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(Review Article)

The role of probiotics in animal nutrition and health

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Abstract

The purpose of this review article is to discuss the role of probiotics in animal nutrition and health. In the last 15 years, probiotics have become increasingly popular in many animal production systems. Inadequate scientifically-based, all-encompassing, and unified data on the effects of probiotics in monogastric and ruminant animals prompted the current review. Feed supplements containing live microorganisms, known as probiotics, are shown to improve intestinal balance and overall health when given on a consistent and adequate schedule. Probiotics are a type of live microorganism that can be added to animal feed to help improve the health and productivity of cattle by balancing the microbes in the animals' digestive systems. This article summarizes the literature on the effects of yeast and bacterial probiotics on the gut microbiome of ruminants and monogastric animals and the implications of these findings for animal nutrition and health. Lastly, the positive effects of probiotics are outlined, including increased animal growth, decreased mortality, and enhanced feed conversion efficiency.

Keywords: Probiotics; Animal Nutrition; Animal Health; Bacteria; Gastro-Intestinal Tract

1 Introduction

One of the fastest-growing subsets of the agricultural industry is livestock production. Livestock provides a significant portion of the food supply for 75 percent of rural residents and 25 percent of urban dwellers [1]. Domestic animals host diverse microbial populations, including bacteria, protozoa, fungi, archaea, and viruses, in their gastrointestinal tracts (GITs) [1]. To maximize output in intensive production systems, providing cattle with concentrated, limited nutrients to satisfy their nutritional needs is common practice. In addition to its nutrient content, a feed's nutritional quality is affected by its hygienic preparation, anti-nutritional factor content, digestibility, palatability, and impact on intestinal health. Thus, feed additives have been critical to this accomplishment [2]. Concerns about the potential for sub-therapeutic use of antibiotic growth promoters in animal feed, as well as a growing appreciation for the contribution of the gut microbiome to livestock productivity, have led to an uptick in the creation and application of probiotic products in animal nutrition. There is a substantial body of evidence supporting the use of probiotics in preventing or treating digestive disorders. The most studied probiotics are lactic acid bacteria, such as *Lactobacillus and Bifidobacterium* species. The microbial population density in the host's digestive tract can be altered, and probiotics can eliminate harmful microorganisms. Once probiotics have changed the balance between beneficial and detrimental microbes, a more optimal microbial community has been established [3] [4].

2 What are Probiotics?

The word "probiotics' was first introduced by Stillwell and Lilly in 1965 [5]. They identified chemicals produced by a protozoan ciliate that enhanced the growth of other ciliates. This phrase currently encompasses a far wider range of living things. Parker (1974) first described probiotics as "organisms and substances which contribute to gut microbial

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balance," a broad definition encompassing both living and non-living things. The food and Agriculture Organization (FAO) defines probiotics as "live microbe when provided in a suitable amount, delivers a health benefit to the host" [2].

3 Role and Effects of Probiotics in Animal Health

Probiotics have been used as feed supplements for livestock since the 1970s. The initial intent of including them in feed was to boost growth and health by raising the animal's resistance to sickness [6]. Nonetheless, probiotic use has been frequently described in the scientific literature, both in people and animals like young pigs. Humans and animals given probiotics have been proven in numerous studies to have improved intestinal bacterial populations, increased resistance to disease, decreased pathogen shedding in response to the oral challenge, enhanced intestinal immunity, reduced disease symptoms, and overall better health. Yeast cultures can encourage ruminants' fodder consumption by speeding up the rumen's fiber digestion during the first 24 hours after feeding. A shift in the composition of the bacteria living in the rumen has been linked to increased efficiency with which the animal digests and absorbs its food early on. Live weight gain, milk output, and fat milk content can all improve with a higher forage intake, but the effects are often modest in dairy cows. Many studies have shown that probiotics help reduce the number of coliform bacteria in newborn calves, suggesting that they play an important role in establishing and maintaining a healthy microbial balance [7].

Furthermore, it has been found that higher rates of *Lactobacillus* loss are linked to lower rates of diarrhea. Conversely, when animals are stressed, the *Lactobacillus* population drops, and diarrhea in newborns is more common. Reducing the prevalence of diarrhea, which is especially common in young pre-ruminants (especially within the first three weeks of life), is probably more significant than performance responses. Before entering the feedlot, beef calves are subjected to various challenges, including weaning, transportation, fasting, assembly, vaccination, castration, and dehorning [5]. Microorganisms in the rumen and lower gut are among those that change due to these pressures, contributing to diminished performance and increased morbidity and mortality. The introduction of probiotics into the diet may therefore mitigate these shifts in the microbiome. It has been shown in multiple trials that adding probiotics to a carcass does not change its yield grade, quality grade, dressing percentage, or marbling score. Yet, when probiotics were included in the diet, hot carcass weight was typically higher. However, heifers given a Propionibacterium probiotic during both the receiving and finishing stages had a higher percentage of carcasses graded than those not given the probiotic [8].

