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REVIEW ARTICLE

Effects of Probiotics on Carcass, Gut Microbiota, and Immunity of Broilers

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A B S T R A C T

The poultry industry significantly contributes to GDP and revenue generation in multiple countries worldwide. The poultry sector relies on broiler production and its performance because the broilers are an economical source of a high-protein diet and their short span of production. However, there are multiple problems being faced by the broiler production, including stress, loss of production, and disease vulnerability. Antibiotic resistance and a decline in the efficiency of growth promoters have led scientists to focus on alternative strategies. Among all alternative strategies, probiotics have been found to have multiple biological activities. Probiotics such as *Lactobacillus*, *Bacillus*, and *Bifidobacterium* species improve nutrient utilization, strengthen gut barrier integrity, and reduce pathogen colonization. Enhanced butyrate production and activation of microbiota–immune signalling pathways were identified as central mechanisms driving improved health and productivity. This review mainly explains the activities of probiotics in improving the carcass quality, immunity, and gut microbiota of broiler birds.

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INTRODUCTION

The poultry industry has expanded tremendously over the recent decades (Kleyn and Ciacciariello, 2021). The poultry industry's expanded growth is due to increased demand for high-quality, low-priced animal protein worldwide (Attia *et al.*, 2022). The industry depends on broiler chickens as they have a high rate of growth, turnover rate, and are within a short span of production (Maharjan *et al.*, 2021). However, the broiler production has come with its own multiple issues, including emerging disease vulnerability, metabolic ailments and loss of performance because of stress (Hafez and Attia, 2020; Nawaz *et al.*, 2021; Wickramasuriya *et al.*, 2022). Antibiotic growth promoters (AGPs) are in use for a long time to combat these significant broiler problems birds (Cowieson and Kluenter, 2019; Paul *et al.*, 2022). AGPs enhanced growth rate and feed ratios and reduced morbidity and mortality of flocks (Upadhayay and Vishwa, 2014; Pewan *et al.*, 2025). Uninhibited and continuous usage of AGPs has raised the issue of antimicrobial resistance (AMR) (Mesfin *et al.*, 2024). However, drug residues in broiler meat and eggs are a major health concern caused by AGPs (Akram *et al.*, 2023). These problems are increasing, pose a threat to animal and human health, and result in significant economic losses (Sagar *et al.*, 2023; Khalifa *et al.*, 2024). Multiple countries have restricted the use of AGPs in broiler birds to avoid the health and economic concerns (Nordeus, 2023; Zheng *et al.*, 2025). New alternative strategies based on natural products are gaining significant attention due to their low toxicity and high health benefits in broiler birds (Vlaicu *et al.*, 2023). There are multiple alternative strategies suggested to improve the quality of broiler carcass, immunity, health of gut microbiota, and reduce the rising concern of antimicrobial resistance (Abbas *et al.*, 2025). Among all the alternative strategies, probiotics are considered as the best because of their diverse biological activities (Terpou *et al.*, 2019; Sharifi-Rad *et al.*, 2020). The FAO and WHO recognize probiotics as living microorganisms that, when consumed in the right proportions, bring health benefits to the host (Latif *et al.*, 2023). Probiotics in broilers usually contain useful bacteria of the genus *Lactobacillus, Bifidobacterium, Bacillus, Enterococcus,* and *Pediococcus*, as well as strains of the genus *Saccharomyces cerevisiae* (Yousaf *et al.*, 2022; Soren *et al.*, 2024). These microorganisms can survive in the uppermost part of the gastrointestinal tract, attach to the lining of the gut, and colonize the intestine (Han *et al.*, 2021). After colonization, probiotics then interact dynamically with the digestive, immune and metabolic systems of the host (Selvamani *et al.*, 2021). However, for better understandings, the mechanisms of probiotics must be discussed.

