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# Postbiotics: A Novel Feed Additive Transforming Poultry Production

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**Introduction:**

According to scientific research, the new term "postbiotics" are described as substances derived from bacteria that are no longer alive, or from their metabolic processes. These are low molecular weight soluble compounds, including extracts from bacterial cells which have been shown to provide health benefits to humans and animals when taken in adequate quantities orally or applied topically (Saeed *et al.*,2023 and Johnson *et al.*, 2019). These substances encompass enzymes, peptides, teichoic acids, peptidoglycan-derived muropeptides, polysaccharides, cell surface proteins, and organic acids. These substances primarily originate from bacterial species such as Lactobacillus, Bifidobacterium, Streptococcus, and Faecalibacterium, as documented in various studies (Wafaa *et al.*, 2022). Postbiotics are considered superior to probiotics because they consist of microorganisms that cannot replicate, thus reducing the risk of bacteremia or fungemia compared to probiotics. Additionally, postbiotics exhibit several advantageous traits, including diverse molecular structures, extended shelf life, and safe dosage profiles. They are also characterized by effective metabolism, absorption, distribution, and excretion, influencing numerous organs and tissues and performing various biological functions. Postbiotics exhibit antimicrobial, antioxidant, anti-inflammatory, immunomodulatory, hypocholesterolemic, antiproliferative, hepatoprotective, and growth-promoting properties, all contributing to enhancing the health of the host (Saeed *et al.*,2023). Thus, exploration of new strategies to find an alternative to antibiotics which enhance growth and health practices in Poultry industry has emerged as a primary focus of research.

**Classification:**

Postbiotics are defined as the metabolites produced by the microbiota, including SCFAs, exopolysaccharides, cell wall fragments, enzymes/proteins, and other compounds. Additionally, postbiotics can be categorized as structural components like peptides, teichoic acids, and plasmalogens (Hernandez *et al.*,2020).

- **Exopolysaccharides:**
  Exopolysaccharides (EPS) are complex, high-molecular-weight polymers consisting of branched repeating units of sugars or sugar derivatives, primarily synthesized by lactic acid bacteria (LAB). Immunomodulatory, antitumor, antimutagenic, antioxidant, anti-inflammatory, antihypertensive, antibacterial, antiviral, cholesterol-lowering, and gastrointestinal protective activities found in EPSs made by *Lactobacillus* strains (Thorakattu *et al.*,2022).
- **Enzymes:**
  Enzymes are predominantly sourced from a select group of bacterial strains, notably *Bacillus subtilis* and *Bacillus licheniformis*, and industrially from fungal strains such as *Aspergillus niger* and *Aspergillus oryzae*. Research has also shown that certain strains

of Lactobacillus fermentum contain significant amounts of glutathione peroxidase, exhibiting potent antioxidant properties in vitro (Thorakattu *et al.*,2022).

- **Cell wall fragments:**
  Several components of bacterial cell walls, such as teichoic acids and lipoteichoic acids, are immunogenic; meaning they can trigger an immune response, which are mostly found in Gram-positive bacterium. Research studies has demonstrated that lipoteichoic acid was extracted from *Lactobacillus plantarum* strains K8, K88, K5-5, and K55-5 (Thorakattu *et al.*,2022).
- **Cell-Free Supernatants:**
  Cell-free supernatants (CFS) are liquid solutions containing metabolites and residual nutrients from microbial fermentation. CFSs produced from *Lactobacillus acidophillus*, *Lactobacillus casei, Lactobacillus rhamnosus* GG has shown anti-inflammatory, anti-oxidant and anti-cancer properties (Thorakattu *et al.*,2022).
- **Short Chain Fatty Acids:**
  Short-chain fatty acids (SCFAs) are crucial metabolites synthesized by gut bacteria via the fermentation of plant polysaccharides. Acetate, the most prevalent SCFA, is primarily generated through fermentation by enteric bacteria. It can also be produced by hydrogenotrophic bacteria like *Acetobacterium woodii* (Thorakattu *et al.*,2022 and Hernandez *et al.*,2020).
- **Bacterial Lysates:**
  Bacterial lysates are derived from bacterial cells that have been disrupted, with the goal of triggering the immune system to identify and combat infections. These lysates are obtained through the chemical or physical breakdown of both Gram-negative and Gram-positive bacteria (Thorakattu *et al.*,2022).
- **Other Metabolites:**
  Additional metabolites synthesized by bacteria include vitamins, aromatic amino acids, and metabolites derived from phenolic compounds. The gut microbiome can produce B group vitamins such as B12, B2, B6, B9, and vitamin K through de novo synthesis, which also plays a role in synthesizing and processing aromatic amino acids, which function as bioactive compounds in the brain, kidney, and cardiovascular systems (Thorakattu et al.,2022).

