PHYTOBIOTICS, PARAPROBIOTICS AND POSTBIOTICS: NATURAL ALTERNATIVES FOR ENHANCING POULTRY NUTRITION AND HEALTH

***Komal[1], Kachave Mukund Ramesh[2], Rajesh Kumar[3], Amit Kumar[4]**
[1]Assistant professor, Department of Animal Nutrition, Mahatma Gandhi Veterinary College, Bharatpur, Rajasthan, India, [2]PhD Scholar, Department of Animal Genetics and Breeding, ICAR-National Dairy Research Institute, Karnal, Haryana, India,[3]Assistant professor, Department of Veterinary and Animal Husbandry Extension Education, Mahatma Gandhi Veterinary College, Bharatpur, Rajasthan, India, [4]Assistant professor, Department of Veterinary Biochemistry, Mahatma Gandhi Veterinary College, Bharatpur, Rajasthan, India
Corresponding author email: *dalalkomal07@gmail.com*
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INTRODUCTION

The poultry industry is a major contributor to global food security, providing high-quality animal protein in the form of meat and eggs. To enhance growth, feed efficiency, and disease resistance in poultry, various feed additives have been explored. Among these, phytobiotics—plant-derived bioactive compounds—have emerged as promising alternatives to antibiotic growth promoters (AGPs). These natural compounds are known to improve digestion, immunity, and overall health.

Additionally, the concept of paraprobiotics has gained attention. These are non-viable microbial cells or their components that retain health-promoting properties without requiring colonization of the gut. Recently, a further advancement in this field has emerged in the form of postbiotics, which refer to non-living microbial metabolites or cell components that confer physiological benefits to the host. Together, phytobiotics, paraprobiotics, and postbiotics represent a trio of natural strategies to improve poultry productivity, health, and sustainability.

CLASSIFICATION OF PHYTOBIOTICS

Phytobiotics are classified based on their chemical nature and mode of action. The major categories include:

1. **Essential Oils** – Volatile aromatic compounds extracted from plants, such as thyme, oregano, and eucalyptus oils. They possess antimicrobial, antioxidant, and appetite-stimulating properties.
2. **Saponins** – Plant glycosides found in herbs like fenugreek and yucca. They enhance nutrient absorption and reduce ammonia emissions from poultry waste.
3. **Flavonoids** – Polyphenolic compounds with strong antioxidant and anti-inflammatory properties, present in citrus fruits, green tea, and berries.
4. **Tannins** – Astringent plant compounds having antimicrobial and anti-parasitic effects.
5. **Alkaloids** – Nitrogen-containing compounds such as capsaicin (from chili peppers) and berberine, known for their antimicrobial and metabolic-regulating properties.
6. **Mucilages and Gums** – Plant-derived polysaccharides that improve gut health and digestion by acting as natural prebiotics.

PARAPROBIOTICS

Paraprobiotics, also called non-viable probiotics, ghost probiotics, or heat-killed probiotics, consist of inactivated bacterial cells or their metabolites. These are obtained through heat treatment, UV radiation, or chemical processes that deactivate the microbes while preserving their bioactive properties. Unlike traditional probiotics, paraprobiotics do not require colonization of the gut, making them stable and effective alternatives in poultry feed.

COMMON TYPES OF PARAPROBIOTICS

Paraprobiotics are derived from well-known probiotic strains, including:

- **Lactobacillus spp.** (*Lactobacillus acidophilus, Lactobacillus rhamnosus*)
- **Bifidobacterium spp.**

- **Enterococcus spp.**
- **Saccharomyces boulardii** (yeast-derived paraprobiotic)

POSTBIOTICS

Postbiotics are bioactive compounds produced by probiotic bacteria during fermentation, including short-chain fatty acids (SCFAs), enzymes, peptides, polysaccharides, and cell wall fragments. Unlike probiotics, postbiotics are non-living but exert measurable health benefits.

