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Antibiotic Resistance in Dairy Microorganisms

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ABSTRACT

The focus of this review article is dairy and the microorganisms that are developing antimicrobial resistance, especially *Klebsiella pneumoniae* and some other associated pathogens. AMR is one of the important public health risks now a days and it is increasing the prevalence of disease and mortality rates. Different mechanisms by which bacteria develop resistance such as enzymatic degradation, protein modification and alteration in membrane permeability are described in the review. Focus is placed especially on the increased resistance of *K. pneumoniae* to conventional antibiotics, including carbapenems. Specifically, the factors that could lead to the development of AMR in dairy animals, such as the overuse and misuse of antimicrobials, as well as approaches to promote responsible use of antimicrobials globally via initiatives like World Health Organization WHO initiatives. Unseen public health threats or poor awareness will lead to a rise in disease rates, directly or indirectly. They are trained on data until October 2023 and use strategic planning, education, and research to help formulate effective AM practices of management, while making it certain that dairy growth is in an eco-friendly environment and also reducing the public health hazards.

Keywords: *Klebsiella pneumoniae*, AMR, dairy, public health hazards, antimicrobial management

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Introduction

Antimicrobials are substances, including antibiotic, antiviral, antifungal, and antiparasitic, utilized for the prevention and management of infectious diseases in humans, animals, and plants. When bacteria, viruses, fungi, and parasites generate the ability to resist these antimicrobials it is called Antimicrobial Resistance (AMR). This resistance slows down the impact of antibiotics and makes antimicrobials ineffective, causes complications in the treatment of infections, and increases the rate of illness, disease spread, and death rates.

AMR is a natural process that occurs slowly by genetic mutations in pathogens. However, human activities are increasing its occurrence and multiplication, mainly due to the overuse and misuse of antimicrobials in various hosts for treating, preventing, or controlling infections. The worldwide rise in antibiotic resistance poses a serious threat because it's ruining the effectiveness of commonly used antibiotics against prevalent bacterial infections. In 2020, one in five cases of urinary tract infections were caused by *Escherichia coli* reducing the susceptibility to common antibiotics like ampicillin, co-trimoxazole, and fluoroquinolones, complicating the effective treatment of common infections The concerning resistance rates among bacterial pathogens present in The 2022 Global Antimicrobial Report and Use Surveillance System (GLASS) that shows 42% resistance rates for third-generation cephalosporin-resistant *E. coli* and 35% for methicillin-resistant *Staphylococcus aureus* reported across 76 countries.

K. pneumoniae, an intestinal bacterium, has increased resistance to important antibiotic classes. Carbapenem resistance is also becoming evident in many regions due to increasing levels of resistance to antibiotics the risk of infection treatment also increasing. (OECD) Organization for Economic Cooperation and Development presents a twofold increase in resistance to last-resort antibiotics by 2035 as compared to 2005 so there is an immediate need for management strategies and improved surveillance worldwide. The World Health Organization (WHO) monitors the spread and public health implications, mainly fungal infections that are causing challenges in the treatment of infections, as well as HIV. Candida auris, an invasive fungal infection, and its multi-drug resistance is also a threat. The WHO has developed a Fungal Priority Pathogens List, which includes a thorough review of global fungal infections and drug-resistant fungi (1). The primary objective of this review article is to explore the mechanism of resistance, key microorganisms involved in dairy, factors, and their implications.

Mechanisms of Antibiotic Resistance

Antimicrobial resistance in bacteria can be caused by three fundamental mechanisms: (1) Enzymatic degradation of antimicrobials (2) Change in bacterial proteins that play a role as targets for the drugs, and (3) Change in membrane permeability that decreases antibiotic entry. Enzymatic degradation, by beta-lactamase, moves to the hydrolysis of beta-lactam antibiotics, making them ineffective. Moreover, changes in target proteins, like penicillin-binding protein 2, play a role in resistance against methicillin. So, there is decreased antibiotic penetration into bacterial cells which can stop the effectiveness of many classes of antibiotics, including aminoglycosides and quinolones, letting bacteria live even in the presence of these treatments.

