**Biotics as Sustainable Alternatives to Antibiotics in Nigerian Poultry Farming**

**Abstract**

Poultry production is a crucial sector in Nigeria, contributing significantly to the economy, food security, and livelihoods of millions. However, productivity remains challenged by disease outbreaks, antibiotic resistance, and inefficient feed conversion. With growing restrictions on antibiotic use and increasing consumer demand for antibiotic-free poultry products, probiotics, prebiotics, and postbiotics are emerging as sustainable alternatives. These biotic additives play a key role in improving gut health, digestion, immunity, and overall poultry performance.
Probiotics are live, beneficial microorganisms that help maintain gut microbial balance and prevent harmful pathogens from colonizing the intestines. Prebiotics are specific non-digestible feed components that promote beneficial gut bacteria growth and metabolic activity, enhancing nutrient absorption. Postbiotics, the metabolic byproducts of probiotics, provide additional immunomodulatory and antimicrobial benefits without the viability concerns of live probiotics. Together, these biotics contribute to better feed conversion, improved disease resistance, and greater sustainability in poultry production.
This paper reviews the latest developments in probiotics, prebiotics, and postbiotics in Nigerian poultry farming, examining their mechanisms of action, effectiveness, and practical applications. It also explores emerging trends such as precision nutrition and innovative delivery technologies while addressing challenges related to adoption, regulation, and cost-effectiveness. Integrating these biotic strategies into poultry feeding programs can enhance productivity, reduce antibiotic reliance, and promote long-term sustainability in Nigeria’s poultry industry.

**Keywords:** Biotics, Sustainable, Gut Health, Poultry, Nigerian Farming

**Introduction**In poultry, the gastrointestinal (GI) tract does far more than just digest food—it plays a key role in absorbing nutrients and regulating immune function. A healthy, balanced gut microbiota helps birds break down complex nutrients and defend against harmful pathogens [1].
In Nigeria, poultry farmers have traditionally relied on antibiotics to boost growth and manage infections. Commonly used classes include tetracyclines like oxytetracycline, macrolides such as tylosin, β-lactams like ampicillin, sulfonamides such as sulfadimidine, and polymyxins like colistin sulfate. These antibiotics are often added to feed or water at low doses, but this long-standing practice has contributed to the growing issue of antimicrobial resistance [2, 3].

With rising global concern about antibiotic-resistant bacteria, many countries are now restricting or banning the use of antibiotics as growth promoters. Consumers are also demanding safer, antibiotic-free poultry products. This shift has sparked increased interest in natural, science-backed alternatives that can support poultry health and performance without the risks linked to antibiotic use [4, 5]. Antibiotic resistance in poultry doesn't just affect animals—it can also pose serious risks to human health. Resistant bacteria can transfer from birds to people through direct contact, undercooked meat, or contaminated environments. This can make infections harder to treat and lead to public health challenges. The economic consequences are also significant, with farmers facing higher disease-related losses and the environment suffering from the spread of resistance genes in poultry waste [6, 7]. In response, attention is turning toward biotics—a group that includes probiotics, prebiotics, and postbiotics. Interestingly, Nigerian farmers have long used traditional fermented foods like ogi (fermented maize), nunu (fermented milk), and palm wine sediment in poultry feed. These natural ingredients happen to contain beneficial microbes such as Lactobacillus spp. and Saccharomyces cerevisiae. What began as a folk practice is now being validated by science for its positive effects on poultry gut health and performance [8, 9].
Each type of biotic serves a unique purpose. Probiotics are live microorganisms that benefit the host when consumed in the right amounts [10]. Prebiotics are non-digestible food components that fuel the growth of helpful gut bacteria [11]. Postbiotics are the helpful byproducts of probiotic metabolism, offering immune and gut health benefits without needing live microbes [12]. Maintaining a healthy gut ecosystem is essential for efficient digestion, strong immunity, and optimal growth in poultry. When this microbial balance is disrupted—a condition known as dysbiosis—birds may absorb nutrients poorly and become more vulnerable to disease. Therefore, adopting feeding strategies that support a diverse and stable gut microbiota is key to healthier flocks and a more sustainable poultry industry.

