



Original Article

## Prevalence and Tissue Tropism of *Edwardsiella* spp. in Market-Sourced Finfish in Kano State, Nigeria



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### ABSTRACT

*Edwardsiella* species are emerging zoonotic pathogens with increasing significance in aquaculture, posing risks to both fish health and public safety. Despite their relevance, data on their distribution in commercially important freshwater fish in Nigeria remain limited. This study investigated the occurrence and tissue distribution of *Edwardsiella* spp. in two finfish species; *Clarias gariepinus* (African catfish) and *Oreochromis niloticus* (Nile tilapia) sourced from Galadima Fish Market, Kano State, Nigeria. A total of 80 organ samples (gills, liver, spleen, and intestine) from 20 live fish specimens were analyzed using standard microbiological and biochemical techniques. The overall isolation rate of *Edwardsiella* spp. was 5% (2/40) in *C. gariepinus* and 10% (4/40) in *O. niloticus*. In *C. gariepinus*, isolates were found only in the intestine (20%) while in *O. niloticus*, isolates were detected in the gills (20%), spleen (10%), and intestine (10%), but not in liver tissues of either species. Biochemical tests identified traits consistent with *Edwardsiella tarda*, including motility, indole production, and hydrogen sulfide generation. Observed prevalence rates were low, suggesting geographical, environmental, or management-related variability. *Edwardsiella* spp. were present in both fish species, particularly in intestinal and systemic sites, with a higher frequency in *O. niloticus*. These findings indicate conceivable health threats for consumers and highlight the task played by the fish to serve as reservoirs of zoonotic pathogens. The detection of *Edwardsiella* spp. in market-sold fish highlights the need for strengthened aquaculture biosecurity, routine diagnostic surveillance, and improved hygienic handling practices to protect consumer health and support sustainable fish farming.

**Keywords:** Aquaculture safety, *Clarias gariepinus*, *Edwardsiella*, fish pathogens, *Oreochromis niloticus*, zoonosis

### 1.0 INTRODUCTION

Fish and fish products are essential to global food security, providing high-quality animal protein, essential fatty acids, vitamins, and micronutrients to millions of people worldwide (Akinjogunla *et al.*, 2021; Akinjogunla & Usman, 2023). In some countries, fish constitutes more than 50% of animal protein intake, underscoring its dietary significance (FAO, 2020). In Nigeria, where fish demand is

estimated at 2.7 million tonnes per annum, costly importation however gave a significant production deficit of 1.9 million tonnes (Federal Department of Fisheries, 2020). This has spurred a rapid expansion in domestic aquaculture, particularly of African catfish (*Clarias gariepinus*) and Nile tilapia (*Oreochromis niloticus*), which are favored for their fast growth, environmental resilience, and economic value (Akinjogunla *et al.*, 2023a; Inyang *et al.*, 2024).





## 2.2 Sampled Size and Sampling Techniques

A total number of 20 fishes were obtained from Galadima fish market in Kano state, of which 10 were tilapia species (Plate 1) and the other 10 were catfish species (Plate 2); the fishes were obtained live from different random fish marketers on 3 separate visitations to the market, the fishes were then kept in an icebox and transported to a laboratory in Centre for Dry land Agriculture, CDA in Bayero University Kano, Kano State. A total of 20 live fish specimens

were collected across three independent visits to the market using a random sampling technique to ensure unbiased selection. The sample included ten (10) African Catfish - *Clarias gariepinus* (Plate 1) and ten (10) Nile Tilapia - *Oreochromis niloticus* (Plate 2), acquired from different vendors. Fish specimens were immediately placed in iceboxes to preserve freshness and transported to the laboratory at the Centre for Dryland Agriculture (CDA), Bayero University, Kano.

Plate 1: *Clarias gariepinus* (African Catfish)

X250mg



Source: Fieldwork, 2024



Plate 2: *Oreochromis niloticus* (Nile Tilapia)

X250mg

Source: Fieldwork, 2024

## 2.3 Sample Processing and Microbiological Analysis

Upon arrival at the laboratory, each fish specimen was measured for length (cm) and weight (g) using a measuring ruler and a digital weighing balance, respectively. Dissection was performed under aseptic conditions to collect organ samples (gills, liver, spleen, and intestine). From each fish, 1 g of each organ was aseptically weighed and homogenized in 9 mL of sterile distilled water to obtain a 1:10 dilution. Serial dilutions were performed up to  $10^{-5}$  following the method described by Akinjogunla *et al.* (2023b). From the  $10^{-4}$  and  $10^{-5}$  dilutions, 0.1 mL aliquots were plated in duplicate using the spread plate technique on three types of culture media: Nutrient Agar, MacConkey Agar, and Blood Agar. The media were commercially obtained in powdered form and prepared following manufacturer instructions autoclaved at  $121^{\circ}\text{C}$  for 15 minutes before being

poured into sterile Petri dishes. Plates were incubated at ambient temperature ( $26 - 30^{\circ}\text{C}$ ) for 18 – 24 hours.

