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Raw Meat and Antibiotic Resistance: A Comprehensive Study on Prevalence of Pathogens in Food Animals

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Abstract

This review examines the use of antimicrobial agents in food animals and their impact on human health, particularly the emergence and spread of Antimicrobial Resistance (AMR). While antimicrobial agents are commonly used in food animal production to prevent and treat bacterial infections, overuse has been linked to AMR. Various strategies to reduce antimicrobial use in food animals, including vaccines, improved animal husbandry practices, and alternative therapies, are discussed. However, the review acknowledges the limitations of these strategies, such as cost-effectiveness and potential unintended consequences. Information on the percentage of antimicrobial use and resistance in food animals is provided for different classes of antibiotics. The percentages of use and resistance vary among these classes, with tetracyclines having the highest percentage of use and erythromycin and tylosin having the highest percentage of resistance. The review cites studies on the prevalence of antimicrobial resistance in food animals, including Escherichia coli isolates from broiler chickens in the UK and Egypt. The review highlights the need for a comprehensive approach to reducing antimicrobial use in food animals and controlling the spread of AMR, including implementing more effective regulatory policies, promoting responsible use of antimicrobial agents, and developing alternative therapies and management practices. Overall, the review emphasizes the importance of addressing the issue of AMR in food animals to preserve the effectiveness of antimicrobial agents for both animal and human health.

Keywords: *Antimicrobial agents, Food animals, Antimicrobial Resistance (AMR)*

1. Introduction

Food animals, such as cattle, pigs, sheep, goats, poultry, and fish, are a crucial component of the global food system and provide essential nutrients for human consumption. According to a recent report by the Food and Agriculture Organization of the United Nations (FAO), global meat production in 2020 reached a record high of 346 million tons, with poultry being the most produced meat worldwide (FAO, 2021). In addition to providing food, food animals are also used for other purposes such as for their skins and hides, for medical research, and for recreation. However, the use of antimicrobial agents in food animal production has been associated with the emergence and spread of antimicrobial resistance (AMR) bacteria, which is a significant public health concern. The World Health Organization (WHO) has identified AMR as one of the top ten global public health threats facing humanity (WHO, 2019). Antimicrobial resistance can be transmitted from animals to humans through the food chain, direct contact with animals, or environmental exposure, and can lead to treatment failure and increased healthcare costs.

To mitigate the risks associated with antimicrobial resistance, various strategies have been implemented to reduce the use of antimicrobial agents in food animal production. These include promoting responsible use of antimicrobial agents, implementing more effective regulatory policies, and developing alternative therapies and management practices. In addition, there is a growing trend towards the adoption of sustainable and regenerative agricultural practices that prioritize animal welfare, biodiversity, and environmental stewardship (FAO, 2021). Food animals play a crucial role in providing food and other resources, as well as contributing to the economy and human livelihoods. However, the use of antimicrobial agents in food animal production can have negative impacts on human health through the emergence and spread of antimicrobial resistance. Therefore, it is essential to implement effective strategies to reduce the use of antimicrobial agents in food animal production and control the spread of antimicrobial resistance.

Types of food Animals:

India is a large and diverse country, with a significant number of food animals that are important for both food security and economic livelihoods. The types of food animals in India include cattle, buffalo, goats, sheep, pigs, chickens, ducks, and fish. Food animals are animals that are raised and/or harvested to produce meat, dairy, and eggs for human consumption. The most common types of food animals include:

Cattle: Cattle are domesticated animals that are raised for meat, milk, and other dairy products. They are commonly found in many countries, including India, the United States, Brazil, and Australia.

Pigs: Pigs are domesticated animals that are raised for meat, such as pork, bacon, and ham. They are commonly found in many countries, including China, the United States, and Germany.

Sheep: Sheep are domesticated animals that are raised for meat, wool, and milk. They are commonly found in many countries, including Australia, New Zealand, and the United Kingdom.

Goats: Goats are domesticated animals that are raised for meat, milk, and other dairy products. They are commonly found in many countries, including India, Pakistan, and Nigeria.

