

Combined Effects of Encapsulated Butyric Acid and Prebiotics on Broiler Performance: A Review

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ABSTRACT

The increasing global demand for poultry products necessitates sustainable and efficient broiler production practices. Traditional antibiotic growth promoters (AGPs) are facing scrutiny due to concerns about antibiotic resistance, driving the search for effective alternatives. This mini-review synthesizes recent findings on the combined effects of microencapsulated butyric acid and prebiotics, specifically mannan-oligosaccharides (MOS), on broiler chicken performance. Studies indicate that these feed additives can positively influence growth performance, meat quality, nutrient digestibility, blood hematology, intestinal morphology, and liver health. The synergistic potential of their combined application, particularly in microencapsulated forms, offers a promising strategy for enhancing broiler productivity and health in an antibiotic-free production system. Future research should focus on optimizing dosage and understanding the precise mechanisms of their combined action.

Keywords: Butyric Acid, Mannan-Oligosaccharides, Prebiotics, Broiler Chickens, Growth Performance, Meat Quality, Intestinal Health

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Introduction

The broiler industry is a vital component of global food security, yet it grapples with challenges such as disease outbreaks, fluctuating feed prices, and the imperative to reduce antibiotic use [1]. The development of antibiotic resistance has spurred significant research into alternative feed additives that can maintain or improve broiler health and productivity without relying on AGPs. Prebiotics and organic acids have emerged as reliable alternatives, promoting gut health and growth performance [2]. Mannan-oligosaccharides (MOS), derived from yeast cell walls, are known to enhance intestinal flora balance and inhibit harmful bacteria [3]. Similarly, organic acids like butyric acid improve growth performance, digestibility, and feed efficiency by reducing pathogenic bacteria and maintaining gastrointestinal pH [4,5]. Microencapsulation is a technique that ensures the slow and continuous release of these compounds throughout the digestive tract, increasing their availability [6]. While individual effects of MOS and butyric acid are well-documented, there is limited data on the synergistic effects of their combined supplementation, especially in microencapsulated form, on various broiler performance parameters. This mini-review aims to consolidate current knowledge regarding the combined impact of microencapsulated butyric acid and mannan-oligosaccharides on broiler growth, meat quality, nutrient digestibility, blood hematology, intestinal morphology, and liver performance.

Review of Literature

A comprehensive literature search was conducted to identify relevant studies on the effects of prebiotics (mannan-oligosaccharides) and organic acids (butyric acid) on broiler chickens. The search primarily focused on research published between 2017 and 2025, with some foundational articles from earlier years also considered for context. Keywords used for the search included "butyric acid," "mannan oligosaccharides," "prebiotics," "organic acids," "broiler chickens," "growth performance," "meat quality," "nutrient digestibility," "blood hematology," "intestinal morphology," and "liver performance." The review synthesizes findings from approximately 40 peer-reviewed articles.

Current Findings / Discussion

Recent Developments in Growth Performance

Recent studies highlight the positive impact of both prebiotics and organic acids on broiler growth performance. Organic acids, including butyric acid, have been shown to significantly improve body weight, weight gain, and feed conversion ratio (FCR) [7,8,9,10]. Mannan-oligosaccharides (MOS) have also been reported to enhance growth rate and decrease FCR [11]. While some studies on MOS alone showed no significant difference in overall body weight gain [12], the general consensus points towards their beneficial role as antibiotic alternatives.

Effects on Blood Hematology

The supplementation of prebiotics and organic acids can influence broiler blood parameters. Butyrate formulations have been shown to improve serum total proteins and digestive enzymes, while reducing total lipid and cholesterol levels [13]. Organic acids generally lead to increased red blood cell count and hemoglobin levels, indicating improved oxygen carrying capacity, and a reduction in the heterophil to lymphocyte ratio, suggesting

reduced stress [10]. MOS supplementation has been linked to increased hemoglobin levels and a reduced heterophil to lymphocyte ratio [14,15,16], although some studies reported no significant changes in general blood parameters with MOS alone [17,18].