Probiotics have multiple mechanisms of action. The most important mechanism of probiotics is to facilitate the growth of friendly microorganisms and suppress the activity of the unfavourable organisms (Tegegne and Kebede, 2022; You *et al.*, 2022). Probiotics produce antimicrobial agents, which include organic acids, bacteriocins, and hydrogen peroxide (Hernández-González *et al.*, 2021). The organic acids produced by probiotics significantly lower intestinal pH, making it very difficult for harmful pathogens to survive (Stasiak-Różańska *et al.*, 2021). Probiotics also increase the amount of digestive enzymes (amylase, protease and lipase) considerably to improve absorption of the nutrients (Luo *et al.*, 2022). These mechanisms of probiotics significantly enhance carcass conversion, yield of the feed, and meat quality (Maas *et al.*, 2021). Probiotics enhance the immune system of immunoprophylaxis and adaptive immunity (Shaheen *et al.*, 2019; Montesinos *et al.*, 2021). They activate the lymphocytes, macrophages, and other important immune cells (Javanmardi *et al.*, 2024). Immunogenic cells and macrophages increase the synthesis of antibodies and cytokine regulation (Strzelec *et al.*, 2023). This makes birds resistant and able to fight against various infections and stress conditions (Cisneros *et al.*, 2022). Multiple studies indicate that the microbiota of the gut has a direct relationship with the performance, health, and diet of poultry (Fathima *et al.*, 2022; Shehata *et al.*, 2022; Wickramasuriya *et al.*, 2022). Broiler chicken intestinal microbiota is a complicated community, which stabilizes the condition of nutrient metabolism, immune development, and the intestinal barrier (Liu *et al.*, 2021). When the intestinal community becomes imbalanced (dysbiosis), nutrient absorption is affected, inflammation rises, and the birds are most likely to die of enteric diseases (Obianwuna *et al.*, 2023). Probiotics would contribute towards recovery of the microbial balance by activating beneficial species like Lactobacillus and Bifidobacterium and reducing harmful species like *Clostridium*, *Escherichia coli* and *Salmonella* (Yue *et al.*, 2025). An increase in the microbial balance positively impacts the intestinal health, nutrient digestion, immunologic functionality and productivity of broiler birds (Kyoung *et al.*, 2023).

Probiotics enhance the increase in muscle mass, reduce abdominal fat, and enhance meat quality (Saha *et al.*, 2023). These broiler meat qualities include colour, tenderness, water retention, and oxidation stability (Cartoni Mancinelli *et al.*, 2023). The present review combines an in-depth and recent review of the influence of probiotics on broiler chickens by focusing on carcass characteristics, immune responses, and gut microbiota.

Probiotics and Broiler Carcass Characteristics: Carcass traits such as dressing percentage, breast muscle weight, thigh muscle weight, abdominal fat and overall carcass composition are important economic characteristics for broiler producers (Kokoszyński *et al.*, 2022). Meat quality characteristics, including pH, colour, drip loss, and tenderness, are equally important for processors (Alfaifi *et al.*, 2023). Probiotic supplementation has been continuously associated with positive shifts in these characteristics (Mohammed *et al.*, 2021). The incorporation of probiotic mixes in the broiler diets enhances the percentage of dressing as well as the growth of the breast, probably because of the more effective digestion of nutrients and the growth of lean tissue (Soumeh *et al.*, 2021). In a study by Valipourian *et al.* (2025), broilers that were given different doses of the commercial probiotic Protexin® experienced increased weight gain and improved feed conversion ratios, but most carcass traits, aside from dressing percentage, did not significantly change.

Probiotics improve carcass composition by enhancing digestive enzyme activity, increasing villus height, and expanding nutrient absorption (Soumeh *et al.*, 2021). They also reduce intestinal inflammation, lower energy loss to immune responses, and strengthen the gut barrier for better overall growth (Ahmad *et al.*, 2022). Probiotic supplementation can regulate nutrient absorption and interactions between the gut and microbiomes, thereby improving production outcomes (de Sire *et al.*, 2022). The use of probiotics is also associated with decreasing the contours of abdominal and internal fat deposition, an admirable aspect in the contemporary broiler production (Herich *et al.*, 2025). Multiple studies have found better carcass and meat quality of the broilers fed probiotics because of the enhanced protein utilization and the decrease in the pathogenic load (Atela *et al.*, 2019; Al-Shawi *et al.*, 2020; Khalil *et al.*, 2021; Muneeb *et al.*, 2025).

