

Hidden Threats: Antibiotic Residues in Animal-Based Foods and the Risk of Antimicrobial Resistance

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ABSTRACT

In recent years, the widespread use of antibiotics in animal agriculture has raised significant public health concerns, particularly regarding the presence of antibiotic residues in animal-based foods. These residues, which can persist in meat, dairy, and other products, pose a hidden threat by contributing to the development and spread of antimicrobial resistance (AMR)—a global crisis that renders once-treatable infections increasingly difficult to manage. As bacteria adapt to survive exposure to antibiotics, they become resistant not only in animals but also in humans who consume these contaminated products. This intricate link between antibiotic use in livestock and the growing AMR challenge underscores the urgent need for stricter regulations, improved monitoring, and greater awareness of the risks associated with antibiotic residues in our food supply.

Recently Dare and his colleague evaluate the levels of oxytetracycline (OTC) residues in Muscle, Liver, and Kidney Tissues of Cattle and Pig . This research addresses a critical public health concern regarding antibiotic residues in food products, particularly in the context of increasing antibiotic resistance and food safety.

The study's findings, which indicate significant levels of oxytetracycline (OTC) residues in various tissues, are alarming and warrant further discussion. While the authors have provided a thorough analysis of the residue levels in muscle, liver, and kidney tissues, I would like to expand on the implications of these findings and suggest additional avenues for research.

Keywords: Drug residue, antibiotic Residue, oxytetracycline Residue, Antimicrobial Resistance, Human Health Hazards

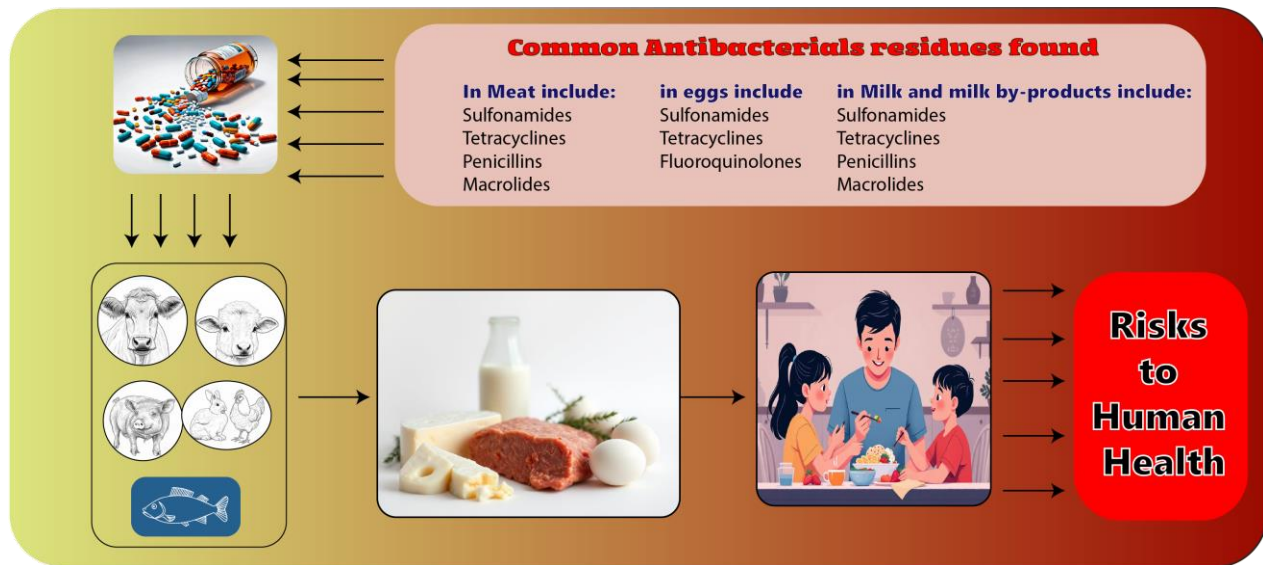


Fig. 1. Pathways of Antibiotic Residue Exposure in Consumers via Animal Products

IMPLICATIONS FOR PUBLIC HEALTH

The presence of OTC residues in edible tissues poses potential risks to consumers, particularly vulnerable populations such as children and immunocompromised individuals. The study highlights that certain samples exceeded the maximum residue limits (MRLs), which raises concerns about the long-term health effects of consuming contaminated meat (Dare et al. 2024; Khalifa et al. 2024; El Asely et al. 2025).

Moreover, OTC residues are not limited to cattle and pigs; they have been detected in various other animal species, including poultry, fish, and even honeybees. For instance, studies have shown that OTC residues can accumulate in the tissues of broiler chickens and tilapia, leading to potential health risks for consumers (Kyuchukova 2020; Minarini et al. 2020; Zou et

al. 2024; El Asely et al. 2025). The cytotoxic effects of these residues can lead to adverse health outcomes, including allergic reactions and the development of antibiotic-resistant bacteria (Jeena et al. 2020; Kyuchukova 2020; Shahid et al. 2021; Sweileh 2021; Dare et al. 2024; El Asely et al. 2025). It would be beneficial for future studies to explore the correlation between the levels of OTC residues and the incidence of antibiotic-resistant infections in the population. Such data could provide a clearer picture of the public health implications associated with the consumption of contaminated meat.