Impact on Meat Quality

Prebiotic supplementation, such as oligosaccharides, can improve meat quality by enhancing water-holding capacity and reducing cooking loss, leading to a juicier product [19]. MOS has been shown to increase breast meat yield, water-holding capacity, and reduce lipid oxidation, thereby improving shelf life (Zhao et al., 2024; [1]. While some studies suggest no significant effect of microencapsulated sodium butyrate on meat pH, color, or water-holding capacity [21], others indicate that butyrate can beneficially reduce intramuscular fat and improve water-holding capacity in leg muscles [22]. Mixed organic acids, including butyric acid, have also been found to improve ultimate pH and enhance the desirable red color of thigh meat [4,23].

Influence on Nutrient Digestibility

The inclusion of prebiotics and organic acids generally enhances nutrient digestibility in broilers. Organic acid supplementation has been shown to improve the digestibility of organic matter, dry matter, crude protein, and ether extract [10,24]. Prebiotics like MOS improve the overall digestibility of proteins, fats, and fibers by stimulating beneficial gut bacteria and digestive enzymes [14,25]. Organic acids lower the gastrointestinal tract pH, improving mineral solubility and activating pH-dependent enzymes, while prebiotics enhance gut epithelial health [14,7].

Effects on Intestinal Morphology

Both prebiotics and organic acids contribute to improved intestinal morphology. Combined supplementation of prebiotics and organic acids, or MOS alone, has been shown to significantly increase villus height, villus width, crypt depth, and the villus-height-to-crypt-depth ratio [26]. Microencapsulated butyric acid positively influences gut morphology by increasing villus height and improving the villus height to crypt depth ratio [8,9]. MOS supplementation leads to taller villi and shallower crypts, contributing to enhanced gut health and increased surface area for nutrient absorption [27,28,29,15].

Impact on Liver Performance

Supplementation with mannan-oligosaccharides has a beneficial impact on liver health, often leading to a significant reduction in plasma cholesterol, triglycerides, and liver enzymes like ALT and AST [27,30,14]. MOS can also reduce the cholesterol content of meat [31]. Sodium butyrate supplementation has been shown to reduce serum levels of liver enzymes AST and ALT, indicating improved liver function and reduced hepatic stress, along with a decrease in total cholesterol and triglyceride levels [32]. However, some studies indicate that MOS may not significantly alter liver health and function markers [Abd El Latif et al., 2023], and butyric acid can, in some cases, increase cholesterol levels and AST in a dose-dependent manner [34].

Challenges

Despite the promising results, challenges remain. The optimal dosage and specific combinations of microencapsulated butyric acid and various prebiotics need further investigation to maximize synergistic effects. The precise mechanisms by which these combined additives influence broiler physiology and gut microbiota require deeper understanding. Furthermore, the economic viability of these supplements in large-scale commercial operations needs continuous evaluation.

Future Perspectives

Future research should focus on conducting more studies on the synergistic effects of combined microencapsulated butyric acid and mannan-oligosaccharides, particularly in diverse environmental conditions and broiler strains. Investigations into the long-term impacts on broiler health and productivity, as well as the molecular mechanisms underlying their beneficial effects, would be valuable. Developing novel encapsulation techniques for improved delivery and sustained release of these additives could further enhance their efficacy. Additionally, exploring the interaction of these supplements with other feed ingredients and management practices will contribute to more holistic and sustainable broiler production systems.

Conclusion

The evidence strongly suggests that both microencapsulated butyric acid and mannan-oligosaccharides, individually and in combination, offer significant benefits for broiler chickens. These additives serve as effective alternatives to antibiotic growth promoters, improving growth performance, meat quality, nutrient digestibility, blood hematology, intestinal morphology, and liver health. Their ability to enhance gut integrity and modulate immune responses contributes to overall bird health and productivity. The combined application of these compounds holds considerable promise for fostering sustainable and efficient broiler production, aligning with the growing demand for antibiotic-free poultry.

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