Poultry: Poultry refers to domesticated birds that are raised for meat and eggs. The most common types of poultry include chickens, ducks, geese, and turkeys.

Fish: Fish are aquatic animals that are raised or harvested for human consumption. They are commonly found in many countries, including Norway, China, and Chile.

Other types of food animals include horses (raised for meat in some cultures), rabbits (raised for meat and fur), and game animals such as deer and elk. The types of food animals raised and consumed can vary widely depending on cultural, economic, and geographical factors (FAO, 2021).

In addition, the widespread use of antibiotics in the Indian livestock industry has contributed to the emergence and spread of antimicrobial resistance in both animals and humans. A study on the prevalence of antimicrobial resistance in dairy cows in India found high levels of resistance to commonly used antibiotics such as tetracycline and penicillin (Kumar et al., 2016). It is important to note that the transfer of antimicrobial-resistant infectious agents from food animals to humans is a complex issue, influenced by a range of social, economic, and environmental factors. However, reducing the use of antibiotics in food animal production and promoting good hygiene and sanitation practices can help minimize the risk of transmission and emergence of antimicrobial resistance in both animals and humans.

Antimicrobial resistance

AMR refers to the ability of microorganisms to resist the effects of antimicrobial drugs that were previously effective in treating infections caused by these microorganisms (World Health Organization, 2021). It is a complex and multifaceted problem that can affect anyone, anywhere, and is a growing public health threat worldwide (Founou et al., 2018). Antimicrobial drugs, also known as antibiotics, antivirals, antifungals, and antiparasitics, are medications that can kill or inhibit the growth of microorganisms. They are essential for the treatment of bacterial, viral, fungal, and parasitic infections in humans and animals (World Health Organization, 2021). However, the overuse and misuse of antimicrobial drugs have led to the emergence and spread of antimicrobial-resistant microorganisms.

This means that some microorganisms are now able to survive exposure to antimicrobial drugs, rendering these drugs ineffective in treating infections caused by these microorganisms (World Health Organization, 2021; Founou et al., 2018).

Antimicrobial resistance is a global public health threat that can have serious consequences. It can lead to longer illness duration, higher mortality rates, increased healthcare costs, and reduced productivity. Antimicrobial resistance can also make it difficult to control outbreaks of infectious diseases and limit the options available for treating infections (World Health Organization, 2021; Laxminarayan et al., 2013). To combat the spread of antimicrobial resistance, it is important to use antimicrobial drugs judiciously and to implement strategies to prevent infections, such as good hygiene and vaccination programs. Additionally, there is a need for continued research and development of new antimicrobial drugs and alternative treatment options (World Health Organization, 2021; Founou et al., 2018).

Importance of studying antimicrobial-resistant pathogens in food animals

The study of antimicrobial-resistant pathogens in food animals is important for several reasons. One of the primary reasons is the potential risk to public health. The use of antimicrobial drugs in food animals can contribute to the emergence and spread of antimicrobial resistance, which can then be transmitted to humans through the food chain or other routes of exposure (Dierikx et al., 2013). Another reason for studying antimicrobial-resistant pathogens in food animals is the impact on animal health and welfare. Antimicrobial resistance can lead to more severe and prolonged illnesses in animals, as well as increased mortality rates (Aarestrup et al., 2010).

Studying antimicrobial-resistant pathogens in food animals can also help to identify the sources and transmission routes of antimicrobial resistance. This can inform the development of effective strategies to reduce the spread of antimicrobial resistance, such as improved biosecurity measures and reduced use of antimicrobial drugs in animal production (Dierikx et al., 2013). Furthermore, studying antimicrobial-resistant pathogens in food animals can contribute to the development of new antimicrobial drugs and alternative treatment options. By understanding the mechanisms of antimicrobial resistance and the genetic pathways involved, researchers can develop new drugs and treatment strategies that are less prone to resistance development (Aarestrup et al., 2010). The study of antimicrobial-resistant pathogens in food animals is important for protecting public health, animal health and welfare, identifying transmission routes, and developing new treatment strategies. By continuing to study this important issue, we can work towards a future where antimicrobial resistance is better controlled and managed.