**Key Microbial Groups in Poultry Gut Microbiota**

The gastrointestinal (GI) tract of poultry harbors a complex and dynamic community of microorganisms that are essential for digestion, nutrient absorption, immune modulation, and overall health. Understanding these microbial populations is crucial for enhancing productivity and disease resistance in poultry. Among the dominant bacterial phyla, *Firmicutes* are most abundant in broiler chickens raised under commercial conditions, whereas *Bacteroidetes* and *Proteobacteria* are more common in free-range birds [13]. *Actinobacteria* are also frequently present and are known for their role in degrading complex carbohydrates, thereby improving nutrient utilization [14].

At the genus level, beneficial bacteria such as *Lactobacillus*, *Bifidobacterium*, *Enterococcus*, and *Bacillus* are associated with improved gut health and are commonly used in probiotic formulations [15]. However, genera such as *Escherichia*, *Clostridium*, and *Gallibacterium* include pathogenic strains that may negatively impact poultry health [16]. Beyond bacteria, the poultry gut also contains archaea, protozoa, fungi, and viruses, although these groups are less studied [17]. Distinct microbial communities inhabit various regions of the gut; for instance, the cecum supports microbes that ferment dietary fiber into short-chain fatty acids (SCFAs), such as acetate and butyrate, which are beneficial to gut function and host energy metabolism [18].

Several factors influence microbial composition, including genotype, age, diet, housing system, and antibiotic usage. Research indicates that cage-free environments and soy-free diets promote greater microbial diversity than conventional systems [19].

**The Role of Probiotics in Enhancing Digestive Health and Growth Performance**

In Nigerian poultry production, probiotics are increasingly recognized as sustainable alternatives to antibiotics. They play a vital role in maintaining gut health, improving digestion, and reducing harmful microbial populations [20]. Studies reveal that broiler chickens fed with probiotics show significant improvements in weight gain and blood serum protein levels compared to those on unsupplemented diets, suggesting enhanced growth and metabolic efficiency [21]. Furthermore, probiotics have shown efficacy in controlling *Salmonella* infections, a major challenge in the Nigerian poultry industry [22]. These results are consistent with global findings that highlight the importance of probiotics in reducing enteric infections, stabilizing gut microbiota, and enhancing feed conversion efficiency. Although most probiotics currently used in Nigerian farms are imported, there is growing interest in isolating and developing locally sourced strains better suited to native breeds and environmental conditions [23]. With continued research and stakeholder engagement, probiotics hold strong potential as a sustainable solution for improving poultry health and production outcomes in Nigeria.

**Formulating Probiotic-Based Poultry Feed Using Locally Available Ingredients in Nigeria**

With the growing global shift away from antibiotic growth promoters, Nigeria’s poultry industry is increasingly turning to probiotic-based alternatives as a sustainable solution. Leveraging locally sourced microbial strains offers a promising and cost-effective strategy for enhancing poultry health, productivity, and feed efficiency(24). Local fermented foods like ogi and kunu have been identified as rich sources of beneficial lactic acid bacteria. Notably, *Lactobacillus plantarum* strains isolated from these traditional cereal gruels have demonstrated strong probiotic characteristics, including acid and bile tolerance, antimicrobial activity, and gut adhesion capabilities—key attributes for colonization and efficacy in poultry gastrointestinal tracts (25,26). Their adaptation to indigenous conditions further supports their relevance for local poultry breeds.

Beyond lactic acid bacteria, natural beverages such as palm wine also present a diverse reservoir of useful microbes. Research into yeast diversity in Nigerian palm wine revealed the presence of *Saccharomyces cerevisiae* and other strains with potential probiotic applications. These yeasts contribute to gut health by enhancing feed digestibility, producing essential nutrients, and outcompeting pathogenic organisms within the poultry gut (27). The application of such indigenous probiotics has shown encouraging results. Controlled feeding trials involving broilers supplemented with probiotics formulated from local isolates reported improved weight gain, better feed conversion ratios, and healthier gut microbiota profiles (28). These outcomes suggest that locally formulated probiotic feeds can significantly boost poultry performance under Nigerian farming conditions. Despite the growing evidence base, adoption among feed millers and poultry farmers remains relatively low. Some pioneering local feed producers, particularly in Southwest Nigeria, have begun experimenting with probiotic-based formulations, driven by consumer awareness and the desire to reduce dependence on imported additives (29). However, broader uptake is hindered by limited access to microbial cultures, insufficient technical knowledge, and the absence of clear national standards.

