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Original Article

The Roles of Probiotics in Enhancing Poultry Health and Productivity: A Review

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Abstract - *Probiotics are live microorganisms that, when fed to poultry in an acceptable amount, provide health benefits. As an alternative to the utilization of antibiotic growth promoters, the utilization of probiotics is increasing rapidly in the poultry industry, with significant growth, productivity, immunity, and gut health. This review elaborates on the common probiotic strains, their mechanism of action, and effects on growth rate, immune system, and heat stress alleviation in poultry. An efficient probiotic is characterized by its ability to exert a beneficial effect on a host, resistance to low pH, non-pathogenicity to the host, and the capacity to produce antimicrobial substances against pathogenic microorganisms. Probiotics have several health benefits, with increased growth rate, feed conversion efficiency, weight gain, and carcass quality by promoting lean muscle growth. However, the efficiency of probiotics depends on the dosage, administration techniques, and atmospheric conditions of poultry houses. Utilizing probiotics is an effective method of controlling microbial populations, pH, and gut control in poultry, so the practices of probiotics will be an efficient solution as an alternative to antibiotics. Future research should focus on probiotics use and encourage farmers to utilize probiotics for growth and production.*

Keywords - *Antibiotics, Growth, Heat Stress, Poultry, Probiotics.*

1. Introduction

The poultry sector has developed into a highly productive industry, playing an important role in supporting livelihoods and providing nutritional security to meet the increasing global demand. Animal meat production has grown by 55% over the past two decades, with poultry meat indicating the highest growth rate compared to pork or beef, reaching 34% of the total meat production in 2022, around 123 million tons [13]. This rapid expansion increased production efficiency while impacting environmental pressure, incidence of disease, and challenges related to poultry health. Antibiotic Growth Promoters (AGPs) are widely used to prevent poultry pathogenic disease and increase growth performance and feed efficiency. However, the use of dietary AGPs can pose risks, including antibiotic-resistant pathogens and drug residues in poultry products. So, looking for alternatives to antibiotics is very crucial [57]. Poultry production has faced many challenges and problems due to the outbreak of viral and microbial diseases, and the use of antimicrobial agents for preventive purposes is questionable due to antibiotic resistance. Probiotics are considered a remarkable solution to enhance bird health as an alternative to antibiotics [24].

Probiotics are live microorganisms that confer health benefits to the host when administered in an acceptable amount and have become a vital component in poultry rearing [28, 10]. Probiotics are being considered to take the position of antibiotics, and already some farmers are using them in preference to antibiotics [55, 39]. Despite the plethora of studies documenting the positive effects of probiotics, there are some limitations and gaps. Many studies focus only on individual probiotic strains or parameters such as growth rate or feed efficiency, without adequately incorporating gut health, immune response, meat quality, environmental impact, and mitigation of stress. Furthermore, there are differences in experimental design, probiotic dosage, and strain selection, which make it challenging to conclude studies.

Therefore, the objectives of this review are

- To review the most utilized probiotic strains
- To elucidate probiotic mechanisms of action
- To review the probiotic effect on growth performance, gut health, disease resistance, meat quality, and heat stress

2. Literature Review

2.1. Probiotics Used in Poultry Production

Probiotic supplementation in poultry diet started in the 1960s, while the criteria of selection for the poultry probiotics were hardly provided [47]. As the poultry industry

continues to seek alternatives to antibiotic growth promoters, the use of probiotics and other gut health-enhancing supplements has become a significantly important component of sustainable and efficient poultry production [23, 49, 50]. Feeding probiotics has been reported to have beneficial impacts on commercial animals by increasing weight gain, feeding conversion efficiency, egg/milk production, and lowering the prevalence of disease as well as mortality rates [9]. In laboratory animal experiments, mainly used probiotics are Lactobacillus, Lactococcus, Bifidobacterium, and Saccharomyces [21]. Multiple previous studies documented the benefits of probiotic supplementation in breeding commercial animals, resulting in the Feed Conversion Ratio (FCR) and weight gain, egg/milk production, and the reduction in morbidity and mortality [1, 60, 44]. A probiotic composed of Bacillus subtillus, S. galilaeus, and Sphingo bacteriaceae has been stated to improve egg production, egg quality, and broiler production, while reducing odor [51, 7]. The selection of the most suitable probiotic is significant because the favorable effects of probiotics can vary among different groups of strains based on the prevention or treatment of specific diseases. To get a potential effect from a probiotic, it is essential that the probiotic strain be introduced to an expected site in an active or viable form. The activity and viability of probiotics in the products are considered as a prerequisite for achieving several valuable health benefits [27,41]. Mainly utilized probiotic species are *Bacillus* spp. and *Lactobacillus* spp.