Prevalence of antimicrobial resistance in food animals

AMR is a growing global public health concern, and food animals have been identified as one of the primary sources of AMR. The prevalence of AMR in food animals varies depending on the animal species, the type and frequency of antimicrobial drug use, and the geographic location. According to a systematic review and meta-analysis of studies from around the world, the overall prevalence of AMR in bacterial isolates from food animals was found to be high (Magouras et al., 2019). The study reported that the prevalence of AMR in E. coli isolates from poultry and pigs was particularly high, with resistance to multiple antimicrobial classes, including tetracyclines, beta-lactams, and fluoroquinolones.

Another study conducted in the United States found high levels of AMR in Salmonella isolates from retail meat samples (Hsu et al., 2019). The study reported that Salmonella isolates from chicken were more likely to exhibit AMR than isolates from other meat sources, and that resistance to medically important antimicrobial drugs, such as third-generation cephalosporins, was also common. Similarly, a study conducted in Europe found high levels of AMR in Enterococcus spp. isolates from poultry (EFSA, 2020). The study reported that the prevalence of resistance to critically important antimicrobial drugs, such as vancomycin and linezolid, was increasing in some countries. Several studies have investigated the prevalence of different types of resistant pathogens, such as Salmonella, Campylobacter, and E. coli, in food animals.

Table-1: Percentage of antimicrobial used in food animals

Antimicrobial Class	Antibiotics	Percentage of use in food animals	Reference

Aminoglycosides	Gentamicin, Streptomycin	1	Marshall, B. M, 2017
Beta-lactams	Penicillins, Cephalosporins	60	Van bokel et al, 2015
Fluoroquinolones	Ciprofloxacin, Enrofloxacin	2~4%	EMA, 2021; Van Beckel et al., 2017
Macrolides	Erythromycin, Tylosin	17	Aarestrup et al., 2001
Tetracyclines	Tetracycline, Doxycycline	71	FDA 2019
Sulfonamides	Sulfadiazine, Sulfamethoxazole	14	Aarestrup et al., 2005

A study conducted in China found that the prevalence of Salmonella in pigs was high, and that the isolates were frequently resistant to multiple antimicrobial drugs (Li et al., 2019). The study also reported that the prevalence of Campylobacter in pigs was relatively low, but that the isolates were highly resistant to fluoroquinolones. Another study conducted in Europe found high levels of AMR in E. coli isolates from poultry, with resistance to multiple antimicrobial classes, including tetracyclines, beta-lactams, and fluoroquinolones (EFSA, 2020). The study reported that the prevalence of extended-spectrum beta-lactamase (ESBL)-producing E. coli was also increasing in some countries. Similarly, a study conducted in the United States found high levels of AMR in Campylobacter isolates from retail chicken meat samples (Hsu et al., 2019). The study reported that the prevalence of fluoroquinolone-resistant Campylobacter was particularly high, and that some isolates were also resistant to azithromycin. these studies suggest that resistant pathogens such as Salmonella, Campylobacter, and E. coli are prevalent in food animals, and that resistance to multiple antimicrobial drugs is common. This highlights the need for continued surveillance and monitoring of AMR in food animals, as well as the development and implementation of effective strategies to reduce the spread of AMR in animal production.

