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A REVIEW OF PROBIOTIC APPLICATIONS IN POULTRY: IMPROVING IMMUNITY AND HAVING BENEFICIAL EFFECTS ON PRODUCTION AND HEALTH

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Abstract: A new class of feed additives and nutritional supplements, known as probiotics, include bacterial, fungal, and yeast cultures from various sources. Overall, probiotics are believed to promote the health and well-being of animals, birds, and humans in a variety of settings. Incorporating probiotics into the diets of cattle and poultry has been demonstrated to improve growth, feed conversion efficiency, immunological responses, and the animal's ability to manage enteric infections. The use of probiotic-enriched chicken feed has been shown to enhance egg production by as much as 30% among laying chickens. Probiotics may be used to fight off harmful microorganisms, create antibacterial compounds (such as bacteriocins or colicins), and alter the immunological response of the host, according to the National Institutes of Health. Pathogenic microbial strains such as *Lactobacillus*, *Streptococcus*, *Bacillus*, *Enterococcus*, *Pediococcus*, *Aspergillus*, and *Saccharomyces* are employed in the making of chicken products. The use of subtherapeutic doses of antimicrobial agents, including antibiotics, to combat or remove harmful bacteria and promote animal growth and feed efficiency has resulted in the accumulation of antibiotic residues in animal feed as well as the emergence of drug-resistant microbes in the feed supply chain. As a result of public health concerns, there has been a renewed emphasis on the use of probiotics in chicken production rather than antibiotics in recent years. This research examines the effects of probiotics and direct-fed microorganisms (DFM) on chicken health and performance, with a particular emphasis on the favourable effects they have on poultry health and performance.

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Keywords: Probiotics, Poultry, Production, Health, Immunity

1. Introduction

During the past few decades, poultry farming has developed into a profitable sector in the United States. India is one among the world's top five producers of eggs, broiler chicken, and other poultry meat, according to the United Nations Food and Agriculture Organization [49]. Chicken feed accounts for more than 70% of total production expenses, making its evaluation important to the company's long-term profitability. As a result, it is critical to maximize feed efficiency while keeping expenses as low as possible [2]. Keeping in mind that new chicks have interaction with their mother and acquire microflora from the environment, the normal microflora colonization in the intestine is slow and chicks may become infected during this

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period; as a result, the concept of probiotic products intake, which is extremely beneficial, emerges during this period [32]. Because of the high demands of production, broiler chickens are subjected to a range of stressors, many of which have a detrimental influence on their general health and productivity. Under these conditions, the use of synthetic antimicrobials and antibiotics to decrease stress while simultaneously increasing growth and feed efficiency is common practice. Since the discovery of antibiotic residues and the emergence of antibiotic-resistant bacteria, the use of subtherapeutic antibiotics in chicken feed has been a prohibited in Europe [32, 43].

The term probiotics was coined as a consequence of the Greek phrase "pro bios," which translates as "for life," and refers to bacteria that are beneficial to the body. The stomach would immediately colonize it if it were a good germ, which would block the proliferation and spread of hazardous germs, and therefore prevent them from inflicting any damage. Animals, birds, and the ecology all benefit from the work, in addition to the individuals who do it. Probiotics, on the other hand, have been shown to increase livestock overall health while also boosting feed conversion and immune responses in cows and poultry. The addition of probiotics to animal feed has been shown to be both safe and effective in terms of stimulating growth in poultry birds [11]. There are various microbial species, such as *Bacillus*, *Bifidobacterium* and *Lactobacillus*. *Bacillus and Enterococcus* species are more often used in animal research rather than *Lactobacillus and Bifidobacterium* species which are more commonly used in human investigations [53]. The bacteria *Lactobacillus* has also become more used in the treatment of animals in recent years [44]. The use of probiotic supplements, which include bacteria such as lactobacilli, streptococci, and *Bacillus* bacteria, has been demonstrated to be useful in a study. The mechanism of action of probiotics has been the subject of various hypotheses [48]. The injection of probiotics to a bird's digestive tract promotes the microbial ecology of the tract, which helps to eliminate illnesses from the system. Bacterial adhesion and development in the intestines are a competitive endeavor for probiotic microorganisms. As a result, good bacteria colonize the gastrointestinal tract quickly and helps in fighting against harmful bacteria. Competition for resources, the creation of primary and secondary metabolites (antibacterial compounds), and the activation of the immune system are all factors that influence bacterial activity [50].