Gut-microbiota interactions directly affect the muscle fibre diameter and myogenic gene expression (Abd El-Hack *et al.*, 2021). *Bacillus subtilis* in broilers found increased butyrate-producing bacteria in the cecum alongside improved growth and intestinal morphology, indicating the link between gut microbial ecology and muscle-related outcomes (Zhang *et al.*, 2023). In practice, the economic benefit of improved carcass yield (higher breast meat, lower fat) combined with improved feed conversion makes probiotic supplementation a viable strategy, especially where antibiotic use is restricted (Pewan *et al.*, 2025).

However, results are inconsistent, as some studies report no or limited effect of probiotics on specific carcass traits (Estrada-Angulo *et al.*, 2021). The inconsistency is likely because of factors such as probiotic strain, dose, bird age, diet composition, management conditions and challenge status (pathogen load, stress). Further research must be conducted for consistent results, and the safety index of probiotics must be taken into consideration.

Role of Probiotics in Enhancing Broiler Immunity: The immune system in broilers comprises both mucosal and systemic components, with the gut being a major immune organ (Shehata *et al.*, 2022; Horodincu and Solcan, 2023). Probiotics have been widely shown to influence immune responses, through both direct and indirect pathways (Wang *et al.*, 2021). Probiotics significantly enhance the humoral immunity, shown by increased levels of immunoglobulins such as IgA and IgG (Kazemifard *et al.*, 2022). They also demonstrate improved cell-mediated immunity, including higher lymphocyte proliferation and greater macrophage activity (Yeşilyurt *et al.*, 2021). Modulation of cytokine production, including interleukins, interferon gamma and tumour necrosis factor alpha, has also been observed (Farhadi Rad *et al.*, 2024). Increased levels of IL-4, IL-6, IL-10 and enhanced T-cell populations ($CD4^+$, $CD8^+$), which are associated with a broad immunomodulatory effect (Rodrigues *et al.*, 2021). The detailed mechanism of probiotics enhancing the immunity in broilers is depicted in Figure 1. In research by He *et al.* (2019), broilers fed diets with 500mg/kg of Bacillus subtilis recorded high serum immunoglobulin, renewed jejunal mucosal IgA and IgG. The supplementation also improved the expression of the jejunal barrier gene occludin, indicating improved gut integrity. The enhanced barrier integrity implies that it is a less translocation of the pathogens or endotoxins, and this decreases inflammatory load and the diversion of energy to growth (Awad *et al.*, 2017). Moreover, probiotics are able to concentrate innate immune cells to respond to pathogens in a more appropriate manner (Giorgetti *et al.*, 2015). This is through up-regulation of the toll-like receptors (TLRs) and facilitated phagocytosis (Rehman *et al.*, 2021). The initial expression of TLR2, TLR4, IL-1, and IL-2 following probiotic supplementation increased (Slawinska *et al.*, 2021; Cappellucci *et al.*, 2024). These activities indicate that probiotics regulate interactions between host and microbe, which enhances immune competence and resilience. Table 1 shows various mechanism and effects of probiotics health, production, immunity, and gut health of broilers.

The probiotic mode of action is strongly associated with shifts in microbial composition that boost short-chain fatty acids (SCFAs) formation and stimulate downstream immune responses (Liu *et al.,* 2023). Probiotics increase the growth of commensal bacteria upon their establishment in the gut, where they ferment dietary fibers into SCFAs, including acetate, propionate and butyrate (Wang *et al.*, 2019). The metabolites act as energy sources to the intestinal epithelial cells, reinforce the tight junctions, and ensure the integrity of the barriers (Panwar *et al.*, 2021). Another action of SCFAs is on G-protein-coupled receptors on immune cells, which helps in the production of cytokines and anti-inflammatory action. Probiotics enhance intestinal homeostasis, minimize pathogen settlement and improve the overall immunity via this linking axon (Suganya and Koo, 2020).