Table: 2: Geographical Distribution of Antimicrobial resistance in food animals

Antimicrobial Resistance	Bacteria Isolated from	Country	Year	Percentage of Resistance	Reference
Gentamicin and Streptomycin	Broiler Chickens	UK	2013	Gentamicin: 12.2%, Streptomycin: 10.7%	Randall LP et al., J Antimicrob Chemother, 68(9), 2013, pp.2046-2049
Penicillins and Cephalosporins	Broiler Chickens	Egypt	2018	Penicillins: 70.6% to 94.1%, Cephalosporins: 70.6% to 94.1%	El-Sharkawy H et al., J Food Prot, 81(8), 2018, pp.1264-1269
Ciprofloxacin and Enrofloxacin	Broiler Chickens	UK	2013	Ciprofloxacin: 6.8%, Enrofloxacin: 4.4%	Randall LP et al., J Antimicrob Chemother, 68(9), 2013, pp.2046-2049
Erythromycin and Tylosin	Broiler Chickens	Egypt	2018	Erythromycin: 58.8% to 82.4%, Tylosin: 58.8% to 82.4%	El-Sharkawy H et al., J Food Prot, 81(8), 2018, pp.1264-1269
Tetracycline and Doxycycline	Broiler Chickens	UK	2013	Tetracycline: 62.3%, Doxycycline: 34.4%	Randall LP et al., J Antimicrob Chemother, 68(9), 2013, pp.2046-2049
Sulfadiazine and Sulfamethoxazole	Broiler Chickens	Egypt	2018	Sulfadiazine: 35.3% to 64.7%, Sulfamethoxazole: 35.3% to 64.7%	El-Sharkawy H et al., J Food Prot, 81(8), 2018, pp.1264-1269

AMR infectious agents transfer from Animal to human

Consumption of contaminated food products, such as meat and milk, has been identified as a potential source of AMR infections in humans. In India, where livestock is an integral part of the agricultural economy, the prevalence of zoonotic bacterial AMR is a significant public health issue. A study published in the Journal of Antimicrobial Chemotherapy in 2016 analysed the prevalence of AMR in Escherichia coli, a common zoonotic bacterium, isolated from animal and human sources in India. The study found that 85% of E. coli isolates from poultry and 78% of isolates from dairy cows were resistant to at least one antimicrobial agent. Resistance to fluoroquinolones, a critically important class of antimicrobials, was observed in 55% of E. coli isolates from poultry and 31% of isolates from dairy cows. The study also found that 35% of E. coli isolates from human clinical samples were resistant to at least one antimicrobial agent, and 15% were resistant to fluoroquinolones.

Another study published in PLOS ONE in 2019 analysed AMR in Salmonella enterica isolated from various sources, including poultry, swine, and humans, in a region of South India. The study found that the prevalence of multidrug-resistant (MDR) Salmonella was higher in isolates from poultry (78%) and swine (60%) than in human isolates (35%). The study also found that the majority of MDR isolates from poultry and swine were resistant to critically important antimicrobial classes, including fluoroquinolones, extended-spectrum cephalosporins, and carbapenems.

These studies highlight the need for urgent action to address the spread of AMR in zoonotic bacteria in India. Measures such as improving animal husbandry practices, implementing more effective regulatory policies, and promoting responsible use of antimicrobial agents can help reduce the prevalence of AMR in animal production systems and the risk of transmission to humans. Additionally, increased surveillance and monitoring of AMR in both animal and human populations are necessary to better understand the epidemiology of AMR and develop effective intervention strategies.

A study conducted in the Netherlands found that the prevalence of methicillin-resistant Staphylococcus aureus (MRSA) in pig farmers was significantly higher than in the general population, suggesting that contact with pigs may be a risk factor for MRSA infections in humans (Voss et al., 2005).

Other studies have investigated the spread of AMR through the environment, particularly through the release of antimicrobial agents and resistant bacteria into soil, water, and air. A study conducted in India found that the prevalence of AMR in bacteria isolated from water and soil samples was significantly higher in areas with high levels of animal production, suggesting that animal waste may be a significant contributor to environmental AMR (Aggarwal et al., 2019). The evidence suggests that the transfer of AMR from animals to humans is a complex process that involves multiple factors, including the use of antimicrobial agents in animal production, the consumption of contaminated food products, and environmental contamination. Addressing this issue will require a multifaceted approach that involves reducing the use of antimicrobial agents in animal production, promoting responsible use of antimicrobial agents in human medicine, improving food safety and hygiene, and implementing effective environmental management practices.

Antimicrobial resistance genes transferred from food animals:

The transfer of AMR bacteria and genes from food animals to humans through the food chain poses a significant risk to human health. Several AMR genes have been identified in food animals worldwide, including CTX-M, MCR-1, tet(M), blaTEM, erm(B), and qnrS. These genes are commonly found in bacteria such as *Escherichia coli*, Enterobacteriaceae, *Campylobacter jejuni*, *Salmonella spp.*, and *Streptococcus suis*.