### Identification and Characterization of Isolates

Colonial morphology was observed on incubated plates to identify differences in color, shape, margin, elevation, and surface texture. Gram staining was performed for microscopic examination of bacterial morphology using oil immersion. Biochemical tests including motility, indole production, and hydrogen sulfide production were carried out for further identification, with results compared to standard profiles for *Edwardsiella tarda*.

### Statistical Analysis

All experiments were performed in triplicate. Quantitative data were analysed using Microsoft Excel 2019, incorporating both descriptive statistics (mean  $\pm$  standard deviation) to evaluate differences and trends. Results were organized and presented using tables to enhance clarity and interpretability

### 3.0 RESULTS

#### 3.1 Fish Biometrics

The biometric characteristics of the sampled fish species are presented in Table 1. The *Oreochromis niloticus* specimens ranged from 26.1 to 49.6 cm in total length and weighed between 140 and 1150 g, while the *Clarias gariepinus* ranged from 35.0 to 48.2

cm in length and 353.2 to 1020.5 g in weight. The relatively wide ranges in size and weight indicate a diversity of age classes and maturity stages among the sampled fish, which may influence their susceptibility to infection

**Table 1: Biometric measurements of the *Oreochromis niloticus* and *Clarias gariepinus* collected from Galadima Fish Market, Kano State, Nigeria.**

S/N	Fish Species	Total Length (cm) ± SD	Total Weight (g) ± SD	Standard Length (cm) ± SD
1	<i>Oreochromis niloticus</i> (range)	39.07 ± 5.52 (26.1 - 49.6)	589.23±233.9 (140 - 1150)	36.27±5.23 (22.15 - 47.2)
2	<i>Clarias gariepinus</i> (range)	41.29 ± 3.44 (35.0 - 48.2)	658.94±174.2 (353.2 - 1020.5)	39.0±3.45 (33.3 - 46.0)

\* No of specimens = 10 per species

These measurements provide context for physiological variability, which may correlate with exposure to pathogens. The slightly larger average size of *C. gariepinus* may suggest older or more developed individuals, yet they showed a lower infection rate than *O. niloticus*, pointing toward possible species-specific differences in pathogen susceptibility or immune response.

#### 3.2 Occurrence and Organ Distribution of *Edwardsiella* spp.

Table 2 presents the occurrence of *Edwardsiella* spp. across different organs of the two fish species. A total of 80 organ samples (gills, liver, spleen, and intestine)

were examined, 40 per species. *Edwardsiella* spp. were more frequently isolated from *O. niloticus* (10%) than *C. gariepinus* (5%), suggesting a higher susceptibility or environmental exposure in tilapia. The gills of *O. niloticus* showed the highest infection rate (20%), possibly indicating that this organ, which is in constant contact with the aquatic environment, is a primary entry site. The intestines of both species also showed notable levels of infection (20% in *C. gariepinus*, 10% in *O. niloticus*), indicating likely gastrointestinal colonization. No isolates were recovered from liver tissues of either species, suggesting lower systemic dissemination or liver resistance to colonization.

**Table 2: Occurrence of *Edwardsiella* spp. isolates in the examined organs of the selected fish species from Galadima market, Kano State**

Organ	<i>C. gariepinus</i> (Isolates)	% Positive	<i>O. niloticus</i> (Isolates)	% Positive
Gills	0/10	0%	2/10	20%
Liver	0/10	0%	0/10	0%
Spleen	0/10	0%	1/10	10%
Intestine	2/10	20%	1/10	10%
<b>Total</b>	<b>2/40</b>	<b>5%</b>	<b>4/40</b>	<b>10%</b>

\* (n = 10 fish per species; 4 organs per fish); *C. gariepinus* - *Clarias gariepinus*; *O. niloticus* - *Oreochromis niloticus*

These results reflect a pattern where external and digestive organs are more prone to colonization, supporting the hypothesis of environmental exposure and ingestion as key infection routes.

