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Probiotics in the Control of Enteric Bacterial Pathogens: Veterinary Microbiological Approaches

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ABSTRACT

Global livestock production has been greatly affected by enteric bacterial pathogens (i.e. animal health, productivity, food safety and economic viability). In veterinary medicine there is known to be a reduction in enteric bacterial pathogens by probiotics, particularly in livestock. Pathogens such as *Salmonella spp, Escherichia coli, Campylobacter jejuni, Clostridium perfringens and Lawsonia intracellularis* can cause digestive disorders of poultry, swine, cattle, small ruminants, and companion animals. Advances in veterinary microbiology have revealed that certain strains of lactic acid bacteria, *Bacillus* species, bifidobacteria and yeasts have the potential to lower colonization of pathogens, enhance gut integrity, and increase performance in farm animals by preventing the development of antimicrobial resistant strains. Probiotics have attracted more interest in veterinary microbiology because of their ability to improve host immunity, prevent pathogen colonization, and modify intestinal flora. This article discusses scientific basis, mechanism, use, and issues of use of probiotics for treatment of enteric bacterial pathogens in animals. When taken together, probiotics offer vets a long-term, empirically supported approach to intestinal disease management and also decrease their reliance on antibiotics.

Keywords: Probiotics, Pathogens, Enteric bacteria, Veterinary microbiology, Bacterial diseases

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Introduction

Over the last 20 years there has been a paradigm shift in the veterinary profession away from antibiotic growth promoters and towards using more sustainable and ethical practices [1]. There is an urgent need for solutions that can control enteric pathogens without encouraging resistance selection because the overuse of antibiotics in food and animal production has been connected to the global threat of antimicrobial resistance [2]. These are becoming increasingly common in veterinary medicine and usually involve probiotics of the next generation, lactic acid bacteria, Bacillus species that form spores or yeasts such as *Saccharomyces boulardii* [3].

Probiotics not only have the ability to prevent disease, but can also improve the integrity of the gut, reduce inflammation and increase overall productivity. Veterinary microbiology has gained much knowledge about pathogen-host-microbiome interactions and helped develop targeted probiotic formulations for species, production systems and specific pathogens [4]. Probiotics are one of the best ways of changing the microbiome. The gut microbiota, or GI microbiome that live in the gastrointestinal tract, especially in the intestines is essential for pathogen defense, immune system development, and nutritional metabolic processes [5]. While dysbiosis, or an imbalance of microbial populations, predisposes animals to intestinal infections, healthy animals have a symbiotic relationship with the microbiota. The stability of the microbiome is influenced by several factors including, management techniques (housing, hygiene, stocking density) and dietary components (fiber, proteins, feed additives) [6].

1. Probiotics

Probiotics are live microorganisms that enhance the health of the host when administered in adequate amounts. The selection of veterinary probiotic strains is based on criteria including survival through the GI tract, adherence to intestinal epithelium, antimicrobial activity, among other species-specific benefits [7]. Probiotics used in veterinary medicine generally fall into several categories:

- Bifidobacteria known as commensal bacteria widely used in monogastric species
- *Bacillus spp*. - spore-formers with exceptional stability in feed and during pelleting
- Yeasts like *Saccharomyces cerevisiae* and *S. boulardii,* studied for their immunomodulatory role.
- Next-generation probiotics and bacteriocin-producing strains [8].

2. Mechanisms of Action against Enteric Bacterial Pathogens

Probiotics prevent the colonization and proliferation of enteric pathogens by several mechanisms. Veterinary microbiology has identified the following primary modes of action:

2.1. Competitive Prohibition

Probiotics prevent the adherence of pathogens by occupying binding sites on enterocytes. This type of mechanism has been called a “barrier effect,” and was originally demonstrated in poultry, where CE cultures protected chicks from Salmonella by establishing favorable microbiota quickly [9].