Impact of Probiotics on Gut Microbiota Composition and Function: Gut microbiota of broilers is a dynamic and complex ecosystem that is vital in the digestion of nutrients, immune development, gut barrier, pathogen resistance, and gut metabolic signalling (Yue *et al.*, 2024). Probiotics contribute to the colonization of good bacteria, the suppression or control of bad pathogens, the enhancement of microbial diversity, and an increase in functional capacity, e.g., SCFAs and enzymes (Cuciniello *et al.*, 2023). Probiotics have been shown to elevate significantly the barrier and improve the gut architecture (Konieczka *et al.*, 2022). Various researchers demonstrate that probiotic supplements to broilers enhance the relative abundance of unitary beneficial bacteria like *Bifidobacterium*, *Lactobacillus*, and some butyrate-producing taxa (Onrust *et al.*, 2015; Jacquier *et al.*, 2019; Bilal *et al.*, 2021; Zhang *et al.*, 2021; Memon *et al.*, 2022). It also decreases the existence of rodent or opportunistic bacterial collections in the cecum and the ileum (Averina *et al.*, 2021; Kaźmierczak-Siedlecka *et al.*, 2021). The abundance of Alistipes and Rikenellaceae in the cecum was higher in broilers fed on a compound probiotic (Qiu *et al.*, 2022). However, lower abundance of Proteobacteria at 42 days of age was also observed (da Silva *et al.*, 2024). The increase in butyrate-producing bacteria is particularly significant because butyrate serves as the primary energy source for enterocytes (Han *et al.*, 2022). It also enhances the expression of tight junction proteins such as occludin and claudin and stimulates mucus production (Rose *et al.*, 2021; Mátis *et al.*, 2022). These effects collectively strengthen the gut barrier and improve the nutrient absorption capacity of broilers (Liu *et al.*, 2022). In parallel, improved intestinal morphology (increased villus height, higher villus/crypt ratio) has been reported in probiotic-fed broilers, reflecting improved absorptive surface and gut health (Soren *et al.*, 2024). Probiotics also improve the enzyme activity in the digestive tract (e.g., α-galactosidase, β-glucosidase), indicating enhanced microbial and host digestive function (Włodarczyk *et al.*, 2022). Through these mechanisms, probiotics reduce the energy cost of immune activation, reduce pathogen load, optimize nutrient utilization, and thereby improve growth and carcass traits (Kober *et al.*, 2022).

Probiotics can change microbiota composition of the gut, which can subsequently be converted to significant immune and performance effects (Wang *et al.*, 2019). The positive bacteria cultivated in the intestine can increase nutrient digestion and trigger the synthesis of short-chain fatty acids that develop platforms in increasing gut barrier integrity and anti-inflammatory signalling (Shin *et al.*, 2023). This decreases the colonization of pathogenic agents and the gut inflammation to enhance better digestion and nutrient absorption. An improved microbial set up also leads to enhanced immune surveillance, leading to increased disease resistance and the elimination of energy used on immune stress (Soares *et al.*, 2017). These processes describe the role that the change in microbiota composition during probiotic supplementation is not only keeping the gut healthy but also in enhancing growth performance and total bird productivity (Jha *et al.*, 2020).

The action of probiotics influences the microbiota in strain, dose and environment. Scientists have raised concerns about the potential transfer of antibiotic-resistance genes by probiotic bacteria or their relationship to the original microbiota. This risk has yet to be fully investigated in chickens.