The use of probiotics in animal feed may aid in the improvement of the animal's gut flora balance as well as its growth performance. It is possible to distinguish two populations of microorganisms in a poultry's digestive tract: those that have colonized the gut as a result of natural exposure and eating, and those that have been introduced to the diet *via* feed or water as direct-fed microorganisms (DFM) or probiotics. Each of these communities of microorganisms plays a critical function in maintaining the health of chickens. As a result of exposure to the environment and the bird's normal feeding habits, autochthonous and allochthonous bacteria colonize the bird's digestive system and cause it to malfunction [23]. To obtain desired health and production goals, a number of criteria must be considered while choosing and delivering probiotic microorganisms [41]. Several *in vivo* and *in vitro* studies have shown that the administration of probiotics may be beneficial in the prevention and treatment of the onset of various diseases. Having a healthy commensal gut microbiota helps to keep infections under control, but if it is disturbed, then body will more likely to become ill. As a result, there has been a rise in the use of certain probiotic cultures in the chicken industry, with the goal of enhancing production while also improving animal welfare [32, 38]. This review aims to summarize the current knowledge about the colonization of probiotics in a host's gastrointestinal tract, as well as their beneficial effects on bird immunity, poultry production, and health, as well as their capability of altering a host's productivity in a direction that is more favorable to them.

2. Probiotics' historical development

Following the findings of recent research, chickens may be permitted to forego antibiotics for the first time in their lives in 1930s. Several studies have shown that fermentation of milk products may extend human life and increase vigor in experimental animals, according to Elie Metchnikoff [47], who was the first to suggest that gut bacteria are important in health maintenance. According to the findings of many research, gut bacteria play an important role in the prevention of gastrointestinal disorders. "Probiotics" is said to have originated from the Greek word "pro bios," which translates as "for one's own well-being" or "for one's own benefit." Inventors Lilly and Stillwell [45] came up with the notion of "creative appropriation" and are credited with coining the term "probiotics," which means "friendly bacteria." 'Live microorganisms' are defined as "probiotics" by the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO), which affect the host's intestinal microbiome by promoting the maintenance of an optimal microbiome balance, preventing pathogens from growing and providing health benefits to the host. The term "probiotic" refers to living bacteria that, when consumed in sufficient quantities, have an effect on the host's gut microbiota and are consequently beneficial to the host. Put another way: "live microbial feed additives that benefit

the host by enhancing gut microbial balance" are what probiotics are and have been suggested for use in cattle for many years [42]. If probiotics are only a single bacterial species or a mix of numerous distinct species, the composition of the probiotics is determined by the bacterial strains that are used. It is commonly used in the treatment of diarrhea and other ailments to use probiotic microorganisms, which are strains of lactic acid-producing bacteria that may adhere to the intestinal epithelium and repair diarrhea and other difficulties. A distinct species of bacteria is considered by some to exist in comparison to other microbes [38]. In light of the possible dangers to human health and safety posed by the use of antibiotics in poultry production, finding a viable alternative to antibiotics in poultry production is now more important than it has ever been [32].

3. Criteria for a perfect probiotic

In order to be deemed successful, a probiotic product must include a substantial number of live bacteria that are capable of surviving in an unfavorable intestinal environment, such as that created by pH variations. A healthy microbiome should include bacteria that are not hazardous to humans, as well as strains that are peculiar to a particular host or environment. Because probiotics have a limited shelf life, they must be gathered as soon as possible. Among the characteristics that these bacteria must possess are the ability to quickly and efficiently attach and remove potentially harmful germs as well as the ability to drive away potentially dangerous pathogens in order to guarantee long-term survival in the gut microflora community [3]. In the future, it is envisaged to be able to develop a more effective antibiotic as well as greater control over the immune response. A probiotic's stability throughout the manufacturing process, as well as during processing and storage, is dependent on the presence or absence of antibiotic resistance genes. During the process of adding starter culture, it is essential that they are not recombinant at any time throughout the manufacturing process. It is also critical that they are fully safe to use and do not cause any bad side effects.