Importantly, regulatory oversight remains a critical bottleneck. Current frameworks do not adequately address the production, quality assurance, or safe use of probiotics in animal feed. This regulatory gap raises concerns about consistency, safety, and efficacy of locally produced probiotic feeds. Strengthening legal and policy infrastructure is essential to guide the responsible development and integration of probiotics into Nigerian poultry nutrition (30).

**Table 1:** The **locally available** ingredients and their function at a glance

| **Ingredient** | **Probiotic Strains Present** | **Function in Feed** |
| --- | --- | --- |
| Fermented Maize or Sorghum (Ogi) | *Lactobacillus acidophilus, L. plantarum, L. casei, L. fermentum* | Aids digestion, enhances gut microbiota |
| Fermented Dairy Products (Nunu, Wara Whey) | *Lactobacillus acidophilus, Bifidobacterium* | Enhances immunity, reduces pathogenic bacteria |
| Palm Wine Sediment | *Saccharomyces cerevisiae* (yeast) | Boosts immune function, aids digestion |
| Molasses | Enhances bacterial survival | Provides energy for microbial fermentation |
| Commercial Probiotic Cultures (Optional) | *Bacillus subtilis, Lactobacillus spp.* | Strengthens probiotic diversity in feed |

**Feed Formulation Techniques**

To effectively incorporate these probiotics into poultry feed, a few standardized steps are recommended:

1. Isolation and Culturing: Beneficial microbes are isolated from fermented foods and cultured under controlled conditions to ensure viability and consistency.
2. Stabilization: Probiotic cultures are stabilized through drying or encapsulation to withstand feed processing temperatures.
3. Inclusion: The cultures are then mixed into feed at appropriate concentrations, generally ranging from 10^6 to 10^8 CFU/g of feed.
4. Storage: Feeds containing probiotics must be stored in cool, dry environments to maintain microbial viability.

Local feed mills can adapt this process with minimal investment, offering farmers access to enriched feed at a lower cost [29].

 **Prebiotics in Poultry Nutrition**

Although the role of probiotics in poultry production is well-documented in Nigeria, the benefits of prebiotics remain relatively underexplored. Prebiotics support the development of a healthy gut microbiome by serving as substrates for beneficial bacteria such as *Lactobacillus* and *Bifidobacterium*, thereby promoting digestive efficiency and immune function [31].

Recent studies have highlighted the potential of *Ocimum gratissimum*—a commonly used herb in Nigeria—as a functional prebiotic. Its extract has demonstrated efficacy in suppressing *Escherichia coli* infections in broiler chickens. Birds receiving dietary supplementation with the extract displayed improved gut morphology and reduced mortality rates [32]. Another prebiotic compound, inulin, has been shown to support gut microbial diversity and enhance nutrient uptake. Research by Matthew et al. (2022) confirmed that broilers fed with inulin-supplemented diets exhibited enhanced growth performance and more efficient feed conversion [33].

Despite these promising findings, further research is necessary to standardize dosage, identify synergistic combinations, and evaluate long-term effects. Leveraging locally available plant materials for prebiotic purposes represents a sustainable pathway for enhancing poultry health and farm profitability in Nigeria.

**Locally Available Prebiotic Sources**

A number of agricultural by-products and plant-derived materials commonly found in Nigeria show significant potential as prebiotic agents. These materials support the proliferation of beneficial gut microbes and contribute to improved intestinal function.

