**Aquaculture and Microbiology: The Challenge of Antibiotic Resistance**

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**Introduction:**

The emergence of antibiotic resistance in aquaculture settings poses a significant challenge to public health, as highlighted in recent research papers. Colistin-resistance in bacteria, a last resort antibiotic for treating multidrug resistant pathogens, has been reported in both clinical and non-clinical settings, including aquaculture and poultry farms **(Seethalakshmi et al., 2023)**. The co-existence of colistin resistant genes with other antibiotic resistant genes further complicates the issue of antimicrobial resistance, necessitating a comprehensive one health approach that encompasses human, animal, and environmental health **(Topp et al., 2017)**. A roundtable discussion at the fourth International Symposium on the Environmental Dimension of Antibiotic Resistance (EDAR4) emphasized the importance of antibiotic stewardship and pre-treatment of manure and sludge to reduce emissions of antibiotics from agriculture, including aquaculture **(Dy, Rigano, & Fineran, 2018)**. Antibiotics added to fish and shellfish production sites through feed can directly contaminate the aquatic environment, underscoring the need for sustainable practices in aquaculture. Vaccination has been identified as a key strategy to reduce antibiotic use in high value production systems, such as salmon farming. Consumer and regulatory pressure are expected to drive the reduction of antibiotic emissions from manufacturing, highlighting the importance of stakeholder awareness and best practices in mitigating antimicrobial resistance. In response to the challenges posed by antibiotic resistance in aquaculture, researchers have explored novel antimicrobial strategies, including the use of bacteriophages (phages) as potential treatments for bacterial diseases **(Seethalakshmi et al., 2023)**. Phages are viruses that specifically target bacteria, offering a targeted approach to combating antibiotic-resistant pathogens. Phage-based technologies can achieve antimicrobial activity through bacterial lysis, delivery of lethal genes, and manipulation of bacterial responses to conventional antibiotics. Research on phages as biocontrol agents in agriculture and aquaculture shows promise in addressing the growing threat of antibiotic resistance in food production systems. Overall, the literature review highlights the urgent need for coordinated efforts to address antibiotic resistance in aquaculture, considering the interconnectedness of human, animal, and environmental health. Global initiatives to mitigate antibiotic resistance must prioritize antibiotic stewardship, sustainable practices, and the development of alternative antimicrobial strategies, such as phage-based therapies. By fostering collaboration among stakeholders and implementing evidence-based standards, researchers can work towards sustainable solutions to combat antibiotic resistance in aquaculture and safeguard public health. Antibiotic resistance is a pressing global issue that poses a significant challenge to public health. The emergence and spread of antibiotic-resistant bacteria, particularly those resistant to last-resort antibiotics like carbapenems, have raised concerns about the effectiveness of treatment options for serious infections. **Huang et al. (2023)** highlighted the increasing resistance to carbapenems in various sectors of the food supply chain, including aquaculture. The review emphasized the direct or indirect correlation between carbapenem resistance in the food supply chain and human infections, underscoring the urgent need for further research and strategies to mitigate antibiotic resistance. **Zhou et al. (2020)** focused on the prevalence of antibiotic resistance genes (ARGs) in aquatic environments, particularly in shrimp culture. The study found that culturable bacteria carrying ARGs exhibited temporal variations, with a higher relative abundance of ARGs in shrimp hepatopancreas compared to pond water. The presence of multiple ARGs in a significant proportion of culturable bacteria highlights the complexity of antibiotic resistance in aquaculture settings. The study also emphasized the impact of human activities on the resistance patterns of aquatic bacteria, underscoring the need for comprehensive monitoring and management strategies. **Oliver & Céspedes et al. (2023)** shed light on the challenges posed by multidrug-resistant bacteria in the Chilean aquaculture industry. The inadequate use of antibiotics in aquaculture has led to the generation of bacteria with multidrug resistance, posing a threat to public health. The study specifically investigated the impact of florfenicol, a commonly used antibiotic in aquaculture, on biofilm formation in *Piscirickettsia salmonis* isolates. The findings revealed that sub-MIC concentrations of florfenicol induced increased biofilm formation in all bacterial isolates tested, highlighting the potential role of antibiotics in modulating bacterial behavior and resistance mechanisms. Overall, the literature review underscores the complexity of antibiotic resistance in aquaculture settings and the urgent need for comprehensive research and management strategies to address this challenge. The studies reviewed emphasize the interconnectedness of antibiotic resistance in the food supply chain, aquatic environments, and human health, highlighting the importance of a One Health approach to combatting antibiotic resistance. Further research is needed to elucidate the factors contributing to the spread of antibiotic resistance in aquaculture and to develop effective strategies to mitigate the impact of antibiotic resistance on public health. By gaining a better understanding of the current state of antibiotic resistance in aquaculture and the factors driving its emergence and spread, researchers can work towards developing sustainable solutions to this pressing global health issue.