Synergistic Effects and Practical Considerations: The benefits of probiotics are noticeable on their own, but they are maximized when combined with an extensive treatment regimen (Lopes *et al.*, 2023; Dore *et al.*, 2025). Multi-strain probiotic formulations often outperform single strains because of potential synergistic interactions, niche coverage, and cumulative functionality (Kwoji *et al.*, 2021; Puvanasundram *et al.*, 2022). Combination of probiotics with prebiotics (synbiotics), organic acids, or enzyme additives further improves outcomes (e.g.,

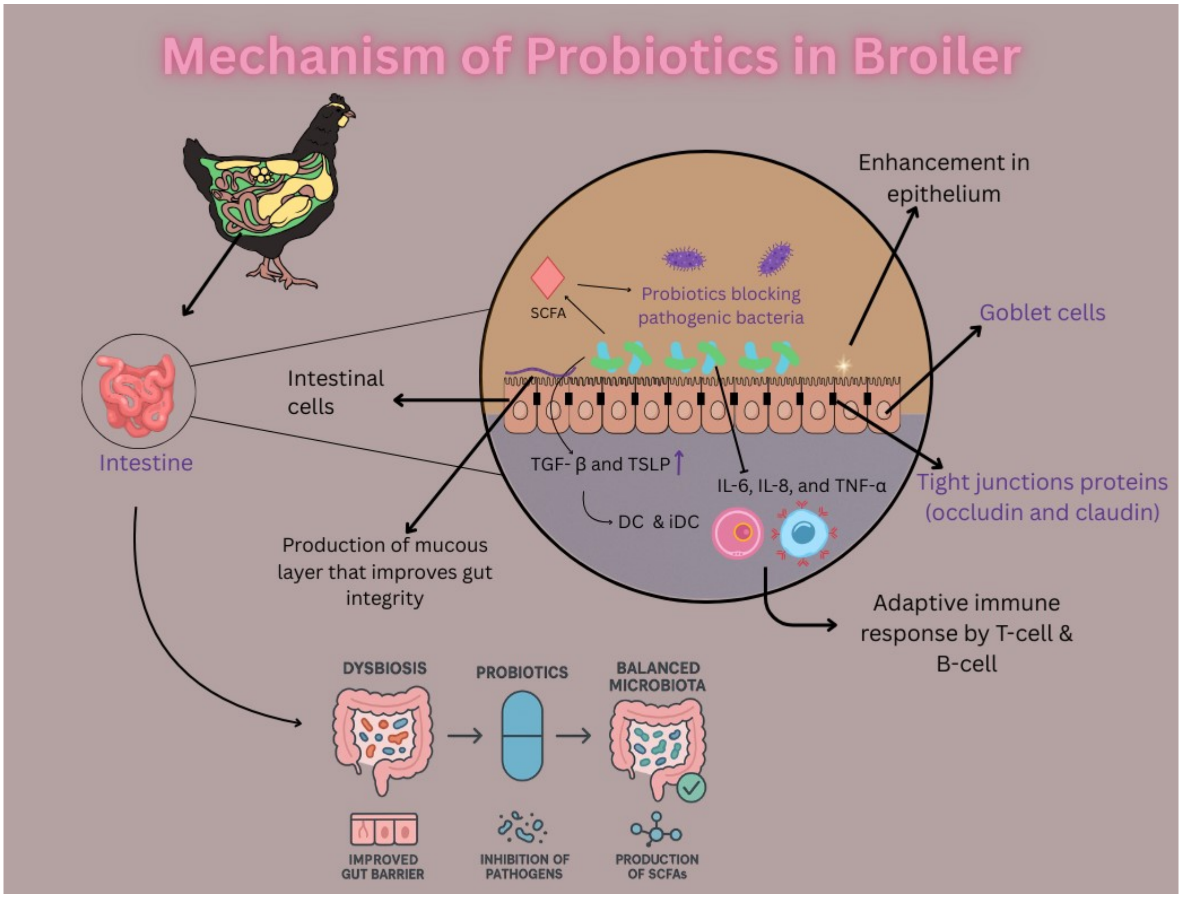

Fig. 1: Mechanism of action of probiotics in broiler birds.

