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Effect of Probiotics (Direct-Fed Microbials) in Poultry Production: A Comprehensive Review

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Abstract

Probiotics are live microbial feed supplements that assist maintain the intestine's microbial equilibrium. A probiotic is a culture of a single bacterial strain or a mix of different strains that were made to help chickens get better from illnesses in their intestines. These bacteria, as well as fermented dairy products like yogurt and cultured buttermilk, are the main sources of probiotics. Antimicrobial properties, tolerance to low pH and bile salts, attachment to and colonization of the intestinal epithelium, as well as nonpathogenicity, are all characteristics of a good probiotic. Furthermore, it boosts immune responses, helps chickens grow and produce more eggs and meat, and enhances the quality of meat and eggs. Thus, probiotics are expected to meet a need in the chicken industry caused by pathogenic bacteria infections and antibiotic resistance, as well as environmental conditions that cause significant obstacles and financial losses in a lot of places. The researchers of this study investigated the favorable effects of probiotics in chicken production as customer tastes shift toward antibiotic- and feed-free animal products.

Keywords: Probiotics, Poultry, Microorganisms, Microbial Flora

Introduction

Probiotics were first defined by Lilly and Stillwell in 1965 as “substances released by a microbe that encourage the development of another”(1) and "live microbial cultures that positively influence the host by enhancing its gut microbial balance" was added to the definition by Fuller in 1989. (2,3)According to Russian scientist and Nobel Laureate Elie Metchnikoff; the long and healthy life span of Bulgarian peasants was due to their intake of fermented milk products at the end of the 20th century. When Lactobacillus was consumed, he felt it had a favorable effect on the gut microflora, reducing the harmful activity of pathogenic bacteria. An animal probiotic, also known as a direct-fed microbiota, is any culture of one or more bacterial strains that may be provided to an animal to enhance its health(4). Probiotics in chicken have been studied using a wide range of microorganisms, some of which have never been seen before. Many experiments employing direct-fed microbials have been aimed at preventing chickens from being infected with diseases in their digestive tracts. Sixth, probiotics have been shown to lessen the occurrence or alleviate the symptoms of a variety of illnesses that are caused by a malfunctioning immune system(5). However, the precise mechanisms by which probiotics suppress the gut's epithelial and immune cells are still unknown. The immune system is boosted by probiotics, and they may also be utilized to prevent sickness. Selection of the most appropriate probiotics for certain illnesses will be critical to their application in the prevention or treatment of specific diseases. A promising probiotic strain must be transported in an active and viable state to the

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appropriate places to exercise its beneficial impact. Several health benefits may be achieved with the viability and activity of probiotics in the goods. (6,7)

The Probiotics' Etymology

While researching "lactic acid bacteria" in fermented milk products and their application to prolong lifespan and maintain young vigor in humans, the idea that gut bacteria played a role in maintaining health was considered (8). One type of bacteria was shown to compete more aggressively for receptor sites in the digestive system than another species, even though neither human nor food animal maggots were included in the study(9). Only when the usual microflora in the intestine was reduced or eliminated could S. Typhimurium persist. Many terminologies have now been coined to express the notion of competitive exclusion using specified probiotics or undefined combinations derived from adult poultry. Fecal and caecal contents have been utilized in various European nations to prevent chickens from competing with each other (10). Probiotics have grown more dependent on the usage of specified cultures in recent years. Before the discovery of these products, there were various Probiotics with either a single or multiple organism composition available. (11) The in-ovo and ex-ovo usage of Lactobacillus reuteri demonstrated the product's unique ability to be administered directly to chickens(12).

