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A NEW ERA IN POULTRY NUTRITION: THE PROMISE OF POSTBIOTICS

Introduction:

Once hailed as miracle drugs, antibiotics transformed modern medicine but their overuse has sparked a global race for safer, smarter alternatives like probiotics, prebiotics, synbiotics and postbiotics. Antibiotic overuse in animal agriculture has led to rising concerns about antimicrobial resistance and harmful residues in meat (Ma *et al*., 2021). Postbiotics, defined as non-viable microbes or their metabolites that provide health benefits, are gaining attention as a safer and more stable alternative to probiotics and antibiotics (Salminen *et al*., 2021). They enhance poultry growth, immunity, and gut health by supporting beneficial gut microbiota, boosting nutrient absorption, and producing antimicrobial compounds like organic acids and peptides. Studies have shown that Lactobacillus plantarum and similar strains can effectively replace antibiotic growth promoters in broiler diets (Chang *et al.*, 2022). Moreover, postbiotics remain active during processing and storage, unlike live probiotics, making them ideal for commercial use. Postbiotics represent a scientifically backed, stable, and safe feed additive that supports poultry performance while addressing public health and food safety concerns.

Components and Functions of Postbiotics: Key components include:

Exopolysaccharides (EPS): Produced by lactic acid bacteria, composed of sugars like glucose, galactose, etc. Exhibit immune-boosting, antibacterial, antioxidant, and anti-inflammatory properties. EPS like β-glucans activate macrophages, aiding in pathogen and cancer defense. These are used as emulsifiers and stabilizers.

Short Chain Fatty Acids (SCFAs): Includes acetate, propionate, butyrate from fiber fermentation. Acetate affects appetite, propionate regulates immune genes and inhibits cholesterol; **butyrate** aids gut repair and lowers inflammation.

Enzymes: Microbial enzymes (e.g., amylase, protease) support nutrient digestion and antioxidant defense. Examples: *L. plantarum*, *L. fermentum* boost antioxidant enzymes like glutathione peroxidase and catalase, useful in prevention of tumors.

Cell-Free Supernatants (CFSs): Contain antimicrobial and anti-inflammatory metabolites (e.g., bacteriocins). Stimulate immune responses, reduce oxidative stress, and offer protection against infections .

Cell Wall Fragments: Include **lipoteichoic acid (LTA)** and peptidoglycans. Act as immune modulators via interaction with host immune receptors. Helps to maintain gut barrier function, though excessive LTA may trigger inflammation, requiring safety evaluation.

Effect of postbiotics on gut health

Postbiotics play a significant role in enhancing intestinal barrier function by promoting mucus secretion from goblet cells, stimulating the release of antimicrobial peptides from Paneth cells, regulating tight junction protein synthesis, and preventing epithelial cell apoptosis. They also modulate the immune system by inducing immunoglobulin A secretion and interacting with gut-associated lymphoid tissue to maintain immune homeostasis, thereby preventing excessive inflammation. Postbiotics exhibit anti-inflammatory effects by reducing pro-inflammatory cytokines like TNF-α and increasing anti-inflammatory mediators, which helps preserve intestinal barrier integrity. For example, fatty acids produced by *Bacteroides thetaiotaomicron* and *Lactobacillus johnsonii* reduce inflammation in colitis models and enhance antifungal activity. These effects contribute to improved intestinal morphology, such as increased villus height and crypt depth, supporting better nutrient absorption and overall gut health.

Immunological Response of Postbiotics

Postbiotics-non-viable microbial products or metabolites, exhibit strong immunomodulatory properties. They upregulate anti-inflammatory cytokines like IL-10, improve T-reg cell responses, and enhance both innate and adaptive immunity. Components like lipoteichoic acid (LTA) and peptidoglycan fro m cell walls modulate cytokine production, shifting immune balance towards Th1 dominance (Teame *et al*., 2020). Additionally, postbiotics from Streptococcus thermophilus and Lactiplantibacillus plantarum improve IgA/IgM levels, growth hormone expression, and disease resistance in poultry.