**The Role of Antibiotics in Aquaculture**

Aquaculture, as a rapidly growing industry, faces significant challenges due to the emergence of diseases that have economic implications. In response to these challenges, various strategies have been explored to combat fish pathogens, with probiotics emerging as a promising solution. Among probiotics, Bacillus species have been shown to be effective in mitigating a wide range of fish pathogens, including *Aeromonas, Vibrio, Streptococcus, Yersinia, Pseudomonas, Clostridium, Acinetobacter, Edwardsiella, Flavobacterium*, white spot syndrome virus, and infectious hypodermal and hematopoietic necrosis virus **(Kuebutornye et al., 2020)**. The mechanisms employed by Bacillus probiotics in combating fish pathogens include the production of bacteriocins, suppression of virulence gene expression, competition for adhesion sites, production of lytic enzymes, production of antibiotics, immunostimulation, competition for nutrients and energy, and production of organic acids. Understanding these mechanisms is crucial for enhancing the efficacy of Bacillus probiotics in aquaculture and improving disease management practices **(Kuebutornye et al., 2020)**. In addition to probiotics, antibiotics have been commonly used in aquaculture for disease control and growth promotion. However, the use of antibiotics in fish culture activities has been associated with the formation of methylmercury (MeHg) in mariculture sediments. Studies have shown that the addition of antibiotics such as tetracycline and oxytetracycline to sediments can lead to the complexation of Hg with the antibiotics, resulting in the transport of electrons and subsequent formation of MeHg. This highlights the potential environmental impact of antibiotic use in aquaculture and the need for sustainable practices to mitigate such effects **(Liang et al., 2018)**. The extensive use of antibiotics in aquaculture, particularly in countries like China where aquaculture production is significant, has raised concerns about environmental contamination and the development of antibiotic resistance genes. The contribution of aquaculture to antibiotic contamination of the environment and the emergence of antibiotic resistance genes pose significant risks to human health and ecosystem health. More research is needed to understand the types and quantities of antibiotics used in aquaculture, their impact on environmental levels, and the spread of antibiotic resistance genes in aquaculture settings **(Mo & Chen, 2015)**. In response to the concerns surrounding antibiotic use in aquaculture, there has been growing interest in exploring alternative strategies such as the use of medicinal plants as immune-stimulants in fish farming. Medicinal plants have been shown to enhance the immune system of fish, prevent and control microbial diseases, and act as growth promoters and immune-modulators. The mode of action of medicinal plants involves stimulating the cellular and humoral immune response, leading to elevated immune parameters and improved fish health. Further research is needed to determine the optimal doses of medicinal plants for enhancing fish immune status and growth performance in aquaculture settings **(Awad & Awaad, 2017)**. Moreover, the potential neurotoxicity of antibiotics commonly found in surface waters has been investigated using zebrafish as a model organism. Exposure to antibiotics such as clarithromycin, chlortetracycline, and roxithromycin has been shown to induce behavioral effects and neural damage in zebrafish larvae. Transcriptome analysis revealed that these antibiotics can affect pathways involved in synaptogenesis, neurotransmission, mitochondrial stress response, and the endocrine system in zebrafish larvae. These findings underscore the importance of understanding the neurotoxic effects of antibiotics on aquatic organisms and the potential risks associated with their presence in aquatic environments **(Zhang et al., 2023)**. In conclusion, the role of antibiotics in aquaculture is multifaceted, with both benefits and risks associated with their use. While antibiotics can be effective in disease control and growth promotion, their environmental impact, including the formation of MeHg in sediments and the development of antibiotic resistance genes, raises concerns about their sustainability. Alternative strategies such as probiotics and medicinal plants offer promising solutions for disease management