Probiotics' Original Providers

Microorganisms

As well as strain, age, host specificity, dosage rate, and the bird's physiological and nutritional status, probiotics' survival and stability are all reliant on the host's genetic make-up. While the crop and proventriculus and gizzard contain fewer bacteria than the small intestine, lactobacilli, streptococci, and anaerobes such as Bacteroides and Bifidobacterium species may all be found in the small intestine in significant quantities. Probiotics colonize the enterocyte, cecal, and colonic epithelium of the gastrointestinal system (GIT).(13,14)Lactobacillus, Bifidobacterium, and Enterococcus are three of the most often used probiotic bacteria in human nutrition. Lactobacillus, Lactobacillus acidophilus, and Lactobacillus rhamnosus are more efficient against yeasts such Saccharomyces cerevisiae in pigs and poultry. (15,16)

Probiotics from Other Resources

Milk products, such as cultured buttermilk and cheese, are a typical source of probiotics due to their low pH environment, which promotes the growth of probiotic bacteria. In the nineteenth century, lactic acid bacteria, Bifidobacteria, and other germs were isolated from fermented milk products. Helpful bacteria have been used in fermented dairy products for many generations in Mongolia and Africa, where spontaneous milk fermentation is a long-standing tradition. Probiotic strains are present in lactic acid bacteria-rich traditional fermented milk such as kefir and kimchi. (17) Non-dairy fermented substrates such as soy-based goods, cereals, legumes, cabbage, sorghum, and pearl millet all contain probiotics in addition to those found in dairy products. (18,19) Probiotics are also present in breast milk,

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the human digestive system, and the digestive tracts of a range of animals, including pigs and rats. The latest research has examined traditional fermented foods to see if they may be utilized as natural sources of probiotic microbes. Lactobacillus is the most often seen genus of microorganisms in fermented foods. (20-22)

The poultry industry's probiotic choosing guidelines

There are several factors to consider when picking probiotic strains besides health benefits such as the strain's capacity to survive in the digestive tract and colonize the host. (23)

1. Low pH and bile salts resistance

Appropriate probiotic strains must have a high degree of acid tolerance to survive and function well. Probiotic strains vary in their survival rates in distinct regions of the gastrointestinal tract. Bacteria such as Lactobacillus acidophilus and Bifidobacteria may pass at very high percentages across the whole digestive system. Probiotic organisms have been demonstrated to survive in vitro and in vivo throughout the stomach transit when the cells are exposed to an acidic environment, as shown by various studies For instance, probiotics' acid and bile salt resistance are very species- and strain-specific (24). To determine bile resistance, bacteria are suspended in Man, Rogosa, and Sharpe (MRS) broth (created in 1960 by de MRS) containing 0.2 percent and 0.4 percent bile salts, respectively. Following that, the soup will be poured into three different tubes. As a control, MRS broth without bile salts is used, while the other two tubes contain 0.2 percent and 0.4 percent bile salts, respectively. Finally, determine their optical density at 540 nm using a spectrophotometer (25)

2. Assimilation into the Intestinal Epithelium

The ability of probiotic bacteria to stick to intestinal mucus and epithelial cells to colonize the intestinal epithelium has long been believed to be a critical selection requirement(26,27). As a consequence, probiotic cells' adherence to the intestinal mucosa may keep them from washing away, enabling temporary colonization and immunological control, as well as pathogen competitive exclusion. The probiotic strain must colonize and survive to provide a source of enzymes and natural antibiotics. (28) Harmful bacteria are projected to attach to mucosal surfaces and modify the digestive tract's microbiota as a consequence of an intestinal infection. Probiotic bacteria may cling to and colonize mucosal surfaces as a result of their offense and defense activity, successfully competing with pathogens for binding sites, nutrition, and immunogenic activation. (29-31)

3. Probiotics' Antimicrobial Effects

When making probiotic supplements and probiotic-rich foods, the probiotic strain needs to be capable of generating antimicrobial chemicals. When probiotics are administered in enough amounts, they benefit the host's health (32) Probiotics may exert antimicrobial activity in a variety of ways, including by synthesizing antibacterial chemicals, competing with pathogens for resources and adhesion sites, and activating immunity. Among the antimicrobial metabolic products generated by lactic acid bacteria are organic acids, fatty acids, hydrogen peroxide,

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and diacetyl. However, the bulk of research is directed on bacteriocins or proteinaceous substances that provide antimicrobial activity across closely related species. (33-35)

Probiotic Effect Pathways

Increased resistance to colonization or direct pathogen inhibitory effects are essential components of probiotics' capacity to reduce sickness frequency and duration. Numerous probiotic strains have been shown in vitro and in vivo to decrease harmful bacteria in several ways. Probiotics have the following effects on poultry:

(1) To maintain a healthy gut microbiota, competitive antagonism and exclusion are used. (36).