#### 3.3 Identification and Biochemical Characterization of Isolates

Out of the 80 tissue samples examined, six (6) isolates demonstrated consistent characteristics with

*Edwardsiella tarda*, based on colonial morphology, Gram staining, and biochemical profiling. Table 3 summarizes the phenotypic and biochemical features of the recovered *Edwardsiella* spp. isolates. The isolates matched previously reported biochemical profiles of *Edwardsiella tarda*, confirming their presumptive identity. The presence of motility, indole production, and H<sub>2</sub>S formation are typical diagnostic features of this species

**Table 3. Morphological and biochemical characteristics of presumptive *Edwardsiella tarda* isolates from fish tissues**

S/N	Parameters	<i>Edwardsiella</i> spp.
<b>Characteristics of Cells</b>		
1	Pigmentation	Yellow
2	Surface	Smooth
3	Edge	Entire
4	Elevation	Raised
5	Shape	Circular
6	Arrangement	Rods
7	Colony color	Yellow-white/Grayish white
<b>Acid Reactions</b>		
8	Gram's staining	Negative
9	Oxidase	Negative
10	Indole	Positive
11	Methyl red	Positive
12	Voger-proskauer	Negative
13	Citrate	Citrate
14	Catalase	Positive
15	Urease	Negative
16	Motility	Positive

\* (n = 6 isolates)

#### 4.0 DISCUSSION

The data from this study demonstrate that *Edwardsiella* spp., likely *E. tarda*, are represented in market-sold tilapia and catfish in Kano, Nigeria, despite the fish appearing externally healthy. The higher isolation rate in *O. niloticus* aligns with earlier reports suggesting tilapia are particularly susceptible to *Edwardsiella*-related infections, which can become systemic under stress or poor handling.

This study provides empirical evidence of *Edwardsiella* spp. contamination in *Clarias gariepinus* and *Oreochromis niloticus* sold at the Galadima Fish Market, Kano State. The detection of this pathogen, albeit at a relatively low prevalence 5% in *C. gariepinus* and 10% in *O. niloticus* signals a latent risk to aquaculture sustainability and public health in Northern Nigeria. While these prevalence rates are modest, their significance lies in the zoonotic potential of *Edwardsiella tarda* and its capacity to cause systemic infections in fish, especially under stressful or immunocompromised conditions.

The findings contrast sharply with higher prevalence rates reported in intensive aquaculture systems. For instance, Ogunleye *et al.* (2021) reported a 62.5% prevalence of *E. tarda* in *O. niloticus* from farms in Ibadan, suggesting that environmental and management differences substantially impact pathogen dynamics. Similarly, Ogbonne *et al.* (2018) found notable infection rates in *Heterobranchus longifilis* in Lagos State, which were linked to poor water quality and high organic load conditions known to exacerbate bacterial proliferation.

In the present study, *Edwardsiella* was detected exclusively in the intestines of *C. gariepinus*, while in *O. niloticus*, it was present in the gills, spleen, and intestine. The organ-specific occurrence with no

isolates from the liver and concentration in the gills and intestines suggests the pathogen may initially colonize mucosal surfaces and only occasionally become systemic. This is critical for surveillance, as screening gill and gut tissues may offer a more effective detection strategy in routine monitoring than liver tissues. The organ-specific distribution points to a dual infection route: gastrointestinal colonization and systemic dissemination. This observation aligns with the investigation done by Oladosu *et al.* (2023), who demonstrated that *E. tarda* can wander from the belly to other complicated internal body parts, leading to septicemia in the finfish, *C. gariepinus*. It also corroborates the broader literature that identifies the gills as an initial point of entry due to their direct interface with the aquatic environment (Shao *et al.*, 2021).

The total isolation rate of 5% in *C. gariepinus* confined to intestinal tissues is consistent with studies indicating that this species may serve as a reservoir host for *Edwardsiella* without always manifesting systemic infection (Akinbowale *et al.*, 2022). However, it diverges from the 18% prevalence reported in *C. gariepinus* by Abd El-Tawab *et al.* (2020) in Egypt, where molecular techniques revealed higher infection loads.

Conversely, the 10% prevalence in *O. niloticus*, with *Edwardsiella* isolated from multiple organs, indicates a potentially more acute or systemic infection profile. This supports the hypothesis of species-specific susceptibility, as previously proposed by Emil (2017), who found that *C. gariepinus* exhibits greater resistance to *Edwardsiella* invasion compared to *O. niloticus* among farmed fish in Morogoro, Tanzania. Moreover, the isolation of the pathogen from gill and spleen tissues in tilapia suggests active systemic

dissemination rather than passive colonization, as also observed by Xu *et al.* (2020), who reported tissue-specific immune responses following *Edwardsiella* infection in fish models.

Geographic and ecological context also appear to play a decisive role in shaping pathogen prevalence. The lower rates observed in Kano may reflect the relatively short holding time and minimal confinement stress faced by market-sold fish compared to farmed counterparts, where overcrowding and nutrient-rich effluents create ideal conditions for bacterial proliferation. This trend supports the notion that Edwardsiellosis is an opportunistic disease, with outbreaks often linked to environmental stressors such as temperature fluctuations, poor water quality, and inadequate feeding regimes (Shao *et al.*, 2021).