2.2. Production of Antimicrobial Substances

Probiotic organisms secrete various metabolites that inhibit pathogenic bacteria. These are organic acids, lactic, acetic, and propionic acids, which lower gut pH. Bacteriocins are synthesized peptides, effective against closely related species which impede the growth of pathogens and modulate host immunity. Biochemical resources can limit the expansion of such pathogens as Clostridium perfringens and E. coli in different animal species [10].

2.3 Modulation of the Immune System

Probiotics are able to interact with intestinal immune cells, activate dendritic cells and macrophages, increase production of immunoglobulin A (IgA) and enhance responses against invading pathogens. For instance, in poultry, supplementation with Lactobacillus strains has been shown to enhance both innate and adaptive immunity against both Salmonella and Campylobacter [12].

2.4. Enhancement of Gut Integrity

Some probiotics enhance epithelial tight junctions and reduce intestinal permeability, which prevents pathogen translocation. This is very important in weaned piglets since the gut barrier dysfunction commonly predisposes them to E. coli infections [13].

2.5. Inhibition of Quorum Sensing

One area of emerging study reveals that some probiotics interfere with quorum sensing signals utilized by pathogens to regulate virulence gene expression. Interruption of these signals weakens the pathogen pathogenicity even without directly killing them [14].

3. Species-Specific Applications in Veterinary Medicine

3.1. Poultry

Poultry show high susceptibility to enteric pathogens such as *Salmonella enterica, Campylobacter jejuni,* and *Clostridium perfringens*. The ban on antibiotic growth promoters in many regions has accelerated the adoption of probiotics. Documented benefits in poultry include the reduction of colonization of *Salmonella* and *Campylobacter,* Prevention of necrotic enteritis due to *C. perfringens,* Improving villi height and intestinal morphology [15].

3.2. Swine

Enterotoxigenic *E. coli* is a significant causative agent of diarrhea in post-weaning piglets. In addition, yeast-based probiotics have been shown to improve gut function and reduce colonization by Salmonella in growing pigs [16]. In particular labs probiotics and Bacillus species, have exhibited considerable benefit that it lower incidence and severity of diarrhea, reduced shedding of pathogenic *E. coli.* It also improve growth performance and immune responses during critical weaning period [17].

3.3. Cattle and Ruminants

Young ruminants, such as calves and lambs, commonly experience a kind of diarrhea brought about by *E. coli*, *Salmonella*, and *Clostridium* species. Feedlot cattle are also at risk from enteric imbalances due to high-concentrate diets. Probiotics have been used in cattle to reduce incidence of neonatal diarrhea, lower prevalence of *E. coli.* It also improve the development of the rumen and increase fermentation efficiency [18].

3.4. Aquaculture

Probiotics are applied in the aquaculture industry to control bacterial pathogens. The use of probiotics is particularly valuable because treatment options for aquaculture infections are limited when compared to terrestrial animals. It improve water quality, bacterial infection alleviation, strengthening of mucosal immunity in fish and shrimp [19].

3.5. Companion Animals

Probiotics are increasingly used to treat gastrointestinal disorders in dogs and cats, such as acute diarrhea, antibiotic-associated dysbiosis, and chronic enteropathies. LAB and Enterococcus-based probiotic help to restore the balance of microbiome and suppress pathogens such as pathogenic *E.coli* [20].

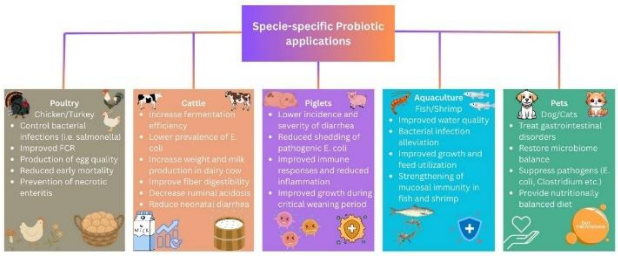

Figure 1: Specie specific probiotic applications

4. Probiotic Formulation and Delivery in Veterinary Practice

Probiotics highly depends on good formulation strategy with viability, stability, and dosage. Veterinary microbiologists are looking into the next generation of delivery systems, such as bacteriocin-expressing probiotics, recombinant strains, and species-specific transplantation of the microbiome [21]. Important factors to take into account are Spore-based formulations for improved shelf stability, Microencapsulation to shield bacteria from stomach acidity, and Prebiotics to enhance the colonization of beneficial microbes [22].

