

Microbiological Quality and Prevalence of Bacterial and Fungal Contaminants in African Catfish (*Clarias Gariepinus*) From Ajiwa Dam, Katsina State, Nigeria

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ABSTRACT

The microbiological quality of fish is an important consideration in food safety because contamination may occur from the aquatic environment or during harvesting, transportation and handling. This study investigated bacterial and fungal contaminants associated with African catfish (*Clarias gariepinus*) obtained from Ajiwa Dam, Batagarawa Local Government Area, Katsina State, Nigeria. Fish were collected from three landing sites: Gajeren Giwa, Kwatani and Masabo during four weekly sampling visits in May. Fillet portions were aseptically processed, serially diluted to 10^{-4} and 10^{-5} , inoculated on culture media, and incubated for microbial enumeration. Bacterial isolates were characterized using Gram staining and conventional biochemical tests. Five bacterial taxa and seven fungal taxa were recovered. Among the nine bacterial isolates, *Escherichia coli* was most frequent (33.3%), followed by *Bacillus* spp. and *Staphylococcus aureus* (22.2% each), while *Klebsiella* spp. and *Micrococcus* spp. each accounted for 11.1%. Among nine fungal isolates, *Aspergillus niger* and *Saccharomyces cerevisiae* were most frequent (22.2% each), whereas *A. fumigatus*, *Penicillium* spp., *Fonsecaea* spp., *Cladosporium* spp. and *Fusarium oxysporum* each accounted for 11.1%. Reported bacterial plate counts ranged from 36 to 198 CFU/g and fungal counts from 21 to 84 CFU/g across the evaluated dilutions. The microbial profile is consistent with possible environmental and/or post-harvest contamination; however, the present design cannot identify the specific contamination source. Improved hygienic handling and periodic microbiological monitoring of fish and the dam environment are therefore recommended.

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INTRODUCTION

Fish is an important source of high-quality protein and essential nutrients and contributes substantially to household food security in many tropical countries. African catfish (*Clarias gariepinus*) is particularly important in Nigeria because it is widely harvested and cultured, is relatively affordable and is highly accepted by consumers (Adewumi et al., 2015; Omodara et al., 2016). Despite its nutritional value, fish is highly perishable because its tissues provide favourable conditions for microbial growth when handling, storage and temperature control are inadequate.

Microorganisms associated with freshwater fish may originate from the aquatic environment, sediments, feed, harvesting equipment, handlers or post-harvest contact surfaces. Some bacteria form part of the normal aquatic microbiota, whereas others may indicate sanitary contamination or poor handling. The occurrence of *Escherichia coli* in fish is of particular interest because it is commonly used as an indicator of faecal contamination, while *Staphylococcus aureus* may be introduced or amplified through human handling and contaminated surfaces. Previous studies have reported bacterial contamination of freshwater and marketed fish in Nigeria, emphasizing the importance of hygienic handling and appropriate preservation (Eze et al.,

2011; Shinkafi & Ukwaja, 2010; Bichi et al., 2025). Fungi may also contribute to spoilage and may reflect environmental exposure or poor storage conditions.

Ajiwa Dam is an important multipurpose reservoir in Katsina State, supporting water supply, irrigation and fishing activities. Because fish harvested from the reservoir enter the local food chain, information on their microbiological quality is relevant to food hygiene and public health. The objective of this study was therefore to determine the bacterial and fungal contaminants associated with *C. gariepinus* harvested from selected landing sites around Ajiwa Dam and to describe their relative prevalence and microbial counts.

MATERIALS AND METHODS

Study Area

Ajiwa Dam is located in Batagarawa Local Government Area of Katsina State, northwestern Nigeria, within the Sudan Savanna ecological zone (Figure 1). The area has distinct wet and dry seasons, with rainfall occurring mainly from May to October and the dry season extending approximately from November to April. The reservoir was constructed primarily for municipal water supply, with irrigation and fishing as additional uses. Its principal inflow is River Tagwai.