(2) changing metabolism by increasing the activity of digestive enzymes and lowering the activity of bacterial enzymes and ammonia production (37).

(3) facilitating digestion and nutrient absorption(38), and (4) recharging the immune system(39) Probiotics are effective against zoonoses and common poultry diseases. Competitive exclusion in chickens under typical conditions reveals the consumption of intestinal bacteria that are normally found in poultry and chicks ready to be placed in a brood of chicks' nest. (40-42) This originally came to light during a campaign to remove Salmonella infantis from Finnish broilers. They discovered that only a small amount of Salmonella (1-10 cells per culture) was sufficient to cause salmonellosis in chicks(43). Additionally, scientists discovered that the first week after hatching is the most sensitive period for chicks to contract Salmonella infection. It has not been demonstrated that consumption of Lactobacillus species provides protection. As a result, they wanted to ascertain the uncontrolled quantity of Salmonella infantis-resistant intestinal bacteria in adult chicks(44). This was dubbed the Nurmi approach or competitive exclusion. Inoculating one-day-old chicks with cultivated microflora and observing their intestinal function and illness resistance indicates the influence of intestinal bacteria on intestinal function and disease resistance(45). While competitive exclusion fits the concept of probiotics, this strategy provides produced intestinal microorganisms rather than supplementing the microbes developed for each chick with one or more bacterial species. Inoculating one-day-old chicks raised by competitive exclusion or with more conventional probiotics provides an excellent model for evaluating the activity and effectiveness of these bacteria(46). This is also commercially relevant, as one-day-old chicks are susceptible to illness. Marwi et al demonstrate using this model that certain probiotics may aid in the reduction of Salmonella and Campylobacter colonization and transmission (47)Probiotics deliver a considerable amount of acid lactic bacteria to the digestive tract at the rate at which they are consumed. These bacteria are in charge of controlling the intestinal environment and supplying the intestines with enzymes and other useful compounds.(48) Supplementing chicks with Lactobacillus acidophilus or a mixture of Lactobacillus cultures significantly (P 0.05) increases amylase levels after 40 days of feeding. Supplementation with probiotics (a mixture of Lactobacillus and Streptococcus faecium species) improves glucose activity in the small intestine of pigs. Lactobacillus colonizes the intestine and may produce

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enzymes that increase intestinal amylase activity. (49-51) Probiotics have been found to alter the intestine's pH and bacteria, enhancing the action of intestinal enzymes and digestion. Additionally, probiotics have been shown to reduce ammonia production in the intestines, hence benefiting avian health. (52) The term "probiotic" refers to a broad category of goods that contain yeast cells, bacterial cultures, or a mix of the two, in which microorganisms are stimulated to alter the intestinal environment to improve health status and nutritional function. Probiotics improve FCR function by altering the intestinal flora, stimulating the growth of anaerobic and gram-positive bacteria that produce lactic acid and hydrogen peroxide, limiting the growth of intestinal pathogens, and improving nutrient digestion and absorption.(53-55)

The Effects of Probiotics on the Microbial Flora's Diversity and Metabolic

The human digestive system's microbial flora is largely consistent, however, it differs from person to person. (56) Even yet, probiotics administered to infants and adults affect the microbial makeup and metabolic activity of feces. When these adjustments are given in pathogenic settings, they are often sufficient to repair the disease. Probiotic administration increases the number of Bifidobacteria and Lactobacillus, decreases the pH of feces, and impairs the action of bacterial enzymes in certain circumstances. (57)

Multiple Factors Influencing the Probiotic Advantage

The interactions between a microbial addition and the microflora of the host's digestive system have a wide range of effects. Several variables that contribute to this result are discussed in detail below(58)