CLASSIFICATION OF POSTBIOTICS

1. **Metabolic By-products:**
   - SCFAs (acetate, propionate, butyrate)
   - Organic acids (lactic acid, acetic acid)
2. **Cell Wall Components:**
   - Peptidoglycans
   - Teichoic acids
   - Surface layer proteins
3. **Functional Proteins and Peptides:**
   - Bacteriocins
   - Enzymes
   - Antioxidant peptides
4. **Exopolysaccharides (EPS):**
   - Complex sugars that enhance gut barrier function and immune modulation.

MECHANISM OF ACTION OF PHYTOBIOTICS, PARAPROBIOTICS, AND POSTBIOTICS

Phytobiotics, paraprobiotics, and postbiotics exert synergistic effects that collectively enhance poultry health, growth, and resilience. These bioactives interact with the gastrointestinal system to improve digestive efficiency by stimulating the secretion of digestive enzymes, enhancing nutrient absorption, and modulating the gut microbiota. Phytobiotics, rich in essential oils, flavonoids, and saponins, exhibit potent antimicrobial and anti-inflammatory properties, reducing pathogen load and supporting the growth of beneficial microbes. Paraprobiotics, being inactivated microbial cells, bind to intestinal receptors and interact with gut-associated lymphoid tissue (GALT), modulating both innate and adaptive immune responses without the need for colonization. Postbiotics, which are metabolic by-products such as short-chain fatty acids (SCFAs), bacteriocins, and exopolysaccharides, fortify gut integrity, lower intestinal pH to inhibit pathogens, and provide direct immunomodulatory and antioxidant effects.

Together, these compounds enhance intestinal barrier function, reduce oxidative stress, and boost immunity, while also improving feed palatability and promoting gut health. This triad approach creates a holistic internal environment that reduces disease risk, supports antibiotic-free production, and enhances overall poultry performance in terms of growth, feed conversion, and product quality.

BENEFITS IN POULTRY NUTRITION

The inclusion of phytobiotics and paraprobiotics in poultry feed offers several advantages:

- **Enhanced Growth and Performance:** Birds supplemented with these additives show improved weight gain and feed efficiency.
- **Better Gut Health and Microbiome Balance:** Phytobiotics promote beneficial gut bacteria, while paraprobiotics strengthen intestinal health.
- **Reduced Antibiotic Dependence:** Serve as natural alternatives to AGPs, supporting sustainable poultry farming.
- **Improved Meat and Egg Quality:** Some phytobiotics enhance meat texture, color, and shelf-life, while paraprobiotics support nutrient absorption.
- **Environmental Benefits:** Phytobiotics enhance digestion, reducing nitrogen and phosphorus excretion, lowering pollution.
- **Increased Stability and Safety:** Unlike live probiotics, paraprobiotics and postbiotics remain stable under extreme conditions and do not risk microbial overgrowth or infection.

CHALLENGES AND FUTURE PROSPECTS

Despite their advantages, several **challenges** persist:

- **Inconsistency in results** due to differences in sources, dosage, and bird genetics.
- **Lack of Standardization** in preparation methods and quality control.
- **Cost of Extraction and Production**, especially for high-purity postbiotic compounds.

FUTURE RESEARCH SHOULD FOCUS ON

- Developing **synergistic combinations** (e.g., phytobiotic + postbiotic blends).
- **Nanotechnology-based delivery systems** for improved bioavailability.
- Large-scale field trials and **omics-based approaches** (genomics, metabolomics) to understand precise modes of action.

CONCLUSION

Phytobiotics, paraprobiotics, and postbiotics represent natural, multifunctional feed additives capable of supporting poultry health, enhancing productivity, and minimizing reliance on antibiotics. Their collective benefits—ranging from antimicrobial and antioxidant action to improved digestion and immune function—make them ideal candidates for sustainable poultry production. As the industry continues its shift toward antibiotic-free strategies, these natural alternatives will play a pivotal role in ensuring animal welfare, product quality, and environmental stewardship. Continued research, formulation innovation, and regulatory support will be essential to fully realize their potential in commercial poultry nutrition.

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