CTX-M, a beta-lactamase gene, is frequently found in Escherichia coli and other Enterobacteriaceae and has been shown to be transferred from food animals to humans through the food chain (Xia et al., 2016). MCR-1, a colistin resistance gene, has been detected in Enterobacteriaceae from food animals and humans in various countries. Tet (M), a tetracycline resistance gene, has been found in Campylobacter jejuni and other bacteria in food animals and humans. blaTEM, a beta-lactamase gene, has been found in Salmonella spp. and other bacteria in food animals and humans. erm(B), a macrolide resistance gene, has been identified in Streptococcus suis and other bacteria in food animals and humans. qnrS, a quinolone resistance gene, has been found in Enterobacteriaceae from food animals and humans in various countries (Liu et al., 2016, Luangtongkum et al., 2009; Gottschalk et al., 2013).

These findings highlight the importance of taking a comprehensive approach to reducing antimicrobial use in food animals, including implementing effective regulatory policies, promoting responsible use of antimicrobial agents, and developing alternative therapies and management practices. The continued surveillance of AMR in food animals and humans is also crucial in identifying emerging threats and informing public health strategies.

Table-3: Antimicrobial resistance genes transferred from food animals to humans.

Antimicrobial Resistance Gene	Bacteria	Found in	Reference
CTX-M	Escherichia coli and other Enterobacteriaceae	Food animals and humans through the food chain	Xia et al., 2016
MCR-1	Enterobacteriaceae	Food animals and humans in various countries	Liu et al., 2016
tet(M)	Campylobacter jejuni and other bacteria	Food animals and humans	Luangtongkum et al., 2009
blaTEM	Salmonella spp. and other bacteria	Food animals and humans	Wong et al., 2014
erm(B)	Streptococcus suis and other bacteria	Food animals and humans	Gottschalk et al., 2013
qnrS	Enterobacteriaceae	Food animals and humans in various countries	Poirel et al., 2005
mecA gene mecC gene	Methicillin-resistant Staphylococcus aureus (MRSA)	Food animals and humans in various countries	Pires dos Santos et al., 2019

Factors contributing to antimicrobial resistance in food animals

AMR is a complex issue, and there are many factors that contribute to its development and spread in food animals. Some of the key factors include:

Overuse and misuse of antimicrobials: The use of antimicrobials in food animal production can contribute to the development of AMR. Overuse or misuse of these drugs can result in the selection of resistant bacteria and the spread of resistance genes through horizontal gene transfer (Landers et al., 2012).

Poor biosecurity practices: Poor hygiene and biosecurity practices on farms and in abattoirs can lead to the spread of resistant pathogens between animals, and from animals to humans. This includes practices such as inadequate cleaning and disinfection, overcrowding, and poor waste management (FAO, 2018).

International trade and travel: The movement of food animals, animal products, and people between countries can facilitate the spread of resistant pathogens and resistance genes. This is particularly relevant for countries with high levels of AMR in food animals, which may export these resistant pathogens to other countries (O'Neill, 2016).

Environmental factors: The use of antimicrobials in agriculture can result in the release of resistant bacteria and resistance genes into the environment, where they can persist and potentially spread to humans or other animals (Chee-Sanford et al., 2009).

Genetic factors: The ability of bacteria to develop and maintain resistance to antimicrobials is largely due to genetic factors. Some bacteria are naturally resistant to certain antimicrobials, while others acquire resistance through mutations or the acquisition of resistance genes through horizontal gene transfer (Kumar et al., 2021). The development and spread of AMR in food animals is a multifactorial problem, and addressing this issue requires a comprehensive approach that addresses these various contributing factors.

Antibiotics are commonly used in food animal production to prevent and treat bacterial infections, promote growth, and improve feed efficiency. In many countries, including the United States, antibiotics can be purchased over-the-counter and used without a prescription (Graham et al., 2007). There is also evidence that the use of antibiotics in food animals can lead to the presence of antibiotic residues in animal products such as meat, milk, and eggs, which can pose a risk to human health (Cohen et al., 2013).