4. Microbes are commonly used as probiotics

Alive and infectious bacterial strains of *Bacillus, Streptococcus, Bacillus* and *Enterococcus* bacteria are often used to supplement the cattle and poultry. Cattle and fowl are also treated with *Saccharomyces*, a kind of yeast. Bacteria that produce lactic acid, has a good effect on hens' performance, are extensively utilized in this business, as are strains of these bacteria. As a treatment for antibiotic-resistant infections, *Lactobacillus* and *Bifidobacterium* strains have been shown to be the most potent bacteria. "Direct Feed Microbials (DFM)" was developed to define these organisms in acknowledgement of the fact that probiotics may also comprise fungus and yeast. One or a combination of microorganisms that are regarded harmless are often included in probiotic supplements. In terms of probiotics, *Lactobacillus* bacteria-derived ones are the most common. Due to their high resistance to pelleting temperatures and storage conditions, sporogens of yeast and *Lactobacillus* have been found [5].

5. Probiotics in poultry applications

In order to maintain a steady bacterial population in the avian gut, which is crucial for proper immunological function and feed conversion, probiotics are an important supplement. Among the many reasons why probiotics are beneficial in chicken farming include their ability to maintain a healthy gastrointestinal microbiome, increase nutrient uptake, and reduce ammonia generation [32, 38]. Chicks and poults have been shown to benefit from the use of effective probiotics [11]. *Salmonella* infection in birds may be prevented and treated with probiotic spray treatments even in chicks. Improved egg production, weight/size, and food uptake ratio may assist enhance the performance of layers and turkeys by adding probiotics to diet [4, 32, 38]. Cholesterol levels in chicken blood, egg yolks, and yolks are reduced, as is broiler limb weakness, as a result of lactic acid uptake.

6. Gastrointestinal tract probiotic colonization

Creating and maintaining a healthy microflora in the bird's digestive system is essential, as it helps to remove dangerous bacteria from the digestive tract. Chicks' stomachs are sterile when they are hatched, but they begin acquiring germs from the surroundings as soon as they are old enough approximately after 7 to 10 weeks. During this time, bad germs are more likely to spread than helpful bacteria, which means chicks are more likely to get ill. A balance between beneficial and detrimental bacteria is established as the days pass after hatching. Because of this, probiotic supplementation becomes a viable option when the balance between these two is disrupted by external or internal factors like viral pressure or stress [6]. For probiotic colonization to be successful, factors such as microbial stability and long-term interactions with hosts, as well as dose and frequency of usage, must all be considered. colony forming units (CFU) are used to measure

colonization in the beak and colon (CFU). 10^4 to 10^8 CFU/ml (lactobacilli, streptococci and enterobacteria) are found in the digestive tract, which serves as a reservoir for a range of anaerobic bacteria. Between 10^{10} and 10^3 CFU/ml, the colon and caecum are awash in bacteria A study published by Heczko et al. [39], found that some prebiotics may be found attached to particular feed particles (such as starch granules), whereas others reside fully in the digesta's watery matrix. There are many places where germs may thrive in chickens and the mucous membranes that coat the epithelial lining of intestinal villi and the caecal and colonic surfaces are among them. Mucus and epithelial cell adhesion is key selection criteria for a prospective probiotic. Lactobacilli may be found in all parts of the digestive system, either on the surface of the epithelial cells or growing in meal ingredients [7].