Despite the low overall prevalence, the detection of *Edwardsiella* spp. in fish intended for human ingestion raises concerns for food security. The pathogen has been associated with gastroenteritis and extraintestinal infections in humans, especially immunocompromised individuals (Pereira *et al.*, 2020). Its presence in edible organs such as intestines highlights the importance of thorough cooking. Furthermore, routine surveillance of market-sold fish could serve as a cost-effective public health measure, particularly in informal markets with limited regulatory oversight.

In terms of public health, the detection of *Edwardsiella* in edible organs like intestines and the potential for zoonotic transmission through poor handling or undercooked fish emphasizes the need for improved hygienic practices at fish markets and enhanced diagnostic surveillance protocols, especially in high-volume markets like Galadima.

## 5.0 CONCLUSION

The findings of this study offer important insights into the presence and tissue tropism of *Edwardsiella* species in two key aquaculture fish species in Nigeria, *Clarias gariepinus* and *Oreochromis niloticus*. It establishes a valuable baseline for understanding the prevalence and behaviour of these pathogens, while also emphasizing the need for species-specific disease management strategies. Notably, *O. niloticus* exhibited a higher infection rate than *C. gariepinus*, suggesting that different fish species vary in their susceptibility to *Edwardsiella* infections, likely due to physiological characteristics or environmental exposures in terms of husbandry conditions.

The presence of *Edwardsiella* spp. in fish sold at the Galadima Fish Market in Kano State emphasizes a significant food safety concern, particularly within informal supply chains. These findings highlight the need for heightened microbial risk awareness among consumers and market operators associated with such supply chains and stresses the need for increased vigilance and intervention. The study further reveals

organ-specific infection dynamics. While the isolation of *Edwardsiella* spp. from the intestines of both fish species suggests gastrointestinal colonization or shedding, the pathogen's presence in the gills and spleen of *O. niloticus* points to possible systemic dissemination. This may occur via mucosal invasion and bloodstream spread, suggesting the capacity of the pathogen to move beyond localized infection sites and affect internal organs.

Interestingly, the overall prevalence of *Edwardsiella* spp. in this study was lower than rates reported in similar investigations conducted in other regions, including other parts of Nigeria, Egypt, and Tanzania. This disparity may be attributed to differences in environmental conditions, water quality, stocking densities, and hygiene practices in local markets. Nevertheless, even these comparatively low detection rates carry significant implications for public health. The zoonotic potential of *Edwardsiella tarda*, particularly in immunocompromised individuals, calls for proactive measures to safeguard consumer health. Enhanced public education on food safety and improved hygiene practices in fish handling are critical components of risk mitigation.

## 5.1 Recommendations for aquaculture and food safety

In response to these findings, several recommendations are proposed to enhance aquaculture biosecurity and food safety. Routine bacteriological surveillance should be implemented across fish farms and in fish markets. Strict hygiene protocols must be enforced during fish handling, processing, and sale. In addition, fish vendors and handlers should be trained in basic biosecurity practices to minimize the risk of cross-contamination. Fish farmers should be encouraged to adopt stress-reducing management practices, such as maintaining appropriate stocking densities and ensuring optimal water quality, to reduce susceptibility to infection.

## Policy relevance and strategic implications

From a policy perspective, this study contributes valuable epidemiological data to guide the development of national aquaculture strategies and public health regulations. Regulatory authorities / agencies should consider implementing risk-based inspection protocols for fish pathogens in open markets. Guidelines for disease reporting and management in aquaculture systems are also essential, alongside targeted public health campaigns focused on the safe handling and cooking of fish products to mitigate the risk of zoonotic infections.

## Directions for future research

Future research efforts should prioritize the use of molecular diagnostic tools to enhance the precision of pathogen identification, differentiate strains and track transmission pathways. Expanding the geographic



and sample scope of such studies will help map regional variations in pathogen prevalence. Additionally, investigating the antibiotic resistance profiles of *Edwardsiella* spp. is critical to address emerging treatment challenges developing effective mitigation strategies.

Largely, this study addresses key scientific gaps while offering practical public health recommendations and policy applications. It contributes significantly to efforts aimed at improving disease control, ensuring consumer safety, and promoting the sustainable development of Nigeria's aquaculture industry.

## 6.0 AUTHOR'S CONTRIBUTIONS

Author VFA conceived the research while author MDU drafted and finalized the methodology. Both Authors (VFA and MDU) collected the data while Author MDU interpreted the data and drafted the 1<sup>st</sup> manuscript. Author VFA finalized the manuscript and included relevant literature materials. All authors read and approved the final manuscript.

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