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# ANTIMICROBIAL DRUG RESIDUES, ANTIMICROBIAL RESISTANCE, AND HUMAN HEALTH RISKS IN FRESHWATER FISH FROM THE VOLTA LAKE, GHANA

## Abstract

This study assessed antimicrobial drug residues, antimicrobial resistance (AMR), and associated human health risks in cage-cultured Nile tilapia (Oreochromis niloticus) from the Volta Lake, Ghana. A systematic review of 44 studies identified tetracyclines and sulphonamides as the most commonly reported antibiotic residues in freshwater aquaculture. Field investigations involved the collection of 384 tilapia samples from 57 cage farms and analysis of 15 antibiotics using UHPLC-QQQ-MS. Fourteen antibiotics were detected, with oxytetracycline and enrofloxacin frequently exceeding International maximum residue limits. Banned or unapproved antibiotics, including chloramphenicol and metronidazole, were also detected.

Human health risk assessment involving 402 consumers showed low dietary exposure, with Hazard Quotients below 1, metronidazole cancer risk values below $10^{-6}$, and chloramphenicol Margin of Exposure values exceeding the European Food Safety Authority benchmark of 10,000. A survey of 289 fish farmers revealed widespread empirical antibiotic use, limited awareness of withdrawal periods, and poor antimicrobial stewardship practices.

Microbiological analysis identified *Staphylococcus spp., Acinetobacter haemolyticus, Enterobacter cloacae,* and *Lactococcus garvieae* as the predominant bacterial isolates. Approximately 15% of isolates exhibited multidrug resistance, particularly to erythromycin, tetracycline, trimethoprim-sulfamethoxazole, and β-lactam antibiotics.

Although current dietary risks appear low, the detection of banned antibiotics, evidence of misuse, and the presence of multidrug-resistant bacteria highlight the need for strengthened antibiotic regulation, farmer education, antimicrobial stewardship, and integrated surveillance to support sustainable aquaculture and protect public health in Ghana.

**Keywords: Antimicrobial resistance, Human health risk, Nile tilapia, Aquaculture**