improved microbial colonisation, improved gut morphology, enhanced immune responses) (Ma *et al.*, 2021; Atuahene *et al.*, 2025). The interaction between probiotic and MOS (mannan oligosaccharides) improved antibody titres against infectious bursal disease in broilers fed antibiotic-free diets (Teng *et al.*, 2021; Ruvalcaba-Gómez *et al.*, 2022). Factors such as supplementation timing, diet composition, and farm management significantly affect the effectiveness of probiotics (Islam *et al.*, 2025). It is especially crucial in broiler production where environmental stress (high stocking density, heat stress, pathogen challenge) can blunt performance (Herich *et al.*, 2025; Vu *et al.*, 2025). Probiotics play a significant role in stress mitigation under these conditions (Bustos *et al.*, 2025).

Farmers should carefully select well-characterized probiotic strains that survive feed processing and resist gastric and bile conditions (Kouhounde *et al.*, 2022). Dosage and timing are also necessary, with early-life administration often promoting better gut colonization (Pantazi *et al.*, 2023). Cost-benefit considerations, including feed savings, improved carcass yield, and reduced disease losses, should guide decisions (Azabo *et al.*, 2022). Maintaining good farm management is equally critical (Jones *et al.*, 2005). Proper feed hygiene, litter management, ventilation, and biosecurity are essential, as probiotics cannot fully compensate for poor husbandry (Gray *et al.*, 2021). Probiotics can improve feed conversion, lower mortality, enhance carcass quality, and support premium pricing for antibiotic-free or natural products, which directly reduces the economic burden (Leistikow *et al.*, 2022). Reduced antibiotic use and lower pathogenic pressure contribute to more sustainable poultry production (Tian *et al.*, 2021).

Adverse effects of probiotics in broilers: Probiotics are considered harmless and healthy (Zou *et al.*, 2022). But when the strains, doses and conditions of management are not suitable in broiler production, they may cause adverse effects (Arczewska-Włosek *et al.*, 2022; Luise *et al.*, 2022). One of the most frequent is gastrointestinal disorder (Grozina *et al.*, 2023). Higher doses or excessive supplementation may cause temporary diarrhea, wet litter, or digestive disturbances since there is a rapid change in the microbial community (Ortiz Sanjuan *et al.*, 2022). If probiotics are over-supplied, they may compete with the bird for dietary nutrients, potentially reducing feed intake or slowing initial development (Krysiak *et al.*, 2021). Microbial translocation also represents a potential problem, particularly when gut integrity is compromised (Matara *et al.*, 2022). In stressed birds with immunocompromised, gut inflammation may result in the cross of probiotic bacteria, including *Lactobacillus* and *Enterococcus* (Sangiorgio *et al.*, 2024). This may result in infection or local inflammation (Jankowski *et al.*, 2022). Bacteraemia has occasionally been observed when the gut lining is compromised (Ni *et al.*, 2024). Strains that generate surplus organic acids or bacteriocins may alter

Table 1: Effects of probiotics on health, production, immunity, and gut health of broilers