* **Cassava Peels**: When properly dried and processed, cassava peels offer a rich source of resistant starch and dietary fiber. These components enhance microbial fermentation in the gut, leading to improved nutrient absorption and gut health [34].
* **Banana and Plantain Peels**: These fruit by-products are abundant in fructo-oligosaccharides (FOS), which selectively encourage the growth of beneficial microbes such as *Lactobacillus* and *Bifidobacterium*. Inclusion of these peels in poultry diets has been associated with improved microbial diversity [35].
* **Moringa oleifera Leaves**: Known for their antioxidant and phytochemical content, moringa leaves provide both prebiotic and antimicrobial effects. Their fiber-rich composition supports microbial balance while enhancing immunity [36].
* **Palm Kernel Meal**: As an agro-industrial by-product widely available in West Africa, palm kernel meal contains mannan-oligosaccharides (MOS). These have been linked to better intestinal morphology, enhanced immune function, and improved gut barrier integrity in poultry [37].
* **Garlic and Onion Extracts**: These culinary staples are rich in inulin-type fructans and sulfur-containing compounds. Their inclusion in poultry diets promotes microbial activity and diversity, creating a more resilient gut environment [38].

**Postbiotics: A Promising Approach to Poultry Gut Health**

Postbiotics are emerging as a novel class of bioactive compounds in poultry nutrition. Unlike probiotics, which rely on the presence of live microorganisms, postbiotics consist of non-viable microbial products or metabolic byproducts resulting from fermentation. These compounds, which include short-chain fatty acids, enzymes, peptides, and organic acids, exert beneficial effects on host health by modulating the immune system, enhancing gut barrier function, and controlling pathogenic bacteria [39].

One of the key advantages of postbiotics is their stability during feed processing and storage, making them particularly suitable for poultry environments where live microbes may not always survive. Furthermore, they pose no risk of microbial translocation or infection, offering a safe alternative to live probiotics.

In Nigerian poultry research, early investigations into postbiotics have shown promising outcomes. A study by Kareem et al. (2016) demonstrated that dietary supplementation with microbial fermentation products enhanced immune response and improved feed conversion efficiency in broiler chickens [40]. These results underscore the potential of postbiotics to serve as effective immunomodulators and growth enhancers.

Recent studies have also highlighted the antioxidant and antimicrobial properties of postbiotics. Waqas et al. (2024) reported that specific postbiotic compounds helped reduce oxidative stress and suppressed common bacterial infections, leading to improved gut integrity and overall performance in poultry flocks [41]. These benefits position postbiotics as an important component of antimicrobial-free poultry production strategies.

Despite these promising findings, postbiotics remain the least studied among the biotics—probiotics, prebiotics, and postbiotics—particularly within the Nigerian poultry context. Limited awareness, lack of standardized production protocols, and insufficient commercial formulations have slowed their adoption.

Nonetheless, the opportunity for innovation remains high. Further research is needed to characterize the bioactive compounds responsible for postbiotic activity, optimize delivery mechanisms, and assess long-term effects under field conditions. If adequately explored, postbiotics could provide a stable, sustainable, and effective tool for improving poultry health, especially in systems transitioning away from antibiotics.

**Postbiotic Feed Formulation: Harnessing Local Resources for Poultry Nutrition**

As the poultry industry increasingly seeks natural and stable alternatives to antibiotic growth promoters, postbiotics have emerged as promising candidates. These bioactive compounds—produced during the fermentation of substrates by probiotic organisms—offer significant benefits for poultry health, including immunomodulation, improved gut barrier function, and antimicrobial activity. Unlike probiotics, postbiotics are not dependent on microbial viability, which allows for greater stability and ease of integration into feed systems [42].

Nigeria’s diverse agro-ecological environment provides access to several locally available ingredients with postbiotic potential. The utilization of such resources can provide sustainable and economically feasible feed solutions for poultry farmers.

**Fermented Rice Bran**

Fermented rice bran is one such resource with considerable functional value. Through microbial fermentation, rice bran is enriched with short-chain fatty acids (SCFAs), including butyrate, propionate, and acetate. These SCFAs act as primary energy sources for colonocytes, help maintain gut epithelial integrity, and regulate inflammatory responses. They also contribute to improved feed efficiency and disease resistance in poultry [43].

**Yeast Culture Residues from Local Breweries**

By-products from local breweries, particularly yeast culture residues, are rich in beta-glucans and nucleotides—two key components recognized for their postbiotic activity. These compounds have been shown to enhance the composition of gut microbiota and stimulate both the innate and adaptive immune responses in poultry. Their inclusion in poultry diets can lead to reduced disease incidence and better growth performance [44].