and immune enhancement in aquaculture. Continued research is needed to optimize the use of antibiotics and explore sustainable practices that minimize their environmental impact while ensuring the health and productivity of aquaculture systems. The Role of Antibiotics in Aquaculture Antibiotics have long been a crucial tool in aquaculture to combat bacterial infections and ensure the health and well-being of farmed fish. However, the indiscriminate use of antibiotics in aquaculture has raised concerns about its impact on the environment, public health, and the development of antibiotic resistance. Several recent studies have shed light on the complex interplay between antibiotics, gut microbiota, and the biotransformation of contaminants in fish, highlighting the need for a more nuanced understanding of the role of antibiotics in aquaculture. In a study by **Yin et al. (2022)**, the effects of antibiotic (florfenicol) application on gut microbiota and mercury (Hg) biotransformation in tilapia were investigated. The results showed that florfenicol treatment altered the gut microbial community, leading to a decrease in methylation and complete termination of demethylation of Hg in fish. This shift in microbial methylators/demethylators in the fish gut resulted in an increased potential for methylmercury (MeHg) accumulation by fish, highlighting the importance of judicious antibiotic use in aquaculture to mitigate environmental risks of Hg contamination. **Barathan et al. (2024)** explored the alarming issue of antibiotic resistance (ABR) in aquatic environments and its impact on ecosystems and public health. The study emphasized the role of antibiotic use in aquaculture, agricultural runoff, and industrial waste in promoting the development and dissemination of resistant bacteria. The intricate interplay between environmental factors, horizontal gene transfer, and bacterial extracellular vesicles (BEVs) in accelerating the spread of ABR was comprehensively discussed, underscoring the urgent need for effective strategies to mitigate ABR in aquatic environments. **Yang et al. (2024)** investigated the changes in the intestinal microbiome and pathogen susceptibility of zebrafish following chronic antibiotics exposure. The study revealed that chronic antibiotics exposure led to gut microbiome dysbiosis, resulting in reduced pathogen susceptibility and enhanced innate immunity in zebrafish. These findings provide new insights into the impact of antibiotics on gut microbiome composition and host-pathogen interactions in fish, highlighting the importance of maintaining a balanced gut microbiome for fish health. **Velázquez et al. (2023)** examined the antimicrobial and immunomodulatory effects of Pituitary Adenylate Cyclase-Activating Polypeptide (PACAP) on rainbow trout infected with Yersinia ruckeri. The study demonstrated that PACAP exhibited direct antimicrobial activity against Y. ruckeri and modulated immune responses in rainbow trout, suggesting its potential as an alternative to antibiotics in aquaculture. These findings support the role of PACAP as a promising antimicrobial and immunomodulatory peptide for preventing and treating bacterial infections in teleost fish. **Rigas et al. (2023)** investigated the impact of oxytetracycline (OTC) treatment on the gut microbiota of seabass in a commercial open-water aquaculture setting. The study revealed that OTC treatment caused persistent dysbiosis in the gut microbiome of seabass, leading to an increase in gut parasites and a decrease in microbial diversity. These findings underscore the importance of interventions to restore a healthy and protective gut microbiome in farmed fish to mitigate the adverse effects of antibiotic treatment. In conclusion, the role of antibiotics in aquaculture is multifaceted, with implications for gut microbiota composition, contaminant biotransformation, antibiotic resistance, and host-pathogen interactions. The studies reviewed highlight the need for sustainable antibiotic use practices in aquaculture, as well as the development of alternative strategies to mitigate the environmental and public health risks associated with antibiotic use. By gaining a deeper understanding of the complex interactions between antibiotics, gut microbiota, and fish health, researchers can contribute to the development of effective and sustainable aquaculture practices that prioritize both animal welfare and environmental stewardship.