Mechanism of action of Postbiotics:

1. Modulating gut microbiota (quorum sensing inhibition),
2. Strengthening intestinal barrier (via SCFAs),
3. Triggering immune responses through pattern recognition receptors (PRRs),
4. Altering systemic metabolism (via microbial enzymes and bile acids),
5. Neuroimmune signaling through serotonin release.

Postbiotics also offer antimicrobial, antioxidant, anti-inflammatory, anticancer, and cholesterol-lowering properties. Bacteriocins from postbiotics inhibit pathogens and may serve in food preservation and pharmaceuticals (Simons *et al*., 2020). Lactobacillus plantarum strains have shown effectiveness across species including broilers, pigs, and rodents.

Compared to probiotics, postbiotics are more stable, not sensitive to heat or oxygen, and have a longer shelf life making them suitable for regions without cold chains. As part of a broader biotic strategy including prebiotics, probiotics, and synbiotics, postbiotics stand out as a safe, efficient, and shelf-stable alternative to antibiotics in animal production. Postbiotics: Promising Effects in Livestock and Poultry.

Promising Effects on Other Animals

Postbiotics have demonstrated significant benefits across various animal species. In lambs, supplementation improved weight gain, feed intake, nutrient digestibility, antioxidant activity, and immune markers, while reducing harmful rumen microbes and enhancing beneficial ones (Izuddin *et al.*, 2020). In rats, LAB metabolites

increased growth and beneficial gut bacteria, though taste may reduce water intake suggesting powder formulation as preferable. In mice, postbiotic-treated L. casei showed anti-carcinogenic properties. In piglets, L. plantarum metabolites improved growth, gut health, protein digestibility, and reduced diarrhea.

In the poultry industry, postbiotics have improved growth performance, immunity, gut morphology, and egg quality. L. plantarum-based postbiotics helped broilers under heat stress and reduced yolk cholesterol in layers (Humam *et al*., 2019). In broilers, combinations with inulin enhanced feed efficiency, GHR expression, and gut structure. Postbiotics improved immune responses and reduced intestinal pathogens and mortality (Abd El-Ghany *et al.*, 2022). Other notable outcomes include reduced serum cholesterol and fat, improved meat quality, and effective AGP replacement in quails. In layers, S. cerevisiae-based postbiotics helped reduce Salmonella Enteritidis, enhancing food safety (Gingerich *et al*., 2021).

Beneficial Effects of Postbiotics on Meat and Egg Quality

Postbiotics have emerged as effective, natural alternatives to antibiotics in poultry, enhancing meat and egg quality while supporting antibiotic-free production. They improve poultry health and product safety, supporting global food security (Reuben *et al*., 2021).

Postbiotics reduce plasma cholesterol levels in eggs and improve breast meat quality by lowering shear force and increasing pH, especially under heat stress (Humam *et al*., 2019). L. plantarum metabolites enhanced both meat quality and cholesterol profiles in broilers. Postbiotics combined with inulin showed better meat quality than antibiotics.

In laying hens, postbiotic metabolites from L. plantarum increased hen-day egg production and improved overall egg quality. These effects make postbiotics a promising tool to meet the rising global demand for safe, high-quality poultry products (Hussein *et al.*, 2020).

Conclusion:

Postbiotics represent a safe, stable, and effective alternative to antibiotics in animal agriculture, particularly in poultry production. They enhance gut health, immunity, growth performance, and product quality, including meat and eggs, while addressing concerns over antibiotic resistance and food safety. Their diverse bioactive components contribute to improved intestinal barrier function, immune modulation, and antimicrobial activity. With proven benefits across multiple animal species and superior stability compared to probiotics, postbiotics offer a promising solution to sustainably meet the increasing global demand for safe and high-quality animal-derived foods.

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