1.QA (Quality Control)

The ability of a probiotic product to survive is critical. However, the quantity of live microorganisms is not necessarily the same as the amount listed on labels. Another confusing element is the range of strains that may exist within a single species. Consumption of two probiotics derived from equal and same bacterial species is likely to result in inconsistency. When comparing two probiotic products that contain the same species, it is critical to determine if the cultures used to make one probiotic product come from the same strain. (59,60)

2. Mode of Utilization

Experiments on rats and people show that stopping probiotics does not influence their positive benefits. Similarly, probiotics are not identified in the digestive tracts of pigs or poultry seven days after eating. (61)

3. the animal's age and species

It is critical to remember that the microbiota, physiology, and immunological status of animals vary throughout their lifetimes. As a basic rule, it is simpler to influence the flora during childhood than it is later in life since the flora becomes more fixed. As a consequence, probiotics should be started immediately after delivery. This particular period may also see

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alterations in the content of one's meals(62,63). During weaning and the introduction of formula or solid meals, the flora of an infant's digestive tract changes. Milk has been shown to include an ingredient that stimulates Bifidobacteria development and may alter the response to probiotics containing these organisms after they are ingested. Based on the diet, Lactobacillus acidophilus-containing additives may impair enzymatic activity. Although no such effect was shown in rats given a meal of seeds, a favorable response was observed in rats provided with a meat-based diet. (64)

4. Gastrointestinal Flora Distribution in the Animal Host

Probiotics may influence by altering the makeup of bacteria in the host's stomach. According to this viewpoint, the existence of bacteria that cause damage, such as decreased growth, is required for a favorable reaction to the consumption of a probiotic ingredient. As a result, in the absence of a growth-debilitating bacterium, probiotics may have no impact(65,66). Similarly, if the probiotic bacteria is acquired naturally, there will be no reaction to supplementation. The necessity for probiotic supplements originates from the abnormal lifestyles that people and animals are subjected to nowadays. A bird whose eggs have been taken from a brooding hen and placed in a clean incubator is an excellent example of this (67).

5. Product Classification

When taking probiotics daily, the formation and growth of probiotic bacteria may be less critical due to the number of probiotic bacteria already existing in the digestive system(68). When Aspergillus oryzae probiotics are utilized, they must function in this manner, as they are unlikely to multiply or modify rumen metabolism. However, even if probiotics are designed in such a way that they do not require regular ingestion, optimizing their survival in the digestive system and conducting tests on the aforementioned strains may be critical in selecting the most effective strains. (69)

6. Methods of production

Attachment to mucous may be influenced by an organism's growth and harvesting techniques; for example, the energy supply of carbohydrates required for growth or the availability of milk at attachment sites might impact behavior. E. faecium in milk increases pigs' resistance to E. coli-caused diarrhea(70). As a consequence, probiotic microbes floating in milk may have a higher chance of establishing themselves in the digestive tract. Furthermore, the stage of life at which the probiotic organisms are gathered may influence their capacity to stick to the mucosal cell(71-73).

Conclusion

Antibiotic resistance and illness outbreaks have recently raised major worries about the future of chicken farming. As a result, the trend among chicken producers and owners these days is toward natural things. Probiotics have since been extensively researched for their potential value as dietary supplements. Probiotics may be a useful technique for avoiding diarrhea

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caused by harmful and contaminated microorganisms. Numerous study publications have shown their beneficial effects on human and animal health. As more information regarding probiotics' therapeutic effects becomes available, they are increasingly being utilized in common medicine to treat gastrointestinal diseases. The main probiotic families are Lactobacillus and Bifidobacterium, however, Pediococcus, Bacillus, and yeasts all have probiotic potential. Numerous studies have been conducted on the function of probiotics as a potent growth promoter, immunomodulator, antidiarrheal agent, and product quality enhancer, to mention a few beneficial features. Finally, commercial use of probiotics in chicken production has continued since there is no danger connected with the use of well-defined probiotics and various benefits are possible.

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