Sr.	Probiotic used	Strain	Dose	Broiler strain	Duration (days)	Study design	Carcass effects	Immune effects	Gut microbiota effects	Other reported effects	Reference
1	Multi-species probiotic	*Lactobacillus* spp., *Bifidobacterium*, *Enterococcus*, and *Pediococcus*	1g/kg feed (and in water at intervals in one group)	Cobb (male)	42	Randomized controlled feeding trial, 4 treatments	Improved growth performance and some improvements in cecal microbiota; dressing percentage not universally different across all groups.	Modulation of cecal microbiota; metabolic activity changes reported.	Changes in cecal microbiota composition and metabolic activities	-	(Mountzouris *et al.*, 2007)
2	Yeast culture	*Saccharomyces cerevisiae* yeast culture	0, 2.5, 5.0, 7.5 g/kg (best effect at 2.5 g/kg)	Arbor Acres	42	Randomized controlled (4 treatment levels), n = 960 chicks	Improved growth performance and meat quality.	Increased NDV antibody titers, increased serum lysozyme, increased IgM and secretory IgA in duodenum.	Improved villus height, crypt depth (duodenum, jejunum, ileum), improved Ca^{2+} and P^{3-} digestibility.	Improved nutrient digestibility (Ca^{2+} and P^{3-}) and mucosal development.	(Gao *et al.*, 2008)
3	*Lactobacillus* mixture	Multiple *Lactobacillus* strains	0.1% of diet (~1g/kg)	Broilers	42	Randomized trial (control vs LC), n=136	Reduced abdominal fat deposition (significant after 28 d), improved body weight gain and FCR.	Serum lipids decreased (total cholesterol, LDL, triglycerides).	-	No significant differences in organ weights.	(Kalavathy *et al.*, 2003)
4	Lactic acid bacteria probiotic (commercial LAB product)	Lactobacillus-based probiotic culture (FM-B11 / LAB mix)	-	Day-old broiler chicks (neonatal challenge model)	Early life (neonatal; evaluated in first weeks)	Challenge trials with *Salmonella* (neonatal broilers)	Maintained carcass quality under challenge (primary outcome was a reduction in *Salmonella* colonization rather than carcass traits).	Reduction of *Salmonella* colonization; temporal reduction in pathogen load and associated intestinal lesions.	Reduced *Salmonella* counts in crop/ceca; temporal modulation of lactic acid bacteria.	Reduced pathogen burden in neonates.	(Higgins *et al.*, 2008)
5	*Bacillus subtilis*	-	2×10^{10} CFU/g and 3×10^{10} CFU/g	Arbor Acres	35	Randomized controlled trial; 270 chicks divided into 3 groups	Improved growth performance, carcass traits inconsistent, but ADG and FCR improved.	Increased serum immunity markers, reduced mortality.	Altered cecal microbial composition (increased beneficial taxa relative to antibiotic control), improved villus height and mucosal barrier markers.	Reduced enteritis index, improved intestinal morphology.	(Zhang *et al.*, 2021)
6	*Bacillus amyloliquefaciens* (CECT 5940)	*B. amyloliquefaciens* CECT 5940	1.0×10^6 CFU/g	Commercial broiler strains	up to 35	Controlled trials (NE challenge and reduced-protein diets)	Increased BWG and improved FCR; carcass composition effects not the central	Noted improvements in health markers; not all immune cytokines reported in	Increased Bacillus and Ruminococcus DNA copy numbers, increased cecal butyrate	Improved ileal digestibility of certain amino acids, resilience to subclinical NE.	(Gharib-Naseri *et al.*, 2021)

							endpoint, but performance improved.	detail.	concentration, and reduced *C. perfringens*.		
7	*Clostridium butyricum*	*C. butyricum* YH 018	1 × 10^9 cfu/g	Ross 308	Group 1 (1-24 days), Group 2 (21-23 days)	Controlled and challenge (NE) n=120; divided into 2 groups	Improved growth performance and feed efficiency. However, specific carcass improvements not reported.	Modulated immune gene expression (TLRs, cytokines), improved mucosal barrier gene expression.	Increased abundance of beneficial genera (butyrate producers), improved intestinal barrier genes; reduced lesion scores under challenge.	Protective in NE and improved gut integrity.	(Huang *et al.*, 2019)
8	Multi-strain probiotics	*Pediococcus acidilactici* I5, *P. pentosaceus I13, Enterococcus faecium C14, Lactobacillus plantarum C16,*	1 × 10^8 cfu/ml	Cobb 500	One-day-old chicks	Randomized controlled trials, n=160	Multi-strain produced better performance, and dressing in Multi group was significantly higher.	Haemato-biochemical parameters were improved significantly.	Probiotic supplementation grossly reduced the number of Enterobacteria in the gizzard, ileum and caeca.	-	(Reuben *et al.*, 2022)
9	Synbiotic (probiotic + MOS)	*Pediococcus acidilactici* + MOS	0.1g/kg *Pediococcus acidilactici* and 2g/kg MOS	Ross 308	35–42	Challenge trials (*S. Typhimurium* challenge), n=420	Maintained carcass metrics under challenge and protected against challenge-related carcass losses	Improved innate immune markers and survival under challenge; better antibody responses in some cases.	Reduced *Salmonella* colonization, improved intestinal histology and gut integrity.	Enhanced survival and resilience during pathogen challenge.	(Jazi *et al.*, 2018)
10	*Lactobacillus plantarum*	*L. plantarum*	1.0 × 10^8 cfu/g	Ross-308 chicks	One-day-old chicks	Experimental trials; n= 280	Lean mass improvement was observed in the carcass.	Enhanced humoral immunity (increased Ig levels) and modulation of cytokines in challenge models	Increased *Lactobacillus* abundance and notable decreased *E. coli* load in birds.	Reduced oxidative stress and significantly reduced H_2S concentrations.	(Sampath et al., 2021)