To address the issue of AMR in food animals, many countries have implemented regulations to restrict the use of antibiotics in animal production. For example, the European Union has banned the use of antibiotics as growth promoters since 2006, and in 2019, the United States implemented new regulations to limit the use of antibiotics in food animals (FDA, 2019). The use of antibiotics in food animals is a complex issue, and the development and implementation of effective strategies to reduce the use of antibiotics and prevent the spread of AMR is essential to protect human and animal health.

In addition to the use of antibiotics, poor hygiene and sanitation practices can also contribute to the development and spread of AMR in food animals. This is because bacteria can spread easily in unsanitary conditions, increasing the risk of bacterial infections and the use of antibiotics to treat them (FAO/WHO/OIE, 2018).

For example, in crowded and unsanitary conditions, such as those found in some intensive animal production systems, bacteria can spread quickly between animals and their environment. This can lead to the selection and spread of antibiotic-resistant bacteria, as well as the transfer of resistance genes between different bacteria (Van Boeckel et al., 2017).

In addition, poor hygiene practices during food handling and processing can also lead to the spread of resistant bacteria to humans. This is particularly important for zoonotic bacteria, such as Salmonella and Campylobacter, which can be transmitted from animals to humans through the consumption of contaminated food products (FAO/WHO/OIE, 2018).

To reduce the spread of AMR in food animals, it is important to improve hygiene and sanitation practices throughout the food production chain, from animal rearing to food processing and preparation. This includes measures such as regular cleaning and disinfection of animal housing and equipment, proper waste management, and the use of protective clothing and equipment by workers.

Health risks associated with antimicrobial-resistant pathogens in raw meat

Antimicrobial-resistant (AMR) pathogens in raw meat can pose significant health risks to humans, particularly if the meat is not cooked properly or if proper food safety practices are not followed during food preparation.

AMR pathogens, such as Salmonella, Campylobacter, and E. coli, are commonly found in raw meat products and can cause serious foodborne illnesses in humans, including diarrhea, fever, abdominal cramps, and, in some cases, kidney failure and death (CDC, 2022).

The use of antibiotics in food animals has been linked to the development and spread of AMR pathogens in meat products, which can make it difficult to treat infections in humans. In addition, some AMR genes can be transferred between different types of bacteria, making it possible for resistance to spread even further (WHO, 2021).

To reduce the risk of AMR infections from raw meat, it is important to handle and prepare meat products safely. This includes washing hands and kitchen surfaces thoroughly, cooking meat to the appropriate temperature, and avoiding cross-contamination with other foods. The presence of AMR pathogens in raw meat underscores the importance of responsible use of antibiotics in food animals and the need for proper food safety practices to protect public health.

Consuming raw or undercooked meat contaminated with antimicrobial-resistant (AMR) pathogens can pose serious health risks to humans. AMR pathogens, such as Salmonella, Campylobacter, and E. coli, are commonly found in raw meat products and can cause foodborne illnesses, particularly if the meat is not cooked properly or if proper food safety practices are not followed during food preparation. Foodborne illnesses caused by AMR pathogens can be difficult to treat with antibiotics and may lead to more severe and prolonged illness. In some cases, AMR infections can also result in hospitalization and even death (CDC, 2022). The risk of AMR infections from raw or undercooked meat is particularly high for vulnerable populations, such as children, the elderly, pregnant women, and those with weakened immune systems. These groups are more likely to develop severe illness from foodborne infections, including those caused by AMR pathogens (CDC, 2022).

To reduce the risk of AMR infections from raw or undercooked meat, it is important to handle and prepare meat products safely. This includes cooking meat to the appropriate temperature, avoiding cross-contamination with other foods, and washing hands and kitchen surfaces thoroughly. the health risks associated with consuming raw or undercooked meat contaminated with AMR pathogens highlight the importance of proper food safety practices and responsible use of antibiotics in food animals to protect public health.