Table 1. Probiotic Strains and Benefits

Probiotics	Strains	Benefits	References
Bacillus Species	Bacillus subtilis Bacillus cereus Bacillus coagulans	Capable of spore forming and stable in the feed	[8]
Bifidobacterium species	Bifidobacterium longum, Bifidobacterium bifidum, Bifidobacterium animalis	Enhance immune response and reduce pathogens	[32]
Lactobacillus Species	Lactobacillus acidophilus Lactobacillus fermentum Lactobacillus jhonsonii	Enhance gut barrier reliability and short-chain fatty acid production	[52, 36, 42]
Enterococcus species	Enterococcus faecium Enterococcus faecalis	Improve gut health and inhibit pathogen	[37]
Streptococcus species	Streptococcus facium	Boost immune function	[21]
Saccharomyces Species	Saccharomyces cerevisiae	Promote gut health and enhance immunity	[43]
Propionibacterium	Propionibacterium acidipropionici	Assist in mucosal development in the gut	[21]

2.2. Mechanism of Action of Probiotics in Poultry Production

Mechanisms of action of probiotics include stimulation of endogenous enzymes, decrease of metabolic reactions that produce deleterious elements, and the creation of vitamins or antimicrobial elements [18]. In in-vitro and in-vivo systems, numerous types of probiotics are used for inhibiting infection of pathogenic bacteria through several mechanisms. Moreover, probiotics maintain normal intestinal microflora by competitive opposition and exclusion in animals [22, 26]. It increased the activity of digestive enzymes and reduced the bacterial enzyme activity and ammonia production, whereas it changed the metabolism [58]. It influences improving digestion and the amount of nutrition, also activates the immune system [5, 4, 40, 6]. Probiotics in feed enhance the host's health by maintaining the balance of gut microbes. They accomplish balance by preventing colonization of harmful bacteria in the gut through competitive exclusion. Probiotics help in digestion by breaking down insoluble fibers, naturally produce VFA and organic acids, improve nutrient absorption and metabolism, and lower the pH of the gut to prevent the effect of pathogenic bacteria like Salmonella spp. and Escherichia coli. Abundant studies have documented that probiotics have the capacity to boost the immune system, and administration of probiotics increased humoral and cellular immune responses by enhancing the production of T cells, CD+, B cells, and anti-inflammatory cytokines [34]. The efficacy of probiotics in poultry production may be influenced by several factors, including the following.

Table 2. Efficacy of Probiotics

Parameters	References
Probiotic strain and dose	[17]
Timing of administration	[3]
Diet and environmental conditions	[20]
Host factors: age, genetics, and immune status	[21]
Interaction with other feed additives	[35]

2.3. Effects of Probiotics: Preventing Bacterial Entry to the Host

Intestinal gut microbes are kept in check by probiotics, which are essential for the animal's growth, production, and efficient feed conversion, as well as for stimulating immunity to fight against diseases. Effective probiotics have been shown to accelerate the formation of a normal microbial population in chicks and poults [14].

2.4. Effects of Probiotics on Poultry Growth Performance and Gut Health

Probiotic feed supplementation on broiler diet improves growth, feed efficiency, and intestinal health of poultry [15, 46]. The effect of probiotics in dietary supplementation and increased growth has been significantly studied in different experiments and reviews. Most of the studies stated that probiotics remarkably increased the growth rate of poultry. This improvement is achieved by reducing intestinal pH, intestinal bacteria composition, and digestive activity. Inclusion of Lactobacillus in the broiler diet resulted in a higher broiler productivity index, which is measured based on daily weight gain, feed conversion efficiency, and mortality rate. Administration of Lactobacillus species reduced the mortality rate, whereas it improved the growth rate. Furthermore, probiotics supplementation to the poultry diet improved feed intake, conversion efficiency, and carcass yield of broilers [48. 54]. On the contrary, through stimulating the immune response, probiotics increase the resistance to colonization of bacteria [18]. The use of Enterococcus faecium in chicken feed had a significant antibacterial effect on the bacterial microbial population in the small intestine [31]. Similar studies documented that providing Streptomyces sp. and Bacillus subtilis had a substantial effect on the intestine [30. 59]. Furthermore, an experiment compared B. subtilis with enramycin, widely used as a feed additive for chickens to prevent necrotic enteritis [59].

2.5. Effects of Probiotics on Poultry Meat Quality

Probiotics have positive effects on poultry meat quality [18]. The probiotics affect the protein and fat contents of meat and thus the meat quality. Abdurrahman *stated that* feed quality deteriorates due to lipid oxidation of fat [2]. This assumption was confirmed by other studies that documented the utilization of *Aspergillus awamori* and *Saccharomyces cerevisiae* in chicken feed decreased saturated fatty acids in blood, and polyunsaturated fatty acids increased [45]. Other comparable research reported that administration with *Bacillus licheniformis* remarkably induced the protein content and essential amino acids. Feed incorporation with *B. licheniformis* enhances the meat color, tenderness, and flavor of broiler chickens [33]. These factors have a significant impact on consumer choice, demand, and appreciation, especially the color.