Abbreviations: MOS: Mannan-oligosaccharides, LAB: Lactic acid bacteria, FCR: Feed conversion ratio, BWG: Body weight gain, ADG: Average daily gain.

gut pH beyond normal levels (Anjana and Tiwari, 2022; Liang *et al.*, 2025). Such alterations slow down the absorption of nutrients, mineral bioavailability and enzyme activity (Zang *et al.*, 2025). Over-acidification of the crop and intestine of some flocks has been associated with a reduced digestibility of proteins and fat (Kang *et al.*, 2025).

Another adverse consequence is strain antagonism (Kardooni *et al.*, 2023). Antagonistic interactions can occur when probiotics are incompatible with the current gut microbiota (Wassenaar *et al.*, 2021; Atanasov *et al.*, 2023). Such interactions can repress positive microbes and disrupt the stability of microbes (Zeise *et al.*, 2021). Another effect of probiotics is the risk of antimicrobial resistance gene entry into the poultry gut that may arise because of the absence of proper screening of various strains used as probiotics (Rokon-Uz-Zaman *et al.*, 2023). The quality of probiotic products with contaminants, unstable strains, and a lack of viability can be harmful to the health of the flock and detrimental to performance (Chang *et al.*, 2020; Idowu *et al.*, 2025). In order to guarantee the safe exploitation of probiotics in the production of broilers, it is necessary to focus on the selection of strains and the optimization of the dose, compatibility testing, and quality control.

Conclusions: Probiotics are scientifically proven and sustainable alternative to antibiotic growth promoters for chickens. They produce numerous advantages, such as better gut health, increased performance, and meat quality. Probiotics enhance components like nutrient absorption and digestion, thus increasing the yield of carcasses. They also help maintain gut microbial balance and reduce metabolic stress, leading to more lean muscle and less fat. Probiotics protect against pathogens by enhancing mucosal and systemic responses against pathogens, by increasing antibody titers, increasing cytokine response, improving barrier properties, thus decreasing the amount of energy expended by growth to stimulate an inflammatory response. The probiotics modulate the gut microbiota modulation is a major process by the probiotics. They increase the concentration of beneficial microorganisms, such as *Lactobacillus* and *Bifidobacterium*, and reduce the concentration of harmful organisms. This alters the intestinal morphology, enhances the activity of enzymes and improves the production of short-chain fatty acids, all contributing to the efficient utilization of nutrients by the bird and the constant stable internal environment. Even with the advancement, the effects are inconsistent because of the variation in probiotic strains, a dose, diet composition, management, and environmental stressors. Further studies are necessary to research strain-specific effects through higher metagenomic and metabolomic approaches. It must establish delivery systems that maximize stability and effectiveness and determine the long-term effects of commercial conditions. Probiotics are safe, environmentally friendly, and acceptable to consumers, and can be used to improve productivity, immunity, and gut integrity in broiler chickens, creating a more sustainable, antibiotic-free poultry market.

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