5. Evaluation of Efficacy and Safety

Clinical trials, genomic screening, and field research on farms are necessary to assess the effectiveness of probiotics. Probiotics should be carefully examined for their effectiveness in reducing a particular pathogen, stability in commercial production and storage conditions [23].

6. Challenges and Limitations

Probiotics have a lot of potential, but variability of results, limited colonization, regulatory hurdles, risk of gene transfer, microbiome complexity are still a few obstacles to overcome [24].

7. Future Directions in Veterinary Probiotic Research

Future directions in the use of probiotics to control enteric bacterial pathogens in veterinary medicine will increasingly concentrate on metagenomics, transcriptomics, and metabolomics. This will enable researchers to map the gut flora of different animal species in a unique way, which will enable the development of probiotic formulations for specific diseases. Rather than relying on a broad spectrum of commercial strains, the probiotics for the future will be tailored to the microbial ecology of the host and be aimed at targeted pathogens [25].

8. Conclusion

Probiotics are a good tool to use in the management of enteric bacterial pathogens in a variety of animal species. Through antimicrobial metabolites production, immune system modulation, and improvement in gut condition, probiotics reduce the extent of pathogens and boost the general health of the animals. Animal gastrointestinal disorders may benefit from the use of probiotics, which have been found to increase immune function in a number of species.

Probiotic use in veterinary microbiology has a promising future in spite of challenges relating to their uneven and efficacy and complex regulations. Precision-based probiotic treatments and next generation microbial solutions will enable sustainable animal production and disease control to an increasingly greater extent. If research and innovation is undertaken and utilised appropriately, probiotics will continue to play a major role in reducing enteric bacterial pathogens and improving animal health and welfare across the world.

References

[1] Quinn PJ, Markey BK, Leonard FC, Hartigan P, Fanning S, Fitzpatrick E. Veterinary microbiology and microbial disease. John Wiley & Sons; 2011 Oct 7.

[2] Weese JS, Sharif S, Rodriguez-Palacios A. Probiotics in veterinary medicine. Therapeutic microbiology: Probiotics and related strategies. 2008 Jul 25:341-56.

[3] Iqbal Z, Ahmed S, Tabassum N, Bhattacharya R, Bose D. Role of probiotics in prevention and treatment of enteric infections: A comprehensive review. 3 Biotech. 2021 May;11(5):242.

[4] Jugan MC, Rudinsky AJ, Parker VJ, Gilor C. Use of probiotics in small animal veterinary medicine. Journal of the American Veterinary Medical Association. 2017 Mar 1;250(5):519-28.

[5] Wynn SG. Probiotics in veterinary practice. Journal of the American Veterinary Medical Association. 2009 Mar 1;234(5):606-13.

[6] Ducatelle R, Eeckhaut V, Haesebrouck F, Van Immerseel F. A review on prebiotics and probiotics for the control of dysbiosis: present status and future perspectives. Animal. 2015 Jan;9(1):43-8.

[7] Jugan MC, Rudinsky AJ, Parker VJ, Gilor C. Use of probiotics in small animal veterinary medicine. Journal of the American Veterinary Medical Association. 2017 Mar 1;250(5):519-28.

[8] Loo KY, Thong JY, Tan LT, Letchumanan V, Chan KG, Lee LH, Law JW. A Current Overview of Next-Generation Probiotics and Their Prospects in Health and Disease Management. Progress In Microbes & Molecular Biology. 2024 Dec 29;7(1).