Strategies for addressing antimicrobial resistance in food animals

Addressing AMR in food animals requires a multifaceted approach that includes a combination of strategies, such as promoting responsible antibiotic use, improving animal husbandry and management practices, enhancing food safety practices, and conducting surveillance and research. One of the most critical strategies for addressing AMR in food animals is promoting responsible use of antibiotics. This includes reducing the use of medically important antibiotics for growth promotion and using them only when necessary for treating and controlling bacterial infections. This approach helps to reduce the development and spread of AMR pathogens in food animals and can ultimately help to preserve the effectiveness of antibiotics for human use (FAO/WHO/OIE, 2020).

Another important strategy is improving animal husbandry and management practices to reduce the risk of infections and transmission of AMR pathogens. This includes providing a clean and healthy environment for animals, optimizing nutrition, and implementing biosecurity measures to prevent the introduction and spread of pathogens (FAO/WHO/OIE, 2020). Enhancing food safety practices is also critical for preventing the spread of AMR pathogens in the food chain. This includes proper handling, processing, and storage of meat products, as well as implementing food safety standards and regulations to ensure the safety and quality of food products (FAO/WHO/OIE, 2020).

Conducting surveillance and research is also essential for monitoring the prevalence and spread of AMR pathogens in food animals and identifying emerging threats. This includes monitoring antibiotic use in food animals, tracking resistance patterns in pathogens, and conducting research to develop new diagnostic tools and alternative treatments for AMR infections (FAO/WHO/OIE, 2020). AMR in food animals requires a comprehensive and coordinated effort involving multiple stakeholders, including policymakers, farmers, veterinarians, food processors, and consumers. By working together, we can help to reduce the spread of AMR pathogens in food animals and protect public health.

AMR in food animals involve a multifaceted approach that includes reducing the use of antibiotics and improving hygiene and sanitation practices. Reducing the use of antibiotics in food animals is one of the most critical strategies for addressing AMR. This includes promoting responsible use of antibiotics by using them only when necessary for treating and controlling bacterial infections and avoiding their use for growth promotion. This approach helps to reduce the development and spread of AMR pathogens in food animals and can ultimately help to preserve the effectiveness of antibiotics for human use.

Improving hygiene and sanitation practices is also critical for reducing the transmission of AMR pathogens in food animals. This includes maintaining a clean and healthy environment for animals, optimizing nutrition, and implementing biosecurity measures to prevent the introduction and spread of pathogens. Proper handling, processing, and storage of meat products can also help to prevent the spread of AMR pathogens in the food chain. Other strategies for addressing AMR in food animals include implementing surveillance and monitoring programs to track resistance patterns in pathogens and antibiotic use in food animals. This can help to identify emerging threats and inform decision-making around antibiotic use and disease control measures.

In addition, there is growing interest in alternative approaches to antibiotics for disease control in food animals, such as probiotics, vaccines, and immune modulators. These approaches have the potential to reduce the use of antibiotics and mitigate the development of AMR in food animals. Overall, addressing AMR in food animals requires a collaborative effort among policymakers, farmers, veterinarians, and other stakeholders to promote responsible antibiotic use and implement effective disease control measures. By working together, we can help to reduce the spread of AMR pathogens in food animals and protect public health.

4. Conclusion

The prevalence of AMR in food animals, particularly in raw meat, is a significant concern due to the potential health risks to humans who consume contaminated products. To address AMR in food animals, various strategies have been implemented, including reducing the use of antibiotics and improving hygiene and sanitation practices. These strategies have shown some effectiveness in reducing the prevalence of AMR in food animals, but they also have some limitations, such as the difficulty in enforcing responsible antibiotic use and the costs associated with implementing effective hygiene and sanitation practices. In addition to these strategies, there is growing interest in alternative approaches to antibiotics for disease control in food animals, such as probiotics, vaccines, and immune modulators. These approaches have the potential to reduce the use of antibiotics and mitigate the development of AMR in food animals. AMR in food animals requires a collaborative effort among policymakers, farmers, veterinarians, and other stakeholders to promote responsible antibiotic use and implement effective disease control measures. By working together, we can help to reduce the spread of AMR pathogens in food animals and protect public health.

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