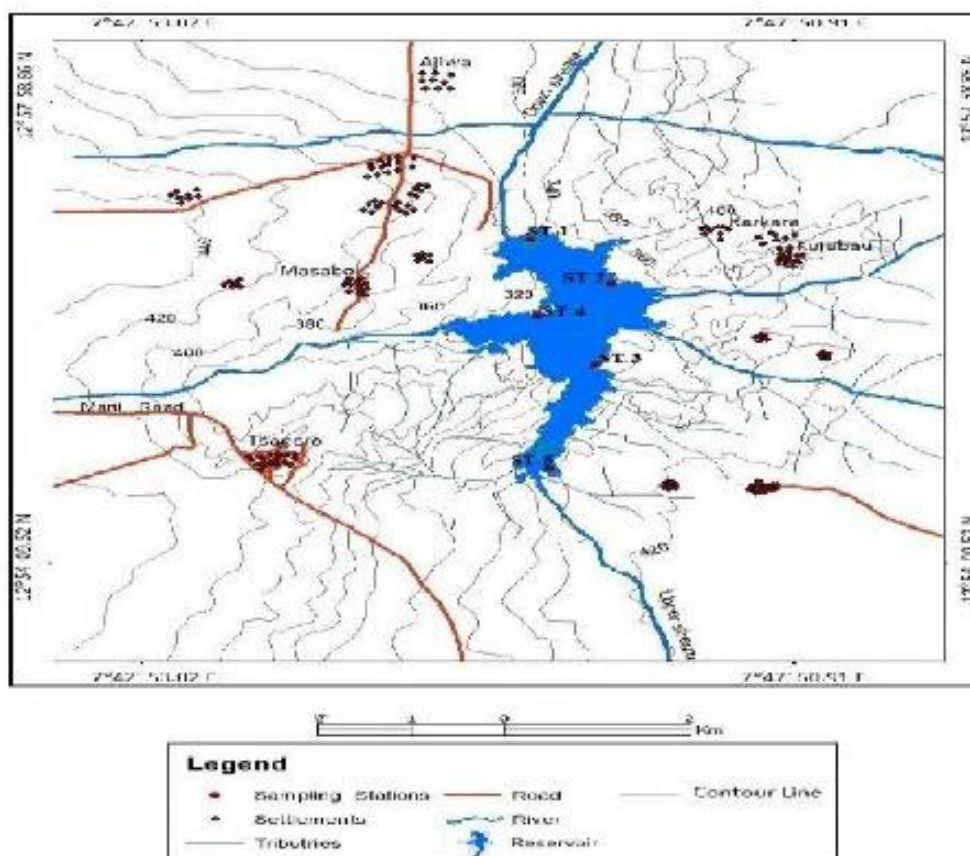


Figure 1: Map of Ajiwa Dam and the Surrounding area showing the SAMPLING stations
Source: Study Map Supplied by the Authors

Sampling Sites and Study Design

Three fish landing sites were selected around Ajiwa Dam: Gajeren Giwa (Site A), Kwatani (Site B) and Masabo (Site C). These sites were chosen to provide geographical coverage of the reservoir environment. Sampling was conducted once weekly over four weeks in May. Fish were randomly purchased from fishermen arriving at the landing sites during morning sampling periods.

Sample Collection and Transportation

Fish specimens were collected using disposable gloves and transferred into sterile sampling bags. Samples were placed in clean cool boxes and transported promptly to the Microbiology Laboratory, Umaru Musa Yar'adua University, Katsina, for processing and analysis. Appropriate aseptic precautions were maintained to minimize contamination during collection and transport.

Sample Preparation and Microbial Enumeration

Fish were eviscerated and filleted under aseptic conditions. Fillet portions intended for microbiological analysis were stored frozen at approximately -18°C until analysis. For microbial enumeration, 1 g of each prepared fish sample was subjected to serial dilution, and dilutions up to 10^{-4} and 10^{-5} were evaluated. A 1 mL aliquot of the appropriate dilution was inoculated onto culture medium and incubated for 24 h at approximately 30°C . Colonies were counted after incubation. Microbial concentration should be calculated as $\text{CFU/g} = C/(V \times d)$, where C is the number of colonies counted, V is the plated volume in millilitres and d is the dilution plated.

Isolation and Characterization of Bacterial Isolates

Representative colonies were sub-cultured to obtain pure cultures. Bacterial isolates were characterized by colony morphology, Gram reaction and conventional biochemical tests including motility, catalase, coagulase, methyl red, Voges-Proskauer, indole, citrate utilization, oxidase and sugar-fermentation tests, following standard microbiological procedures described by Cheesbrough (2006). Organism identification was based on the combined morphological and biochemical reaction profiles.

Data Analysis

Microbial count data were summarized descriptively, while isolate occurrence was expressed as frequency and percentage. For bacterial isolates, prevalence was calculated using nine bacterial isolates as the denominator; fungal prevalence was calculated separately using nine fungal isolates as the denominator.

RESULTS AND DISCUSSION

Reported Microbial Counts

The reported plate-count results for *C. gariepinus* are summarized in Table 1. Bacterial counts were 198 CFU/g at the 10^{-4} dilution and 36 CFU/g at the 10^{-5} dilution, while fungal counts were 84 and 21 CFU/g, respectively. These values indicate recoverable bacterial and fungal populations in the analysed fish.