[9] Corcionivoschi N, Drinceanu D, Stack D, Ştef L, Julean C, Bourke B. The Effect of Probiotics on Animal Health. REVIEW. Scientific Papers Animal Science and Biotechnologies. 2010;43(1):35-.

[10] Nair MS, Amalaradjou MA, Venkitanarayanan K. Antivirulence properties of probiotics in combating microbial pathogenesis. Advances in applied microbiology. 2017 Jan 1;98:1-29.

[11] Isolauri E, Sütas Y, Kankaanpää P, Arvilommi H, Salminen S. Probiotics: effects on immunity. The American journal of clinical nutrition. 2001 Feb 1;73(2):444s-50s.

[12] Haghighi HR, Gong J, Gyles CL, Hayes MA, Zhou H, Sanei B, Chambers JR, Sharif S. Probiotics stimulate production of natural antibodies in chickens. Clinical and Vaccine Immunology. 2006 Sep;13(9):975-80.

[13] Otani S, Coopersmith CM. Gut integrity in critical illness. Journal of intensive care. 2019 Mar 20;7(1):17.

[14] Salman MK, Abuqwider J, Mauriello G. Anti-quorum sensing activity of probiotics: the mechanism and role in food and gut health. Microorganisms. 2023 Mar 20;11(3):793.

[15] Khan RU, Naz S. The applications of probiotics in poultry production. World's Poultry Science Journal. 2013 Sep;69(3):621-32.

[16] Jugan MC, Rudinsky AJ, Parker VJ, Gilor C. Use of probiotics in small animal veterinary medicine. Journal of the American Veterinary Medical Association. 2017 Mar 1;250(5):519-28.

[17] Zhang Y, Zhang Y, Liu F, Mao Y, Zhang Y, Zeng H, Ren S, Guo L, Chen Z, Hrabchenko N, Wu J. Mechanisms and applications of probiotics in prevention and treatment of swine diseases. Porcine health management. 2023 Feb 6;9(1):5.

[18] Várhidi Z, Máté M, Ózsvári L. The use of probiotics in nutrition and herd health management in large Hungarian dairy cattle farms. Frontiers in Veterinary Science. 2022 Sep 20;9:957935.

[19] Kumar V, Roy S, Meena DK, Sarkar UK. Application of probiotics in shrimp aquaculture: importance, mechanisms of action, and methods of administration. Reviews in Fisheries Science & Aquaculture. 2016 Oct 1;24(4):342-68.

[20] Lee D, Goh TW, Kang MG, Choi HJ, Yeo SY, Yang J, Huh CS, Kim YY, Kim Y. Perspectives and advances in probiotics and the gut microbiome in companion animals. Journal of Animal Science and Technology. 2022 Mar 31;64(2):197.

[21] Kailasapathy K. Formulation, administration, and delivery of probiotics. Therapeutic microbiology: Probiotics and related strategies. 2008 Jul 25:97-118.

[22] Sreeja V, Prajapati JB. Probiotic formulations: Application and status as pharmaceuticals—A review. Probiotics and antimicrobial proteins. 2013 Jun;5(2):81-91.

[23] Ezendam J, van Loveren H. Probiotics: immunomodulation and evaluation of safety and efficacy. Nutrition Reviews. 2006 Jan 1;64(1):1-4.

[24] Reuter G. Probiotics--possibilities and limitations of their application in food, animal feed, and in pharmaceutical preparations for men and animals. Berliner und Munchener Tierarztliche Wochenschrift. 2001 Nov 1;114(11-12):410-9.

[25] Nami Y, Haghshenas B, Abdullah N, Barzegari A, Radiah D, Rosli R, Yari Khosroushahi A. Probiotics or antibiotics: future challenges in medicine. Journal of medical microbiology. 2015 Feb;64(2):137-46.