2.6. Anticoccidial Effects of Probiotics

Administration of probiotics may reduce the effect of parasitic infestation on chickens in the absence of anticoccidial activity. The administration of probiotics exerted a coccidiostatic effect against Eimeria tenella, impacting the minimization of risk, spread of coccidiosis, and maintaining intestinal health [15].

2.7. Effect of Probiotics on Disease Resistance

In poultry, probiotics contribute to disease resistance by enhancing the immune system and protecting gut microflora. These live, non-pathogenic microorganisms promote overall health and well-being, which ultimately stimulate immunity and production performance [17]. The efficacy of probiotics against common poultry pathogens, including *Salmonella* spp., has been well documented, as they inhibit pathogen colonization in the gastrointestinal tract. Probiotic supplementation has also been shown to reduce the presence of *Clostridium perfringens* and *Escherichia coli*, leading to improved growth performance, feed efficiency, disease resistance, and overall health. These outcomes highlight the significant positive influence of probiotics on the poultry gut microbiome [16].

2.8. Effect of Probiotics on Heat Stress

Atmospheric temperatures are increasing rapidly due to climate change. This increased temperature has a significant impact on heat stress in livestock and poultry production. Heat stress may be defined as an increased temperature and humidity above the peak estimates, making it harder for birds to regulate their body temperatures through adaptation [29]. In recent studies, it has appeared that feed additives containing Lactobacillus pentosus ITA23 and Lactobacillus acidophilus ITA44 had a progressive effect on growth rate and Feed Conversion Efficiency (FCR). Provision of selenium, L. acidophilus, and S. cerevisiae separately in the diet of poultry did not effectively improve bird health. Supplementation of selenium diets with the addition of a probiotic showed the best effectiveness in reducing heat shock proteins [25]. Effects of probiotics for hens can vary based on the microbiological composition of species, diet,

dosages, linkage with other additives, and environmental stressors [38]. To minimize the detrimental effects of heat stress, specific management techniques have been implemented. Management practices that were used included the provision of cold water in houses, increased ventilation rate, feeding the birds in the morning and night when temperatures are low, and supplementing with potassium chloride to stimulate water intake in birds [19, 56].

3. Prospects

Due to the increased awareness among consumers, it has strongly forced poultry producers to reduce the use of antimicrobial feed additives. As a result, probiotics have become excellent intervention techniques for the spread of pathogenic bacteria [14]. At present, controlling and preventing the spread of pathogenic microorganisms among poultry breeders is a significant focus. In the upcoming days, the feed additive industry will provide more concentration on the maintenance of normal microflora in digestive systems, more precisely, efforts on strain selection and administration of doses, but problems associated with changing environmental conditions of animal husbandry. For investigating the interaction between specific bacterial strains, future research is highly crucial. Metabolites produced by interactions may have toxic effects from the metabolites produced during interactions. This phenomenon happens when the incorporation of *Clostridium Perfringens* occurs, which destroys even closely related strains [53]. Therefore, bacteria live in a symbiosis process in which metabolites of one strain have a positive effect on another type of bacteria, contributing as a nutrient source for bacteria. To create balance in the digestive tract of birds, symbiosis is a cross-feeding phenomenon for bacteria to live. To utilize the remarkable effects of probiotics, treatment with simple alternatives to antibiotics is strictly prohibited. The significant correlation among host, microorganisms, and feed must be considered [12].

4. Conclusion and Recommendation

Antibiotic resistance is becoming an alarming issue nowadays, and the use of antibiotics for the growth rate in the diet of poultry indirectly affects the human body. In poultry rearing, 70% of the total cost accounted for feed cost. This balanced diet is crucial for maintaining gut health and productivity. From this point of view, probiotics have received greater attention for use as an alternative to antibiotics. Probiotics are live microorganisms that confer health benefits to the host when administered in appropriate amounts. So, using probiotics rather than other growth promoters provides better gut health benefits and production of meat and eggs in poultry. Their consumption as nutritional supplements in poultry diets is expanding due to their health-promoting effects, such as increasing growth, improving egg production, fortifying the immune system, and enhancing the health status. In many developing countries, probiotic use is limited in poultry production, and it is an alarming problem for antibiotic resistance. Depending on the above conclusive remarks, the following elements are forwarded as recommendations:

- More research should focus on the advantages of supplementing poultry with probiotics.
- Awareness campaigns to people and farmers on the use of probiotics in poultry production should be motivated.
- Government and private sectors should take steps to establish the use of probiotic feed processing for the improvement of poultry products and the welfare of animal and human health.

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