7. Continuing to improve digestion, nutrient metabolism, and nutrient utilization

In addition to supplying digestible proteins as well as vitamins, enzymes, and other cofactors, lactic acid generation by probiotics aids in the enhancement of digestion, nutritional metabolism, and nutrient utilization. This product's amylase, protease, and lipase content help improve the digestion and absorption of carbohydrates, protein, and fat in the feed, resulting in an improvement in the efficiency of the feed conversion process [8]. It is probiotics that help with mineral and vitamin absorption and synthesis (biotin, Vitamin-B1, Vitamin-B2, Vitamin-B12, and Vitamin-K), which are essential for proper development and metabolism [32]. In probiotic bacterial consortia, the facultative anaerobes Bifidobacterium and Lactobacillus, two forms of facultative anaerobes that diminish the intestinal redox potential, make it easier for obligatory anaerobes to proliferate. When yeast releases enzymes into the environment, it is possible that dry foods will be more readily digested. According to Dhama and Singh [32] the influence of *Aspergillus oryzae* on macronutrient metabolism may be beneficial to laying hens. To have a better understanding of the digestion process's mechanism of action, it is necessary to investigate digestive enzymes and microbial metabolites that are utilized as probiotics [9].

8. Management of harmful pathogens and disease conditions

Various stressors and pathogenic bacteria found in every animal and poultry raising unit have the potential to disrupt the gut microbiota, which may result in the lowering of the body's defenses as well as an imbalance in the gut microbiota [10]. Diarrhea and a lack of appetite are just a few of the symptoms that may occur as a result of bacteria growing in the host's digestive tract. As a result of the eradication of the natural microbiome, the efficiency and immunocompetence of chicken production will be diminished, resulting in considerable economic losses for poultry producers. It is recommended that a probiotic supplement be added in the animal's feed on a regular and timely basis in order to maintain the animal's microbiota's health and balance [12].

Competitive exclusion is a word that refers to a phenomenon that occurs when pathogens and probiotics compete for gut adhesive receptors, which are required for microorganism attachment and growth. In this approach, probiotics have an effect on the colonization of diseases by bacteria. The rapid colonization of the gastrointestinal tract makes it impossible for pathogens to establish themselves there (the creation of a thick layer of microflora). A list of antibacterial substances that can be found in the body such as bacteriocins, lactocin, lactocidin, acidophilin, reuterin, lactic and acetic acids, lactoferrin, and lactoperoxidase. Probiotics assist in neutralizing and/or absorbing the enterotoxins produced by pathogenic bacteria by releasing anti-enterotoxin molecules into the environment. Toxins, such as mycotoxins, have been detected in significant concentrations in animal feed [13]. Due to their superior colonization abilities in the gut, probiotics effectively prevent pathogens from gaining access to resources by making the best possible use of the substrate that is accessible to them. It is possible that the use of probiotics may assist to minimize litter ammonia creation, which in turn will help to lower the risk of keratoconjunctivitis, which is an eye illness caused by an excess of ammonia in the surrounding environment. According to a recent study, boosting the apoptosis of bacteria in the probiotic culture may help to minimize the risk of *Salmonella* infection in humans [40]. As a result of their intestinal microbiota, intestinal epithelium, and immune system, birds exhibit both passive and active resistance to enteric infections [38].

For the time being, we don't know how probiotics produce their positive effects. "Competitive exclusion" and "bacterial antagonism" are two putative mechanisms for probiotic bacteria to prevent viruses from entering the digestive system (such as intestinal villus and colonic crypts, which are favorite sites of enteric pathogens). A main goal of probiotics is to prevent infections from acquiring the nutrition and energy they require to grow and thrive in the gut environment. Bacterial pathogens like *E. coli* and *Salmonella* can't survive in an environment where the pH of the gut has been altered by primary and secondary metabolites

including organic acid, volatile fatty acid (VFA), and lactic acid. A class of compounds known as bacteriocins has been shown to be effective in killing or preventing the colonization of pathogenic bacteria. Piperidine inhibits the binding and internalization of bacteria by intestinal epithelial cells *in vitro*, according to a research [14].