**Antibiotic Resistance in Aquatic Microbiota**

Antibiotic resistance in aquatic microbiota is a pressing issue that requires urgent attention due to the potential impact on public health. The research papers reviewed shed light on the various aspects of antibiotic resistance in aquatic environments, particularly in urban runoff waters, sewage treatment plant effluents, freshwater ecosystems, human-wildlife interactions, and plastic pollution in oceans. The studies collectively emphasize the need to understand the dynamics of antibiotic resistance genes (ARGs) and resistant bacteria in aquatic microbiota to mitigate the spread of antibiotic resistance. **(Almakki & Jumas-Bilak, 2019)** highlighted the environmental pressures exerted on bacterial communities in urban runoff waters, emphasizing the impact of urban activities on antibiotic resistance. The presence of antibiotics in the environment, coupled with continuous release from various sources, creates a selection pressure on microbial organisms, leading to the emergence and dissemination of antibiotic resistance genes. The study proposed that freshwater aquatic wildlife, particularly organisms with high bacterial density tissues, could serve as reservoirs and amplifiers of antibiotic resistance, contributing to the abundance of ARGs and resistant bacteria in the environment. In a study by **(Thibodeau et al., 2024)**, the transmission routes for ARGs and microbiota between humans and water environments were investigated. The research revealed a significant association between human feces and rural sewage treatment systems, indicating a human contribution to the dissemination of ARGs into the environment. The study underscored the importance of understanding the transmission routes and dynamics of antibiotic resistance to prevent further dissemination. **(Zhou et al., 2018)** explored the presence of ARGs and metal resistance genes (MRGs) in microbial communities colonizing plastic particles in the North Pacific Gyre. The study found a higher abundance and diversity of ARGs and MRGs in plastics microbiota compared to seawater microbiota, suggesting that plastics serve as reservoirs for antibiotic and metal resistance genes. The research highlighted the role of microbial community composition in shaping the resistome of microbiota on plastic particles. **(Yang et al., 2019)** investigated the impact of ingested ARGs or antibiotic resistance bacteria on fish gut microbiota. The study developed a plasmid-mediated ARG transfer model in zebrafish and observed the dissemination of ARGs in the gut microbial communities. The findings indicated that aquatic animal guts, such as those of fish, contribute to the spread of ARGs in water environments through conjugal gene transfer. The study emphasized the need to understand the dynamics of ARG dissemination in aquatic animal guts to mitigate the spread of antibiotic resistance. **(Fu et al., 2017)** examined the occurrence of antibiotics and antibiotic resistance genes in sewage treatment plant effluents compared to freshwater ecosystems. The research highlighted the potential role of freshwater aquatic wildlife in disseminating antibiotic resistance within the environment. The study proposed potential avenues for further research and action, including trophic transfer studies and biodiversity eco-engineering approaches to address antibiotic resistance in aquatic microbiota. In conclusion, the literature review of the provided research papers underscores the urgent need to address antibiotic resistance in aquatic microbiota. The studies collectively emphasize the role of urban activities, human-wildlife interactions, plastic pollution, and aquatic animal guts in the dissemination of antibiotic resistance genes and resistant bacteria. Understanding the dynamics of antibiotic resistance in aquatic environments is crucial for developing effective strategies to mitigate the spread of antibiotic resistance and protect public health. Further research and action are needed to comprehensively address the challenges posed by antibiotic resistance in aquatic microbiota.Antibiotic resistance in aquatic microbiota is a growing concern due to the widespread use of antibiotics in various sectors such as aquaculture, human medicine, and terrestrial animal farms. The accumulation of antibiotics and antibiotic resistance genes (ARGs) in aquatic environments poses a significant threat to humans and animals. Several research studies have been conducted to investigate the occurrence and spread of antibiotics and ARGs in aquatic ecosystems, shedding light on the potential ecological risks and implications for public health. In a study by **Zhang et al. (2023)**, Wanfeng Lake in China was examined to assess the presence of antibiotics, ARGs, mobile genetic elements, and microbial community structure. The results revealed high concentrations of antibiotics in both surface water and sediments, with quinolones being the predominant type of antibiotics. Sulfonamide resistance genes were found to be the dominant type of ARGs in the lake. The study also highlighted a positive correlation between antibiotics, environmental factors, ARGs, and microorganisms, indicating a potential pressure of antibiotics on ARGs and the role of microorganisms in the evolution and spread of ARGs in aquatic environments. **Pereira et al. (2022)** focused on Vibrio species associated with marine invertebrates and their antibiotic resistance profiles. The study identified non-susceptibility to antibiotics in a significant proportion of Vibrio isolates, with some exhibiting multidrug resistance. The presence of resistance genes for beta-lactam and heavy metals, as well as plasmids, underscored the potential risk of antibiotic-resistant Vibrio strains in aquatic environments. This research contributes to a better understanding of antibiotic resistance in marine animals and its implications for public health. Chironomids, aquatic insects abundant in freshwater ecosystems, were the subject of investigation in a study by **Costa et al. (2021)**. The research focused on the endogenous microbiota composition of Chironomus ramosus larvae sampled from a river and a laboratory culture. Metagenomic analysis revealed differences in bacterial community composition between river and laboratory-reared larvae, with unique bacterial taxa identified in each group. The presence of bacterial genes conferring resistance to antibiotics in the larval microbiome suggests a potential role in protecting the insects from pollutants in their environment. **Sela & Laviad-Shitrit (2021)** highlighted the toxic effects of antibiotics on fish and aquatic bacterial communities. Antibiotics present in aquatic environments, originating from terrestrial animal farms, human medicine, and aquaculture, have been shown to induce oxidative stress, histopathological lesions, and reproductive disorders in fish. Additionally, low concentrations of antibiotics can disrupt fish symbiotic microbiota and promote the emergence of antibiotic-resistant pathogenic bacteria. This research emphasizes the need to address the environmental impact of antibiotics on aquatic ecosystems and the potential risks to aquatic organisms. **Bojarski et al. (2020)** discussed the relevance of aquaculture in animal protein production and the challenges posed by outbreaks and antimicrobial resistance. Probiotics and bacteriocins were identified as promising alternatives to antibiotics in controlling bacterial infections in aquatic animals. The study highlighted the beneficial impacts of probiotics on intestinal microbiota, immune response, and growth performance, without the drawbacks associated with antibiotic use. The potential role of probiotics and bacteriocins in addressing the challenges of antimicrobial resistance in aquaculture was underscored. The studies highlight the ecological risks posed by antibiotics, the role of microbial communities in the evolution of ARGs, and the potential benefits of alternative strategies such as probiotics in mitigating antibiotic resistance in aquaculture. Further research is warranted to better understand the dynamics of antibiotic resistance in aquatic ecosystems and to develop sustainable solutions to address this pressing issue.