**Mechanism of action:**

Indirectly modulating resident mirobiota or Some microorganisms utilize lactic acid to produce butyrate and short-chain fatty acids (SCFAs), which contribute positively to the microbiota. Enhancements in intestinal barrier function may occur with adequate levels of SCFAs in a postbiotic formulation, potentially shielding against lipopolysaccharide-induced disruptions and modifying epithelial barrier functions. Systemic and local immune responses can be influenced by the immune-modulating activities of microbial molecular patterns interacting with specific immune cell receptors such as nucleotide-binding oligomerization domain receptors, C-type lectins, and Toll-like receptors (Saeed *et al.*,2023). These receptors regulate cytokine production and immune responses. Changes in systemic metabolic responses can result from enzymes and metabolites present on or within the surface of inactivated microorganisms in postbiotics. Bile acids, in addition to influencing the structure of the microbiota and interacting with numerous host receptors, also have diverse effects on host metabolic processes, including lipid metabolism, xenobiotic metabolism, glucose metabolism, and energy metabolism. Systemic signaling through the nervous system can be influenced by adequate levels of microbial metabolites, such as SCFAs, found in postbiotic preparations. These metabolites stimulate enterochromaffin cells, leading to the release of serotonin into the bloodstream (Saeed *et al.*,2023).

**Advantages/Benefits:**

Postbiotics used as supplements in feed can enhance growth performance and overall health in broilers and layers. During heat stress in poultry, addition of postbiotics as feed additives that include *Lactobacillus plantarum* demonstrate antioxidant properties and broiler chickens have exhibited improved maintenance of gut microbiota, growth performance, intestinal morphology with improved meat quality and reduced plasma cholesterol levels . Moreover,

these metabolites enhanced egg quality and decreased cholesterol levels in both yolk and plasma and also increased the hen-day egg output in laying hens (Choe *et al.*,2012 and Humam *et al.*,2019). Postbiotic compounds notably enhanced disease resistance, improved growth performance, boosted immune responses, increased bursa to body weight ratio, and decreased coliform counts in the intestines of challenged chickens (feeding them with non-viable Lactobacilli postbiotic) compared to untreated chickens (Abd El-Ghany *et al.*, 2022). Adding a blend of 12 strains of Lactobacillus to broiler chicken feed had beneficial effects. It lowered serum total cholesterol, LDL cholesterol, triglycerides, and abdominal fat while enhancing feed conversion ratio (FCR) and growth performance (Kalavathy *et al.*, 2003). Supplementing broiler chicken diets with prebiotics and postbiotics containing inulin enhanced feed efficiency, total body weight, and supported growth factor1, mRNA expression of growth hormone receptors (GHRs), and intestinal mucosal structure (Kareem *et al.*, 2016). Postbiotics, when incorporated into quail feed as a novel feed additive, can effectively substitute for antibiotics growth promoters (AGPs). Derived from *Lactobacillus animalis*, these postbiotics enhance performance and support the health of quails by regulating gut microbiota (Kareem,2020). Prebiotics and postbiotics can help mitigate the environmental impact of poultry farming by enhancing feed efficiency and reducing the mortality rate and decreasing waste production with reduced emission of ammonia (Saeed *et al.*,2023).

**Conclusion:**

Postbiotics play a crucial role in enhancing immune resilience and alleviating environmental stress responses in poultry. They combat pathogens through antimicrobial compounds, prevent bacterial translocation, and reduce the production of pro-inflammatory cytokines. Moreover, they stimulate the expression of TLR genes, which are essential for immune regulation. Postbiotics also contribute to regulating the gut microbiome, promoting gut health, enhancing digestive enzyme activities, improving nutrient absorption, and supporting weight gain, especially under conditions such as necrotic enteritis and heat stress challenges. Including postbiotics in poultry diets not only supports antibiotic stewardship but also enhances overall performance, welfare, and food safety in poultry farming (Saeed et al.,2023). In contemporary times, commercial poultry products such as meat and eggs are widely recognized as essential, economical sources of protein in the diets of many people. The demand for these products continues to rise alongside global population growth. As previously mentioned, postbiotics are increasingly favored over probiotics due to their composition of non-replicating microorganisms, which lowers the risk of bloodstream infections compared to probiotics. Therefore, when considering all these factors, postbiotics emerge as a preferable alternative to antibiotic growth promoters. Therefore, the incorporation of postbiotics as a feed additives stands as a promising strategy to optimize poultry production sustainably and effectively.

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