



Tropentag, September 16-18, 2026, hybrid conference

“Towards multi-functional agro-ecosystems
promoting climate resilient futures”

Antimicrobial resistance patterns in *Escherichia coli*, *Salmonella* spp., and *Enterobacter* spp. from broiler meat in Mzimba, Malawi

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Abstract

Antibiotic resistance (ABR) in poultry production poses a growing threat to global food safety and public health, particularly in developing countries where inappropriate antibiotic use is prevalent. This study links the prevalence of antibiotic resistance in broiler meat to the Water-Energy-Food (WEF) Nexus framework, highlighting interconnected links across sectors. Excessive antibiotic use in poultry production generates resistant pathogens that contaminate water resources through runoff, wastewater, and poor waste management in informal markets. This causes treatment failures and production losses, increasing compensatory energy demand for feed production, water treatment, and health care, creating inefficiency, and trade-offs across the nexus. The study assessed the prevalence of antibiotic resistance of *E. coli*, *Salmonella*, and *Enterobacter* species in broiler poultry meat sold in informal markets in Mzimba District, Malawi. A cross-sectional study was conducted between March and May 2025. A stratified sampling technique was used to select 100 chicken meat samples from informal markets across the district. Descriptive statistics and inferential statistics were performed using R version. *E. coli* (69%) and *Enterobacter* (12%) species were the most frequently isolated pathogens. The highest prevalence of antibiotic resistance was observed in *E. coli* against three commonly used antibiotics, ampicillin (91.3%), meropenem (82.6%), and tetracycline (71%). *Enterobacter* spp. showed similar results. MAR values were considerably high, ranging from 0.1 to 0.75. Ninety-seven percent of the isolates had MAR of over 0.2. Twenty-eight isolates (29%) had extreme MAR of 0.5 or higher. Informal markets in Mzimba were the most significant predictors of the MAR index ($p = 6.096e^{-05}$, $\eta^2 = 0.372$). High levels of MAR revealed are concerning. They reflect a high-risk of antibiotic treatment failure in animal and human infections, threatening food security and resilience. Combating MDR requires coordinated, multisectoral approaches through a One Health program to address ABR through a WEF Nexus approach, via coordinated intervention, surveillance, educating farmers and veterinarians regarding antibiotic use, improved waste and water management, and a supportive policy framework to safeguard food safety, protect water, and promote sustainable energy-efficient food systems in Malawi and similar environments.

Keywords: Antibiotic resistance, antimicrobial use, awareness, chicken meat, informal markets, Malawi, Mzimba