PATHWAYS OF ANTIBIOTIC RESIDUE EXPOSURE IN CONSUMERS VIA ANIMAL PRODUCTS

Antibiotic residues can reach consumers through the consumption of contaminated

meat, meat by-products, eggs, and dairy products (Fig. 1). In meat and meat by-products, antibiotic residues can accumulate in tissues such as muscle, liver, and kidney, and can also be present in feed and water. These residues can then be transferred to consumers through ingestion of contaminated meat products. In eggs, antibiotic residues can accumulate in the yolk and albumen, while in dairy products, residues can be secreted into milk through the mammary gland.

Understanding these pathways and implementing robust controls are crucial for minimizing consumer exposure to antibiotic residues, thereby reducing the risk of adverse health effects and the broader implications for public health, including antibiotic resistance.

HEALTH PROBLEMS REGARDING ANTIBIOTIC RESIDUES

The presence of antibiotic residues in food products of animal origin poses significant health risks to consumers (Ben et al. 2019; Chen et al. 2019; Kyuchukova 2020; Shahid et al. 2021; Arsene et al. 2022; Ghimpeteanu et al. 2022). Short-term health problems include allergic reactions, direct intoxication, and hormonal disturbances. For example, antibiotics like penicillin can cause hypersensitivity reactions, while clenbuterol has been linked to food poisoning. Hormonal disturbances can also occur due to endocrine disruptors. Long-term health problems are

more severe and include carcinogenic effects, antibiotic resistance, and disruption of normal intestinal flora. Some antibiotic residues, like metronidazole, have been associated with an increased risk of cancer. The development of antibiotic-resistant bacteria is a critical issue, making infections harder to treat. The disruption of gut bacteria can lead to gastrointestinal disturbances and other health issues.

ANTIMICROBIAL RESISTANCE

The link between antibiotic residues in food products and the emergence of antimicrobial resistance (AMR) is a growing concern. The overuse of antibiotics like OTC in livestock not only contributes to the presence of residues in animal tissues but also fosters an environment conducive to the development of resistant bacterial strains. These resistant strains can be transmitted to humans through the food chain, leading to infections that are more difficult to treat.

Research has shown that the presence of OTC in animal husbandry can select for resistant bacteria in both animals and humans, complicating treatment options for common infections (Sweileh 2021; Adegbeye et al. 2024). The authors of the original study could further enhance their findings by discussing the implications of their results in the context of AMR, particularly how the detected residue levels may correlate with resistance patterns in

pathogenic bacteria isolated from both livestock and human populations.

In summary, antibiotic resistance is a complex issue that requires a coordinated multisectoral approach, such as the One Health strategy, to address its onset and diffusion across human, veterinary, and environmental sectors (Teuber 2001; Palma et al. 2020).

RECOMMENDATIONS FOR REGULATORY MEASURES

Given the findings, it is imperative to advocate for stricter regulatory measures regarding the use of antibiotics in livestock. The authors rightly point out the need for enhanced monitoring systems in slaughterhouses. However, I propose that a comprehensive review of antibiotic usage practices in veterinary medicine be conducted. This review should include an assessment of the guidelines for withdrawal periods before slaughter, which are crucial for ensuring that antibiotic residues are minimized in food products (Sweileh 2021; Adegbeye et al. 2024; Dare et al. 2024).

The phenomenon of antibiotic resistance is exacerbated by non-clinical factors influencing veterinary prescriptions, such as fear, self-confidence, business factors, and owner demands (Servia-Dopazo et al. 2021). These factors highlight the need for targeted interventions to improve antibiotic use in

animals and reduce the global spread of multi-resistant strains (Servia-Dopazo et al. 2021).

Efforts to combat antibiotic resistance include restricting antibiotic use in food-producing animals, which has been shown to reduce the prevalence of antibiotic-resistant bacteria in both animals and humans (Tang et al. 2017). Education plays a crucial role, as increasing awareness and knowledge among veterinary students and practitioners about antibiotic resistance and the One Health approach can lead to more rational use of antibiotics (Ghimpeteanu et al. 2022; Ballal et al. 2023; Khalifa et al. 2024)

ADDITIONAL DATA AND RESEARCH DIRECTIONS

Moreover, I encourage the authors and the scientific community to consider the geographical and environmental factors that may influence the prevalence of OTC residues. For instance, variations in farming practices, veterinary oversight, and local regulations can significantly impact residue levels. Comparative studies across different regions could yield valuable insights into effective strategies for residue management (Minarini et al. 2020; Sweileh 2021; Sobierajski et al. 2022; Adegbeye et al. 2024; Dare et al. 2024; Moffo et al. 2024).

In conclusion, while the study provides a significant contribution to our understanding of OTC residues in livestock, it also opens the door

for further investigation into the broader implications for public health and regulatory practices. I look forward to seeing more research in this area and hope that it will lead to actionable changes that enhance food safety and public health

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