Enteric bacterial infections and coccidian parasites are especially sensitive to probiotic treatment, which significantly enhances the intestinal immunity of birds. It was shown that several pathogens, including *Staphylococcus aureus*, *E. coli*, and *Salmonella* Enteritidis, as well as *Clostridium perfringens, Listeria monocytogenes, Campylobacter jejuni* and *Candida albicans* have been suppressed by probiotic supplements in chicken [32]. Bacteria isolated from chicken gastrointestinal tracts were shown to limit *Salmonella, E. coli* and *Clostridium* perfringens development, as well as possessing potential probiotic characteristics. Chick with coccidiosis were demonstrated to be considerably reduced by strains of *Pediococcus, Lactobacillus,* and *Saccharomyces*. Probiotics may considerably reduce idiopathic diarrhea and *Salmonella* colonization in turkeys and broilers in commercial turkey brooding houses [40]. To avoid foodborne illnesses including *Salmonella*, *Campylobacter*, *Escherichia coli*, and *Listeria monocytogenes*, you should use probiotics sparingly [15].

9. Immunostimulation

Taking probiotics has been shown to have a variety of beneficial benefits on the immune system, including increased macrophage, lymphocyte and natural killer (NK) cell activity, increased oxidative burst in heterophils, and increased immunoglobulin production, to name a few (IgG, IgM and IgA). The usage of probiotics, which help to stabilize the stomach and regulate the immune system, may help to maintain a healthy balance between anti-inflammatory and pro-inflammatory cytokines. As a consequence of these observations, it has been established that probiotics may increase the number of lamina propria lymphocytes (LPL) and intestinal epithelial lymphocytes (IEL) in the small intestine while also inhibiting the development of pathogenic microorganisms [32].

Infection-associated diseases like infectious bursal disease, chicken infectious anemia, reoviral infections, Marek's disease, mycotoxins and other immune-suppressive conditions could possibly be alleviated in part by increasing cell-mediated immunity, which would aid in the fight against viral infections. Chicks are protected against a broad variety of infectious illnesses because their metabolites, which serve as immunomodulatory agents, provide protection against these infections in the first place. The use of probiotics in chicks may help to raise antibody levels against viral infections such as ND and IBD, which are frequent in the industry (IBD) [16]. It is possible to reduce the incidence of secondary infections in birds by utilizing probiotics to strengthen the immune system and check/prevent enteric infections during viral illnesses or immunosuppressive conditions (bacterial, coccidian). Probiotics are beneficial to bird health since they assist to reduce the detrimental effects of pathogenic microbes on the birds. They also significantly reduce the pathogenic microbial load in the stomach, which reduces the chance of pathogenic bacteria spreading *via* fecal contamination and other means. Because bacteria, fungi, protozoa, and viruses are responsible for the transmission of many infectious disorders, a multi-strain probiotic should be included in the diet on a regular basis [38].

The gut microbiota, epithelial cells, and immune system all contribute to the development of passive and active resistance against avian enteric illnesses. In the stomach of the avian, little is known about the control of the immune system and bacterial differentiation between "good" and "bad" bacteria by the bacteria [17]. Because of the constant interactions between diverse cell types, such as components of the innate and adaptive immune systems and bacteria in the gut lumen, epithelium, or lamina propria, intestinal enterocytes monitor the epithelial surface area for the presence of probable pathogens in the gut This equilibrium between hyper-reaction and non-reaction is accomplished as a result of the specific intestinal layout and interdigitation of immune cells across epithelial tissue. In part because the gut contains more lymphocytes than any other tissue and because its size and surface area in touch with both autochthonous and allochthonous probiotics are also important factors, the gut is sometimes referred to as the largest immune organ. It is the enterocytes of the intestinal epithelium that act as a barrier to prevent pathogens from gaining access to nutrition and assist the immune system in recognizing possible infections in the lumen [18].