The examination of antibiotic resistance genes (ARGs) in the soil mainly from the manure of livestock provides us an understanding of antibiotic exposure and the formation of selective pressure whether given to animals directly or indirectly, that promotes the development and consistency of antibiotic-resistant microorganisms. The idea of selective pressure is important for understanding the mechanisms that manage the occurrence and maintenance of antibiotic resistance.

The discussion leads to the ecological outcomes of antibiotic resistance, such as changes in microbial community structure and decreases in microbial efficiency. The metabolic burden of maintaining antibiotic resistance mechanisms, like β-lactamases, can result in an exchange between growth and survival, which may affect the ecological functions of soil microbes. These can also affect ecosystem at broad level.

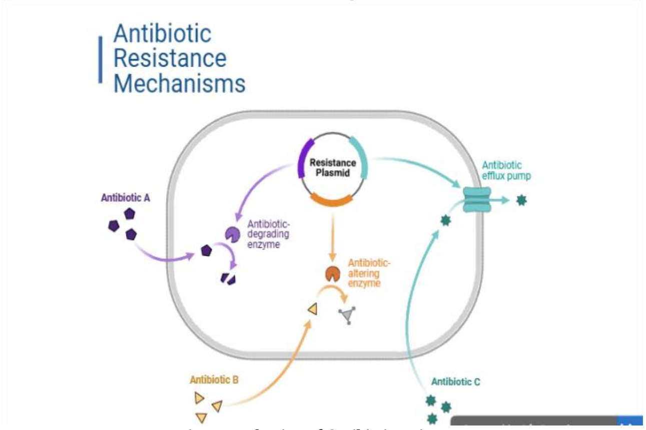

Fig. 1: Mechanism of Antibiotic resistance

Processes like horizontal gene transfer, mutations and microbial community responses to antimicrobial resistance. However, the relationship between microbial growth, soil maintenance and consistency in antibiotic resistance introduces a new mechanism by which factors can influence resistance. So, it emphasizes on the fact that resistant strain not only affect ecosystem but allow microorganisms survival as well as reduce soil efficiency (2).

Key Microorganisms and Their Resistance Profiles

The increasing mass of research on *K. pneumoniae* and its antibiotic resistance emphasizes its importance as a significant pathogen. Many studies are focusing on this like in US, China and India. There are also organizations who are playing a key role in this field to increase the understanding of microorganisms. However, the recent research focuses on medical interventions, therapeutics and reasons of ubiquitous carbapenem-resistant *K. pneumoniae* (CRKP), and their basic mechanism of resistance.

Many new techniques or methods are introduced like Defined Substrate Utilization (DSU®) used for *S. aureus*, methicillin-resistant *S. aureus* (MRSA). Moreover, these methods are useful in rapid detection as compared to traditional methods and it is also necessary in the dairy for management purposes. So, understanding this is significant to make more new strategies.

We have another example of enterococci from clinical and dairy that influence its environment. However, enterococci show less resistance in dairy while in clinical settings it shows resistance to common antibiotics like vancomycin and aminoglycosides due to irregular use of it in medical treatment either misuse or overuse.

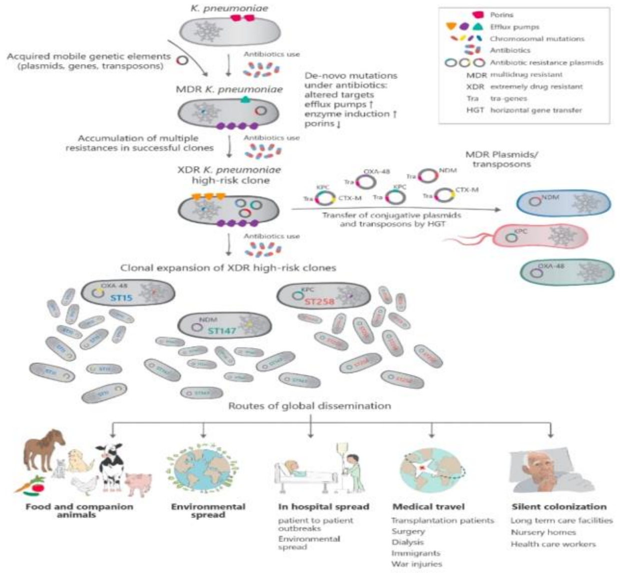

Fig. 2: Mechanism of K. Pneumoniae

Multi-drug resistance in clinical isolates, increasing concerns about the spread of these resistant strains. Both dairy and clinical sources have the same genetic material mechanisms increasing the risk of cross contamination between these two environments. Transfer of resistant genes making it crucial and therefore notable need for antimicrobial management strategies at both medical and agriculture level. (3).