Table 1: Reported Bacterial and Fungal Plate Counts in *C. gariepinus*

Dilution	Bacterial count (CFU/g)	Fungal count (CFU/g)
10 ⁻⁴	198	84
10 ⁻⁵	36	21

Prevalence of Bacterial and Fungal Isolates

A total of nine bacterial isolates representing five taxa and nine fungal isolates representing seven taxa were reported. Using the total number of bacterial isolates (n = 9) as the denominator, *E. coli* had the highest bacterial prevalence (33.3%), while *Bacillus* spp. and *S. aureus* each accounted for

22.2%. *Klebsiella* spp. and *Micrococcus* spp. each represented 11.1%. For fungi, *A. niger* and *S. cerevisiae* were most frequent (22.2% each), whereas *A. fumigatus*, *Penicillium* spp., *Fonsecaea* spp., *Cladosporium* spp. and *F. oxysporum* each accounted for 11.1% (Table 2).

Table 2: Prevalence of Bacterial and Fungal Isolates Recovered from *C. gariepinus*

Bacterial isolate	n (%)	Fungal isolate	n (%)
<i>E. coli</i>	3 (33.3)	<i>A. niger</i>	2 (22.2)
<i>Bacillus</i> spp.	2 (22.2)	<i>A. fumigatus</i>	1 (11.1)
<i>Klebsiella</i> spp.	1 (11.1)	<i>Penicillium</i> spp.	1 (11.1)
<i>S. aureus</i>	2 (22.2)	<i>Fonsecaea</i> spp.	1 (11.1)
<i>Micrococcus</i> spp.	1 (11.1)	<i>Cladosporium</i> spp.	1 (11.1)
		<i>F. oxysporum</i>	1 (11.1)
		<i>S. cerevisiae</i>	2 (22.2)
Total	9 (100)	Total	9 (100)

Interpretation of Bacterial Contamination

The predominance of *E. coli* is microbiologically important because this organism is widely used as an indicator of faecal or sanitary contamination. Its recovery from fish may reflect exposure in the aquatic environment, contamination during capture and washing, or cross-contamination during post-harvest handling. The present study did not analyse water, sediment, fishing gear or handlers; consequently, the source cannot be assigned with certainty. Similar concerns regarding bacterial contamination of freshwater and marketed fish have been reported in Nigeria (Eze et al., 2011; Shinkafi & Ukwaja, 2010).

The occurrence of *S. aureus* also deserves attention because the organism is commonly associated with human skin, nasal flora and food-contact surfaces. Its presence in fish can therefore be consistent with contamination during handling, although environmental contributions cannot be excluded. *Bacillus* spp. may reflect environmental exposure because members of the genus are widespread in soil, water and sediments. *Klebsiella* spp. and *Micrococcus* spp. occurred less frequently but further demonstrate the diversity of bacteria associated with the sampled fish. Taken together, the bacterial profile supports the need for hygienic harvesting, clean contact surfaces, rapid chilling and careful handling after capture.

Interpretation of Fungal Contamination

Among the fungi, *A. niger* and *S. cerevisiae* were the most frequently recovered taxa. The presence of *Aspergillus* and *Penicillium* species may be associated with environmental spores, contaminated surfaces or storage conditions favourable to fungal survival and growth. Recovery of yeasts such as *S. cerevisiae* may similarly reflect environmental or handling-related exposure.

Food-Safety and Public-Health Implications

The detection of multiple bacterial and fungal taxa indicates that freshly harvested fish from the study environment can acquire microorganisms before reaching consumers. The results do not, by themselves, establish that the fish are unsafe for consumption because the study did not determine pathogen-specific infectious dose, toxin production, antimicrobial resistance or compliance with a defined

regulatory microbiological criterion. Nevertheless, the recovery of *E. coli* and *S. aureus* justifies precautionary measures. Fish should be handled with clean equipment, protected from contaminated water and surfaces after capture, rapidly chilled, and thoroughly cooked before consumption. Future surveillance should include simultaneous analysis of fish, reservoir water, sediments, landing-site surfaces and handling equipment to distinguish environmental contamination from post-harvest contamination pathways.

CONCLUSION

This study demonstrated the presence of diverse bacterial and fungal contaminants in African catfish (*C. gariepinus*) obtained from selected landing sites at Ajiwa Dam. Five bacterial taxa and seven fungal taxa were identified. *E. coli* was the most prevalent bacterial isolate, while *A. niger* and *S. cerevisiae* were the most frequently recovered fungal taxa. Reported bacterial counts ranged from 36 to 198 CFU/g and fungal counts from 21 to 84 CFU/g across the evaluated dilutions. The microbial profile is consistent with possible environmental and/or post-harvest contamination; however, the study design does not permit a definitive attribution of contamination to poor reservoir water quality, faecal inputs or fishermen's handling practices. Confirmation of specific sources would require concurrent microbiological examination of the reservoir water, sediments, landing-site surfaces, fishing equipment and handlers. The findings nevertheless reinforce the importance of hygienic fish handling, rapid preservation after capture and periodic monitoring of microbial quality in fish harvested from the reservoir. Future studies should employ a clearly documented sampling design, replicate analyses and source-tracking approaches so that microbial loads can be compared statistically across sites and seasons.

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