Table 1 Main targets for probiotics used in Ruminants Feed [7]

Dairy Cattle	**Beef Cattle**	**Young Ruminants**
Increase Feed efficiency	Promote weight gain	Promote optimal maturation of rumen microflora
Promoting health and limiting acidosis	Limiting the shedding of human pathogens	Increasing digestion safety at weaning
Increase milk yield and quality	Increase feeding efficiency	Reduce the risk of pathogen colonization in the body
	Promote health/reduce acidosis	

Table 2 Main targets of probiotics used in monogastric animals [13]

Equines	**Poultry**	**Fish**	**Pigs**
Increased diet digestibility	Maintain normal intestinal microflora	Stimulate fish gut immune system	Improving pigs fattening
Limiting diarrhea in foals	Modulate immune response	Reduce stress and diseases	Reducing the risk of diarrhea
Limit stress in a racing horse	Improve broiler carcass/meat	Improve growth and metabolism	Limit constipation
Avoid hindgut disorders like Colic	Reduce the risk of salmonellosis in layers		Increasing piglet weight
Improve milk quality in mares			Improving lactation in sow

4 Probiotics for Ruminants and Monogastric Animals

One or more strains of bacteria are used in most probiotic supplements. Some bacterial strains like *Bifidobacterium, Enterococcus, Lactobacillus, Bacillus, Pediococcus, and Streptococcus* are the most widely utilized bacterial probiotics. Viable yeast and other fungi, besides bacteria, have been found in several items. Probiotics can be divided into several distinct categories, each with its unique set of characteristics, biological background, and method of operation [3]. Live yeast (*Saccharomyces cerevisiae*) preparations are the most widely available commercial product for ruminants. Live yeasts consistently improve productivity in dairy ruminants, especially regarding dry matter intake and milk output. Reduce acidosis in high-concentrate-fed animals by supplementing their diets with lactate-producing bacteria (*Enterococcus, Lactobacillus*), which would maintain a consistent level of lactic acid and allow the lactate-utilizing species to thrive. Direct-fed microbes such as *M. elsdenii or Propionibacterium spp*., which utilize lactate as an energy source, could be used to prevent ruminal lactate engorgement. Many items have been observed to increase weight growth and stimulate rumen development in young calves [12].

Horses, whose primary digestive compartment of concern is the caecum colon, benefit greatly from using probiotics, particularly during stress (such as transport) or while fed a high-concentrate diet. Using live yeasts has been demonstrated to decrease the risk of lactic acidosis by increasing fiber digestibility in the colon and shifting the bacterial community composition of the hindgut. Most probiotics for monogastric animals come in the form of yeasts (*Saccharomyces boulardii*) or bacteria (*Lactobacillus spp*., *Enterococcus spp., Pediococcus spp., Bacillus spp*.), as these organisms tend to colonize the hindgut (caecum, colon), which is home to a diverse microbial community [7]. Necrotizing colitis is the most devastating gastrointestinal disease in premature piglet neonates. Still, it can be avoided by changing the initial mucosa-associated colonization pattern of formula-fed piglets through the oral administration of probiotics soon after cesarean section delivery. Throughout the period from birth to post-weaning, piglets are especially vulnerable to growth retardation and diarrhea caused by pathogenic bacteria (*E. coli, Clostridium difficile, Clostridium perfringens, Salmonella, Listeria*), parasites (*Isospora, Cryptosporidium*), or viruses (*Coronavirus, Rotavirus*). Many studies have shown the effectiveness of probiotics. Weaning has been linked to performance gains, such as those seen with *S. boulardii* [6]. According to the results, the yeast probiotic encouraged a "healthy" digestive tract by hastening the recovery from the normal thinning of the intestinal mucosa during weaning. Yeast could lead to enhanced local resistance to infection. A probiotic based on *Pediococcus acidilactici* has shown similar results [10].