Probiotics' role in an immunological context must be examined in greater detail. One way probiotics can help the body is to boost intestinal and/or systemic immunity, but they can also do other things. Studies on the effects of probiotic bacteria on the immune system in animals have shown that there are a wide range of possible interactions and outcomes to take into account [19]. When pathogens infect cells or the microflora, probiotics can reduce inflammation by inhibiting certain signaling pathways, such as MAP kinase and NF-kappa beta, which are involved in the activation of the immune response. Many pro- and anti-inflammatory cytokines' expression has been hypothesized as a potential mechanism of action. A chicken's knowledge of this topic is limited when compared to that of

other animals. Probiotics help the immune system by increasing levels of IgA in the lumen, the number of cells that produce IgA, IgM, and IgG, and the number of T cells in the cecal tonsils [20]. Oral administration of probiotics increases the production of natural antibodies in the stomach and bloodstream against a wide range of antigens. Antigen-specific antibody response has been shown to be increased by both probiotic treatment and vaccination against Newcastle disease. Antibody response amplification may be one effect of probiotic supplementation on heterophils in addition to an increase in the oxidative burst and degranulation of these organisms. However, feeding *Lactobacillus sporogenes* increased immunity against "Ranikhet" disease in broilers when fed at 100 to 150 mg/kg diet for 28 days after vaccination had no effect on carcass characteristics such as dressing percentage or weight of liver, heart gizzard, giblet, and abdominal fat [22].

Much remains to be learned about how these organisms interact with and influence their hosts, as well as the factors that influence their efficacy. We hypothesize that the significance of our findings may be affected by the antigen used to measure the immune stimulatory responses to probiotics [21]. It has been found that the same strain of bacteria can have varying effects on birds' digestive systems and immune systems depending on their genetics and age, which suggests that different types of birds (layers vs. broilers) may require different dosages of probiotic supplements at different times during the year. For both humoral and cellular immune responses, lactobacilli have the potential to be a useful supplement, but they must be carefully chosen and administered. An obvious and convincing effect on cytokine and oocyst formation was seen in infected broilers that had been given a commercial Lactobacillus-based probiotic supplement. By combining *L. casei* and dextran into an oral immunoadjuvant for birds to protect them from infectious diseases, researchers say they may have found the basis for a vaccine in the future [24].

10. Probiotics as a growth institution

The use of growth promoters, such as probiotics, in livestock (particularly pigs and cattle) has been proven to boost growth, feed conversion efficiency, and immunological responses [11]. Many studies on broiler chicken production efficiency have focused on the use of probiotics. To enhance broiler hens' health, live and inactivated probiotics are both effective. There have been recent attempts to create a multispecies probiotic fluid for poultry, using *Lactobacillus* species that were isolated from the digestive system of chickens. It has been observed that *Lactobacillus* strains may boost the immune systems of both chicken breeds [38].

10.1. Lactobacilli

Catalase-inhibitors are not required to prevent the growth of these lactobacilli. There are a number of probiotics that have been employed, including *Lactobacillus casei*, *L. zeae*, *L. paracasei*, and *L. rhamnosus*. As the population of unpleasant stomach bacteria grows, the number of undesired microflora decreases [37]. Lactic acid bacteria may be found in milk and meat products, as well as in sewage, people, plants, and animals (LAB). There are three species here*: L. johnsonii*, *L. avi-arius* (from chicken faeces), and *L. gallinarum* (from chicken faces). *L. casei* can withstand temperatures of up to 72°C, making it a suitable culinary ingredient. Probiotic feed might benefit from additional research into LAB and poultry husbandry settings. Compared to the control, supplementation with four strains of *L. bulgaricus* considerably increased chick growth and feed conversion [25]. When fed jointly, *L. acidophilus* and *L. bulgaricus* improved broiler chick performance. Cultures of *L. bulgaricus* and *L. acidophilus* were given to groups of chicks with low and high protein content and grown on skimmed milk at 37°C for 48 hours; *L. bulgaricus* was shown to provide a stronger growth response than *L. acidophilus,* while *L. acidophilus* was found to be less effective. After 40 days of feeding, either a single strain of *Lactobacillus acidophilus* or a combination of 12 strains of *Lactobacillus* may significantly boost broiler weight growth [26].