**Factors Contributing to Antibiotic Resistance in Aquaculture**

Antibiotic resistance in aquaculture is a pressing issue that requires immediate attention. The indiscriminate use of antibiotics in intensive farming practices has led to the presence of antibiotic residues in aquatic products and the development of bacterial resistance. Several research papers have shed light on the factors contributing to antibiotic resistance in aquaculture. **(Chen et al., 2020)** emphasized the need for reducing antibiotic use to slow down the development of resistance and monitoring resistant pathogens and genes. They also highlighted the importance of managing environmental sanitation in aquaculture and ensuring the quality of water bodies introduced into aquaculture. **(Corno et al., 2014)** conducted a study on the impact of antibiotics on natural bacterial communities in aquatic environments. They found that bacterial abundance decreased significantly in the presence of antibiotics, and the bacterial community composition was altered. Interestingly, they observed that bacterial communities subjected to antibiotic stress showed increased performance in the presence of antibiotics, indicating a potential adaptive response. **(Su et al., 2019)** investigated the dynamics of antibiotic resistance genes (ARGs) in marine aquaculture. They found that environmental factors and the bacterial community play a significant role in the dissemination of ARGs in marine aquaculture, with sediment being a key medium for dissemination. **(Barathan et al., 2024)** explored the role of bacterial extracellular vesicles (BEVs) in the spread of antibiotic resistance in aquatic environments. They highlighted the potential of BEVs as both a threat and a tool in combating antibiotic resistance, suggesting promising strategies for mitigating the spread of resistance. **(Rout et al., 2023)** focused on the prevalence of antibiotic resistance genes in the river Ganges in India. Their metagenomic analysis revealed regional differences in the prevalence of ARGs, emphasizing the importance of targeted public health interventions to combat antibiotic resistance. **(Ahiable et al., 2023)** assessed the antibacterial efficacy of isobutyl cyanoacrylate nanoparticles against major bacterial pathogens of fish. They found that the nanoparticles exhibited dose-dependent and species-specific antibacterial properties, suggesting their potential use as alternatives to antibiotics in aquaculture. Overall, these research papers provide valuable insights into the factors contributing to antibiotic resistance in aquaculture and offer potential strategies for mitigating this growing threat to public health and the environment.