Factors Contributing to AMR in Dairy

1.Role of Antimicrobials in Dairy Farming

Misuse and overutilization of antimicrobials offer the development of resistant bacteria.

2.Global and National Efforts

Involvement of WHO, FAO, and OIE encourages responsible antimicrobial use.

National plans like the UK's "Tackling Antimicrobial Resistance 2019–2024" emphasize disease prevention and biosecurity.

3.Implementation Challenges

Farmers' choice to use antimicrobials often leads to contrary practices. Monitoring systems like veterinary sales data or farm records fail to seize decision-making behaviors thoroughly.

4.Knowledge and Attitudes of Farmers

Notable gaps in awareness about antimicrobials and AMR exist among dairy farmers. Only education may not be enough; behavioral factors and awareness also play a role.

5.Adoption of Mitigation Strategies

Practices like selective dry cow therapy over blanket treatments rely on farmers' will to change behavior.

6.Perception of AMR as a Threat

Many farmers view AMR as a faraway issue and are uncertain about their ability to significantly reduce antimicrobial use.

7.Social, Economic, and Educational Factors

Economic pressures such as milk pricing and seller policies shape AMU decisions. Farmer education levels and demographic factors influence AMR perception and practice. (4).

Implications for Public Health and Dairy Industry

- **Nutritional Benefits:** Dairy products provide essential, high-quality nutrients that offer important health benefits to humans.
- **Economic Contributions:** Dairy production plays an important role in local economies by generating employment, thereby improving public health through economic well-being.
- **Public Health Hazards:** The increase in dairy farming may increase risks related to occupational hazards, zoonotic diseases, and foodborne illnesses, raising concerns about the effect on public health.
- **Major concern:** environmental issues such as disruption in ecosystem and pollution are major concerns that can harm humans and the reason can be the increasing number of dairy industries.
- **Balance Diet:** Balance diet is an important part as there is lot of use of dairy products no doubt it provides nutrition all benefit but overuse of these products can cause an increase in disease rate.
- **Decision making:** Decision making on dairy production, consumption as well as optimal allowance of resources are needed to promote public health benefits while reducing risks.
- **Future Research:** Improved methods of management and strategies for health are significant for future research to understand the potential health impact of dairy. (5).

Conclusion

In conclusion, (AMR) causes an important challenge to both humans and health and dairy industry, including factors like misuse and overuse of antimicrobials but there is lack of awareness in farmers also less practice in dairy farming. With the expansion of dairy products there is a need for enhanced management strategies. The increasing microorganism resistance such as *K. pneumoniae* and *S. aureus* in context of dairy highlights the need for more targeted research and global initiatives and spread awareness about AMR. Furthermore, it is crucial in developing public health strategies.

References

[1] Organization WH. Central Asian and European Surveillance of Antimicrobial Resistance: Annual Report 2019. 2019.

[2] Dever LA, Dermody TS. Mechanisms of bacterial resistance to antibiotics. Arch Intern Med. 1991;151(5):886-95.

[3] Qureshi MA, Fatima Z, Muqadas SM, Najaf DE, Husnain M, Moeed HA, Ijaz U. Zoonotic diseases caused by mastitic milk. Zoonosis, Unique Scientific Publishers, Faisalabad, Pakistan. 2023; 4:557-72. https://doi.org/10.47278/book.zoon/2023.179

[4] Borelli E, Ellis K, Pamphilis NM, Tomlinson M, Hotchkiss E. Factors influencing Scottish dairy farmers' antimicrobial usage, knowledge and attitude towards antimicrobial resistance. Preventive Veterinary Medicine. 2023; 221:106073.

[5] Grout L, Baker MG, French N, Hales S. A Review of Potential Public Health Impacts Associated with the Global Dairy Sector. GeoHealth. 2020;4(2): e2019GH000213.