Regardless of the commercial probiotic utilized in the trial, researchers discovered that blood glucose levels were higher in the probiotic supplemented groups than in the control group. The study group's blood protein levels were unaffected by probiotic administration. The probiotic diet had no effect on the tibiotarsi weight/length index, the robustness index, the diaphysis diameter, the modulus of elasticity, or the yield stress. The medial and lateral walls of the tibiotarsi developed thicker and broader on the probiotic diet than on the control diet. Taking probiotics may increase bone mineralization and bone growth by increasing tibia wall thickness, the tibiotarsal index percent ash, and P content in the bone [27].

10.2. *Aspergillus oryzae*

Commercially available fermented products produced from *the Aspergillus oryzae* and *Aspergillus nige*r were shown to have no effect on egg output, egg weight, or egg shell weight, save for the generation of big eggs. While the digestibility of protein and fat in laying hens increased, their nutritional digestibility did not seem to be significantly impacted. According to another study, laying hens that received probiotic therapy performed better when fed diets that varied in methionine content,

according to the results [28]. It was shown that *A. oryzae* as a supplement to laying chicken feed had positive impacts on hen gut microbiota, pH and moisture levels in the hens' intestines, egg quality, and macronutrient metabolism. *A. oryzae* was shown to have reduced the moisture content of laying hens' droppings while increasing the metabolic stability of gross energy and dry matter. Using *A. oryzae* in broiler chick diets increased performance metrics including body weight growth and feed intake, but had little influence on feed:gain ratios, according to previous studies Growth performance in broiler chickens may be linked to *A. oryzae*, which has also been shown to reduce ammonia gas production and lower blood cholesterol in broilers, as well as having a good effect on their microflora populations [29].

10.3. Yeast

Yeast culture has just recently been discovered to be effective as a probiotic for chicks. The effects of the yeast *S. cerevisiae* and subtherapeutic antibiotics on broiler chicks were investigated, and it was discovered that they reduced small intestine weight while enhancing growth and carcass weight in the birds [30]. The inclusion of yeast in broiler feed improves performance as a result of changes in gastrointestinal flora and increased nutrient utilization on both a quantitative and qualitative basis. When compared to a group feed basal diet, body weight gains are 4.25 % larger and feed conversion ratios are 2.8% lower, despite the fact that feed intake has increased by just a tiny amount in this study. Broiler chick meals including the complete yeast or *S. cerevisiae* cell wall showed reduced oxidation and better growth, meat tenderness, and villus production. Therefore, supplementing broiler diets with yeast may serve as a natural alternative to antibiotics in some circumstances [31]. Hens with mycotoxicosis (ochratoxin) had their hematological and biochemical profiles improved when *S. boulardii* was added to their diet, and this was confirmed to be true. When birds were given yeast culture, they produced more antibodies in response to SRBC and CBH responses than when they were fed the baseline diet, indicating that yeast culture increases the birds' immune response. As shown by the fact that all treatment groups gained the same amount of weight, yeast culture had no negative effect on the weight increase of multiple critical organs [33]. A variety of intestinal diseases were successfully treated in animals using commercially available *S. cerevisiae* strains, and some of the *S. cerevisiae* strains were found to adhere to potentially harmful bacteria such as *E. coli* and *Salmonella* species. Probiotics made from the bacteria *Saccharomyces* have been shown to improve humoral immunity in birds, increasing their resistance to coccidiosis when administered at a concentration more than or equivalent to 0.1 percent in the broiler diet. The probiotic qualities of *S. cerevisiae* and *S. boulardii* (ATCC) yeast strains were shown to be significantly resistant to pH 1.5, with a survival rate of 85.3–92.1 percent, indicating that yeast is an excellent probiotic [38].