**Implications of Antibiotic Resistance in Aquaculture**

Antibiotic resistance in aquaculture is a growing concern with significant implications for public health and the environment. The study conducted by **Dewi et al. (2022)** sheds light on the on-farm practices and environmental risk factors that contribute to the development and emergence of multi-drug-resistant (MDR) *Escherichia coli* and *Vibrio parahaemolyticus* in aquaculture systems. The findings suggest that practices such as manuring the pond and the use of earthen ponds are associated with an increased likelihood of MDR bacteria occurrence. These results highlight the need for targeted interventions at aquaculture farms to mitigate the risk of MDR bacteria that can impact fish of public health importance. In a similar vein, **Liao et al. (2022)** explore the potential of medicinal plants as antibiotic alternatives in aquaculture to combat viral diseases, which pose a significant threat to the industry. The review emphasizes the antiviral activities of medicinal plants and their active pharmaceutical ingredients, showcasing their effectiveness in preventing and treating viral diseases in aquatic animals. Compared to chemical drugs and antibiotics, medicinal plants offer advantages such as fewer side effects, reduced drug resistance, and low toxicity to the environment. The study underscores the value of medicinal plants in improving the growth performance of aquatic animals and their potential as harmless drugs for disease prevention in aquaculture. Overall, the research papers highlight the urgent need for sustainable practices in aquaculture to address antibiotic resistance and viral diseases. By understanding the drivers of antimicrobial resistance and exploring alternative treatments such as medicinal plants, researchers can develop strategies to promote the health of aquatic animals, protect public health, and ensure the sustainability of the aquaculture industry. These findings provide valuable insights for future research and interventions aimed at mitigating the implications of antibiotic resistance in aquaculture.Antibiotic resistance in aquaculture is a growing concern that has significant implications for both human health and the environment. The research conducted by **Gaeta et al. (2020)** highlights the potential risks associated with the overuse of antibiotics in aquaculture, including water pollution and the development of antimicrobial resistance. In response to these challenges, innovative strategies such as photodegradation using TiO2 have been proposed as a promising and sustainable method for removing antibiotic contaminants from water. The study evaluated the efficacy of composite TiO2 powders sensitized with porphyrins in photodegrading antibiotics such as oxolinic acid and oxytetracycline. Among the composite materials tested, TiO2 functionalized with CuTCPP showed promising results in removing oxytetracycline from water under simulated solar irradiation. This research suggests that photodegradation using TiO2-based materials could be a valuable tool in managing antibiotic pollution in aquaculture and protecting public health. In a similar vein, **Akinyele et al. (2011)** conducted a study to assess the antibacterial potential of crude aqueous and n-hexane extracts of the husk of *Cocos nucifera* against Vibrio species and other bacterial pathogens commonly found in food and wound infections. The results of the study demonstrated that both the aqueous and n-hexane extracts exhibited antimicrobial activity against a wide range of bacterial isolates, including Vibrio pathogens. The minimum inhibitory concentrations of the extracts ranged between 0.3-5.0 mg/mL, indicating their potential as alternative therapies against microbial infections. The findings of this study suggest that natural extracts from *C. nucifera* could serve as a valuable resource for combating antibiotic-resistant bacteria in aquaculture settings. Overall, the research conducted by **Gaeta et al. (2020)** and **Akinyele et al. (2011)** underscores the importance of addressing antibiotic resistance in aquaculture through innovative and sustainable approaches. By exploring the use of TiO2-based materials for photodegradation and natural extracts for antibacterial properties, researchers can develop effective strategies for managing antibiotic pollution and combating resistant bacteria in aquaculture. These studies provide valuable insights that can guide future research efforts aimed at safeguarding human health and the environment from the implications of antibiotic resistance in aquaculture.

**Conclusions**

Adopting a multimodal strategy to mitigate antibiotic resistance in aquaculture involves using probiotics, prebiotics, and vaccination programs to boost immune responses and lower disease incidence in addition to better farm management techniques like optimal water quality maintenance and stress reduction. The use of antibiotics is further reduced by strict biosecurity protocols, selective breeding for disease resistance features, and investigation of complementary therapies like herbal cures. In addition to encouraging cooperation between industry players, academics, and governmental organizations to develop sustainable solutions for the long-term health of aquatic ecosystems and global food security, regulatory frameworks along with monitoring, education, and education programs ensure responsible antibiotic stewardship.

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