**Vernonia amygdalina (Bitter Leaf)**

*Vernonia amygdalina*, commonly known as bitter leaf, is widely used in traditional medicine across Nigeria. It contains a range of phytochemicals with antimicrobial and immunomodulatory properties. While not a classic postbiotic, its bioactive components mimic postbiotic effects by favorably influencing the gut microbiota and enhancing resistance to enteric infections [45].

**Fermented Cassava Waste**

Another viable option is fermented cassava waste, a readily available by-product in many Nigerian communities. The fermentation process naturally generates butyric acid, a potent SCFA known for supporting gut health by strengthening intestinal epithelial cells and enhancing nutrient absorption. Its inclusion in poultry diets supports digestive efficiency and improves overall performance [46].

These ingredients present scalable, locally relevant options for formulating postbiotic-enriched poultry feeds. Integrating them into feed strategies can contribute to improved flock health, reduced reliance on antibiotics, and more sustainable farming practices.

**Table 2: Comparative Analysis: Probiotics vs. Prebiotics vs. Postbiotics**

| **Feature** | **Probiotics** | **Prebiotics** | **Postbiotics** |
| --- | --- | --- | --- |
| **Nature** | Live microbes | Non-digestible fibers | Metabolic byproducts |
| **Stability** | Sensitive | More stable | Highly stable |
| **Benefits** | Gut health, immune modulation | Supports beneficial bacteria | Direct gut health benefits |
| **Challenges** | Viability issues | Diet-dependent response | Standardization needed |

**Precision Nutrition and Innovative Delivery Technologies in Nigerian Poultry Farming**

As the demand for sustainable poultry production intensifies in Nigeria, the integration of biotic feed additives—probiotics, prebiotics, and postbiotics—into feeding strategies has gained increasing attention. To maximize their effectiveness, emerging research now emphasizes the importance of precision nutrition and novel delivery technologies. These advancements aim to improve the bioefficacy, stability, and affordability of biotic-based solutions while addressing practical challenges related to adoption, regulation, and cost-effectiveness.

**Precision Nutrition: Customized Feeding for Enhanced Performance**

Precision nutrition involves a data-driven approach to poultry feeding, where diets are tailored to meet the specific nutritional requirements of birds based on factors such as breed, age, health status, and environmental conditions. When aligned with biotic supplementation, precision nutrition enhances gut function, optimizes nutrient absorption, and bolsters immune competence [47, 48].

In the Nigerian context, feed expenses account for up to 70% of total poultry production costs [49]. Precision feeding allows for better resource utilization by minimizing nutrient wastage and improving feed conversion efficiency. This not only supports profitability but also contributes to environmentally sustainable farming practices. However, the widespread implementation of precision nutrition in Nigeria is constrained by limited access to real-time performance data, specialized feed formulation tools, and technical expertise, particularly among small- and medium-scale farmers [50].

**Innovative Delivery Technologies: Improving Stability and Efficacy**

Conventional methods of delivering biotic additives—primarily through feed or drinking water—often face limitations in stability and efficacy, especially in the high-temperature, high-humidity environments typical of tropical climates. To overcome these limitations, emerging technologies such as microencapsulation, nano-formulations, and controlled-release systems are being explored to enhance the targeted delivery and bioavailability of biotic compounds [51].

Microencapsulation, for instance, has shown promise in protecting probiotics during feed processing and gastric transit. Encasing probiotic strains within biopolymer matrices such as alginate or chitosan helps maintain their viability until they reach the lower gastrointestinal tract, where they exert their beneficial effects [52]. Nanoparticle-based carriers and controlled-release platforms further refine delivery by releasing the active compounds in response to specific physiological triggers.

Despite their proven benefits in research settings, these advanced technologies remain largely inaccessible to Nigerian poultry producers due to high costs, lack of local manufacturing capacity, and reliance on imported materials. Bridging this gap requires investment in local innovation, capacity building, and partnerships between academia, industry, and government.

**Challenges in Adoption, Regulation, and Cost-Effectiveness**

Despite encouraging scientific progress, several systemic and practical challenges hinder the successful integration of biotic strategies—probiotics, prebiotics, and postbiotics—into mainstream Nigerian poultry systems.