11. Salient benefits and recommendations for probiotic use

Probiotics may help maintain birds' microbiota healthy and balanced, which can improve both their health and productivity if they are utilized on a regular basis in their diet. It is strongly suggested that probiotics be used in the care of new-born chicks, in stressful situations, and as an alternative to antibiotic growth boosters in broiler chicken. Early chick mortality and gastro-intestinal abnormalities such scouring, lack of appetite, and inappropriate digestion may be prevented when pathogenic microorganisms, particularly enteric pathogens, are eliminated. Chicken breeders may see an improvement in their productivity and avoid major losses as a result of this [34].

Probiotics increase microbial balance, nutrient absorption, digestion, feed conversion, growth rate, and efficiency. Chick mortality is also reduced by preventing the formation of dangerous microorganisms and, in particular, digestive issues induced by bacterial invasions. Egg production and quality, fertility and hatchability of eggs, egg albumen quality, and yolk cholesterol content are all improved by these products. There are several advantages to birds' b-vitamins, such as improved bone structure and reduced contamination, enhanced medication and vaccine effects, and a healthy digestive tract following antibiotic treatment [35]. Although the unlawful and widespread use of antibiotics at subtherapeutic doses may lead to residues in chicken products and the development of drug-resistant bacteria, this does not rule out the use of probiotics to prevent the effects of antibiotics on bacteria. Apart from that, antibiotics used to treat illness impair the host's general microflora, causing bacterial dysbiosis and difficult-to-treat future illnesses in addition to killing harmful bacteria. In addition to preventing diarrhoea, using probiotics with antibiotics helps to maintain the necessary gut microbiota balance without interfering with the medication's effectiveness. It has been advised that the United States consider regulating the use of antibiotics in animal husbandry since drugs have failed to heal human ailments in the past [36]. The European Union has ban the use of antibiotics in animal feeds. Providing probiotics on a regular basis is suggested to keep birds healthy since they are constantly disturbed and under a high level of infectious strain when grown intensively. The greatest outcomes will be obtained if

the supplement is given to the bird before the infection challenge. In stressful situations, the dosage should be increased. After antibiotic treatment, probiotics must be provided to maintain a healthy microbiota population and achieve a well-balanced outcome. Powders and liquids containing probiotics are widely available as feed additives [37]. A single strain of yeast, a single strain of bacteria, or a combination of microorganisms may be utilized to treat numerous illnesses in the commercial probiotic market. As a rule of thumb, a multi-strain probiotic should contain at least 10^7 to 10^9 or even higher guaranteed levels of beneficial microorganisms such as *Lactobacillus acidophilus*, *L. casei, L. bulgaricus*, *Enterococcus fecium, Aspergillus oryzae, Saccharomyces cerevisiae,* etc., per kilogram of the product [1]. According to industry guidelines, chicks/layers/broilers get 0.5–1 kg /tone of feed, whereas breeders receive 1 kg/tone of feed. Feed or water should be supplemented with probiotics, and they should also be provided as a top dressing or as a top dressing for pelleted feed.

12. Conclusions

Probiotics may be given to chicken feed to help lower the incidence of gastrointestinal disorders in the flock. In terms of practical application, it is critical to understand how probiotics might affect the balance of bacteria in the avian gut, promote growth, and raise immunity in the bird population. It is vital to limit the incidence of sickness in poultry via natural means in order to create a strong immune system that will assist in the improvement of chicken production levels. Instead of using antibiotics as a feed additive or growth stimulant, it is better to utilize probiotics since they have no known negative effects and are less expensive. Furthermore, probiotics do not pose any health risks to humans since they do not leave residues in eggs or meat as antibiotics do. Probiotics for birds assist to increase their natural defenses against a broad variety of diseases by increasing the number of bacteria in their stomach. It is believed by a lot of individuals that these "desirable microorganisms" may assist in keeping hens healthy, productive, and happy in poultry farms. Because antibiotic residues in chicken products and the establishment of drug-resistant bacterial strains have the potential to have serious consequences for human health, antibiotic growth boosters are expected to be phased out in the not-too-distant future. Probiotic research is becoming more important as a result of this. The development of new information and experience in understanding probiotics, their unique mechanism of action, and their widespread use in chicken health and productivity in the next years may pave the way for additional advancements in poultry health and productivity.

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