Unlike terrestrial species, aquatic organisms have a far more nuanced, reciprocal connection with their immediate environment; hence this must be considered when evaluating probiotics for underwater use. Fish and shellfish have a digestive tract dominated by Gram-negative facultatively anaerobic bacteria [13]. However, the intestinal microbiota of aquatic animals can vary fast due to the introduction of new microbes from the environment and the food they eat. For animal feed, there are the 'typical' bacterial and yeast species available (*Lactobacillus, Pediococcus, Bacillus, and S. cerevisiae*). Fish eggs and larvae, fish juveniles and adults, crabs, and bivalve mollusks are all fair game, as are other live foods like rotifers, artemia, or unicellular algae [6]. Improvements in feed utilization and digestion, as well as biological control of pathogen colonization, are among the most anticipated benefits of probiotic therapies, which are also among the most researched. Disease outbreaks caused by *Vibrio spp. or Aeromonas spp.* have been acknowledged as a significant limitation on aquaculture productivity, especially in the shrimp subsector, where *vibriosis* is one of the primary diseases discovered at the present moment [5].

5 Mode of Probiotic Action

The beneficial effects seen in the various animal experiments are probably the consequence of a synergistic impact of the many pathways postulated to describe the effects of probiotics. The metabolic activities of the probiotic strains and their survival throughout the gut appear to be of fundamental importance for optimal efficacy. The strain also has a significant role in determining the results [14]. The organic acids made by bacterial probiotics can decrease the gut pH in monogastric, making the environment more conducive to the resident microbiota and reducing the chance of pathogen colonization (lactic acid or acetic acid). It has been shown that some bacteria can emit antimicrobial peptides like bacteriocins, which can halt the growth of dangerous bacteria, or that some bacteria can produce enzymes that can hydrolyze bacterial toxins. The ability of some probiotics to metabolize or help detoxify inhibitory chemicals like amines or nitrates, or to scavenge for oxygen, is crucial in the anaerobic ecology of the gut [5].

Delineating the effects of probiotics on the GIT microbiome of animals, however, requires the application of current DNA sequencing tools due to the limited culturability of the GIT's microbial flora. There was no discernible shift in the microbial communities of the chickens' GITs as measured by culture-based methods. Still, according to probiotic dose-response research, the birds' growth rates did improve [9]. The intestinal microbiota of broiler chickens was not affected by adding a commercial multi-strain probiotic (PoultryStar ME) to poultry feed at a concentration of 108 cfu/kg, although the chickens grew faster. However, the coliform level dropped when the probiotic concentration in feed was raised to 109 cfu/kg, altering the microbial communities in the caecum [6]. Two major considerations regarding the effects of probiotics on gastrointestinal microbial ecology are the apparent species-specific effects of probiotics on GIT microflora (discussed further on) and the inability of traditional culture-based techniques applied in most studies to adequately reflect the actual GIT microbial population. Considering the significant limitations of culture-based methods in distinguishing changes in microbial habitats, modern molecular identification and sequencing approaches are required to shed light on the impact of probiotics on the GIT microbiota [13].

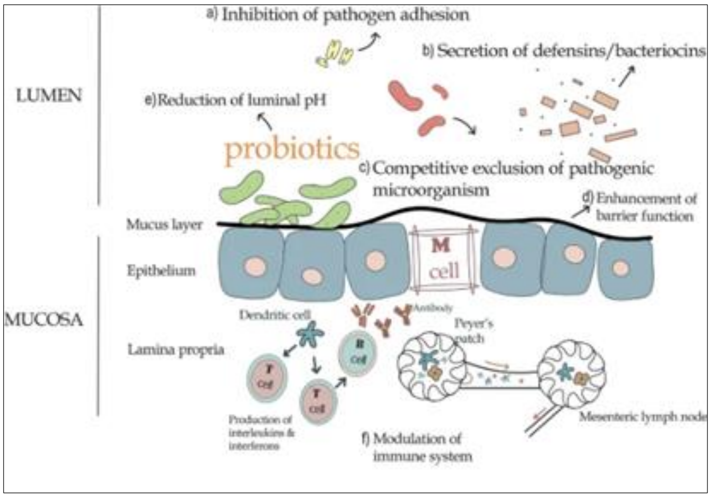

Figure 1 Probiotic mode of action with six proposed mechanisms [1]

6 Conclusion

This review article concludes that probiotic microorganisms, which have a "natural image," have a bright future in animal feed. Controlled research studies show that they can improve animals' health and production by balancing the gut microbiota. But it's important to be careful about how the probiotic strains are chosen. Future probiotic research will have to focus on how to learn more about the structure and functions of the gut microbiota, how gut microbes work together, and how they interact with the cells of the host. Pathogenic microorganisms are becoming more resistant to antibiotics because animal farming is getting more and more intense, and people are using antibiotic growth promoters without thinking. It isn't good for both human and animal health. Live microorganisms have been studied and used as probiotics and as an alternative to antibiotics used to make animals grow faster for a long time. Several probiotics have been shown to help monogastric and ruminant livestock perform better, prevent disease, and stop the spread of enteric pathogens.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares no conflict of interest.

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