**1. Adoption and Awareness**

A critical barrier to the adoption of biotic feed additives is limited awareness among poultry farmers. Many producers remain unfamiliar with the benefits and appropriate application of these interventions. Inadequate agricultural extension services, coupled with persistent misconceptions about the efficacy of antibiotic alternatives, further slow adoption [53]. Educational outreach and hands-on demonstration programs are needed to bridge this gap, particularly for smallholder farmers who often lack access to updated information.

**2. Regulatory Oversight**

The regulatory framework governing the use of feed additives, including biotics, in Nigeria is still developing. Current challenges include inconsistent enforcement, lack of standardized product quality benchmarks, and limited local regulatory capacity. Without clear and robust guidelines, producers face uncertainty in product approval and compliance, while consumers risk exposure to substandard formulations. Strengthening regulatory oversight is essential to facilitate safe usage, stimulate local research, and build consumer trust [54].

**3. Cost and Local Production**

High dependency on imported probiotic strains and encapsulation technologies has made biotics prohibitively expensive for many poultry operations. Local production of microbial strains adapted to Nigerian poultry breeds and environmental conditions is still in its infancy. Equally underutilized are indigenous prebiotic sources such as cassava peels, *Moringa oleifera* leaves, and fermented maize-based products, which could serve as affordable alternatives [55, 56]. Encouraging innovation and investment in homegrown solutions is vital for cost reduction and wider accessibility.

**The Way Forward**

To fully harness the benefits of biotics in Nigerian poultry production, a multifaceted and collaborative approach is required:

* Research and Development (R&D): Investment in local R&D is critical to isolate region-specific microbial strains, optimize feed formulations, and develop cost-effective delivery systems tailored to local production environments [57].
* Farmer Education and Extension: Training programs and model demonstration farms should be established to promote hands-on knowledge transfer. This will empower farmers with practical skills to adopt biotic-based practices confidently and effectively [58].
* Regulatory Reforms: A strengthened and harmonized regulatory environment is needed to enforce product quality standards, ensure safety and efficacy, and foster innovation within the feed additive industry [49].
* Public-Private Partnerships (PPPs): Strategic partnerships can support subsidization of biotic products, promote local manufacturing, and accelerate the transition to antibiotic-free poultry farming [59].

With these coordinated efforts, Nigeria can advance toward a more resilient and sustainable poultry sector rooted in public health, economic growth, and environmental stewardship.

**Conclusion and Future Perspectives**

The exploration of biotics—probiotics, prebiotics, and postbiotics—in poultry production presents a significant opportunity to transform health management practices within Nigeria’s poultry industry. As antibiotic resistance and consumer demand for safe, residue-free poultry products continue to rise, natural alternatives are no longer optional—they are essential.

Probiotics have shown measurable success in promoting gut health, improving growth performance, and strengthening immune responses. Their integration, especially through locally sourced strains from fermented Nigerian foods, is both economically viable and culturally relevant. Prebiotics, though less studied, offer a complementary mechanism of action by nourishing beneficial gut bacteria. The use of agricultural by-products such as cassava peels, plantain skins, and moringa leaves not only supports gut function but also contributes to waste valorization and circular agriculture.

Postbiotics, while the least explored, represent a promising frontier due to their stability, safety, and multifaceted benefits—including antimicrobial and antioxidant effects. With increasing scientific interest, postbiotics may soon find their place in commercial poultry feed, offering producers an additional layer of protection and performance enhancement.

For these strategies to achieve widespread impact, targeted investment in research, farmer education, and regulatory oversight is needed. Multi-stakeholder collaboration—including academic institutions, agricultural extension services, and private sector innovators—will be critical in scaling adoption. Standardizing production methods and validating efficacy through field trials can facilitate trust and encourage uptake across the value chain.

In conclusion, the biotics-based approach aligns with global sustainability goals and holds transformative potential for Nigerian poultry farming. When fully harnessed, these natural interventions could reduce production costs, improve animal welfare, and ensure food safety—ultimately contributing to a more resilient agricultural future.

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