et al.*, 2022), who reported that pesticide accumulation in *C. gariepinus* is influenced more by sediment interaction and feeding habits than water column concentration alone. Furthermore, Ibrahim *et al.* (2019) demonstrated that organophosphate pesticides accumulate efficiently in fish muscle tissues, posing human health risks

CONCLUSION

The findings revealed that both water and fish tissues of Komadugu Yobe River were contaminated with Chlorpyrifos, the concentrations varying significantly across locations. Chlorpyrifos concentrations far exceed the WHO permissible limits (1 µg/L and 10 µg/kg) from both water and fish samples, respectively. The detected high concentrations of Chlorpyrifos from edible

Recommendations

- ❖ Farmers and consumers should be adequately sensitized about the health risks linked to pesticide misuse and the consumption of contaminated fish.

when contaminated fish are consumed, similar to the trend documented in this study. However, work conducted in Nigeria by Akan *et al.* (2014) reported significantly lower concentrations of chlorpyrifos (ranging from 0.77 to 2.22 µg/g) in fish tissues than values detected in this study, probably due to less use of pesticides in agricultural production. Akoto *et al.* (2016) reported mean concentrations of chlorpyrifos in muscle tissues of *C. anguilaris* to be 0.093 ± 0.074 µg/g. This value is also significantly lower compared to the findings of the present study. The values obtained from this study are significantly higher compared to the WHO threshold, which puts water at 1 µg/L and fish at 10 µg/Kg (Nawab *et al.*, 2022). This suggests high input of chlorpyrifos from agricultural field runoff into the aquatic environment.

fish tissues raise serious public-health concerns for communities depending on River Komadugu. Given that organophosphates inhibit acetylcholinesterase activity, long-term exposure even at sub-lethal levels may cause neurological, reproductive, and metabolic disorders in fish and humans.

- ❖ Eco-toxicologists, Environmental Scientists, and Agricultural Scientists should step up public awareness campaigns on the dangers of Chlorpyrifos and similar pesticides.
- ❖ Farmers are to be encouraged to adopt organic farming and

sustainable agricultural practices that protect the natural ecosystem.

- ❖ Fish processors may be encouraged to adopt proper smoking methods that reduce pesticide residues before consumption.
- ❖ Finally, future research should include more sampling sites and multiple seasons to capture broader spatial and temporal variations in Chlorpyrifos concentrations.

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