Is polysaccharides impactful in Poultry Nutrition? A Mini-Review

Obakanurhe O., Isioma, B. C. and Nwosa, I. J.

Department of Animal Production, Dennis Osadebay University, Asaba, Delta State

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***CORRESPONDING AUTHOR**

obakaoghenebrorhie@gmail.com
+2348069632073

ABSTRACT

Nigeria's poultry sector is essential to meeting the country's expanding population's economic needs and food security. However, poultry productivity and health are severely hampered by the tropical climate, which is marked by high temperatures and humidity. Optimizing the nutrition of poultry is crucial to reducing these difficulties. In the production of broilers, polysaccharide complex carbohydrates made up of many monosaccharide units have become important dietary components. Their inclusion in poultry diets has been shown to enhance growth performance, improve feed efficiency, and bolster immune function, particularly in stress-prone tropical environments. They further demonstrate their environmental sustainability by lowering greenhouse gas emissions through higher feed conversion ratios. Additionally, the use of polysaccharides supports resource efficiency by repurposing agricultural by-products, reducing waste, and minimizing reliance on synthetic additives. These benefits contribute to the economic sustainability of poultry farming by lowering veterinary costs and enhancing overall productivity. By lowering the demand for antibiotics and lowering the possibility of antibiotic resistance, the incorporation of polysaccharides into poultry feed also supports biodiversity conservation. Because of their antioxidative qualities, poultry can withstand heat stress and maintain steady production even in the face of environmental changes. By increasing resistance against climatic and environmental stressors, polysaccharides have the potential to promote sustainable poultry production, especially in tropical regions, as this review highlights.

INTRODUCTION

The poultry industry in Nigeria is critical to the yearning demand of the increasing population, where it plays a significant role in food security and economic stability. This sector is, however, highly dependent on optimal nutrition to meet the growing demand for poultry products. In these climates, environmental stressors such as high temperatures and humidity present challenges that can impact poultry bird's growth and health, emphasizing the need for dietary interventions that can enhance resilience and productivity. In recent years, polysaccharides have gained attention in broiler nutrition for their promising effects on growth performance, feed efficiency, and immune function, especially in challenging environments such as the tropics (Ahmad *et al* 2022).

Polysaccharides are complex carbohydrates composed of numerous monosaccharide units, they are divided into categories like storage and structural polysaccharides. Examples include starch, cellulose, and beta-glucans, each with unique roles and effects on poultry health and performance. In poultry diets, polysaccharides can come from various sources, such as grains, legumes, and even specific additives that

serve as prebiotics. The digestive system of poultry is central to their ability to absorb nutrients efficiently, and maintaining gut health is key to optimizing this process.

Polysaccharides have gained significant attention in poultry diets, especially in the tropical regions, due to their potential to enhance growth performance, improve immune responses, and optimize nutrient absorption in poultry. This review provides an in-depth analysis of the effects of polysaccharides on poultry production, with particular emphasis on their implications in the tropical climate.

According to Zhao *et al*. (2023), polysaccharides are essential for promoting sustainability in the poultry industry, in addition to their direct benefits for the health and productivity of poultry. By increasing feed efficiency, polysaccharides help reduce the overall amount of feed required, which in turn lowers the carbon footprint associated with feed production and transportation. This reduction in greenhouse gas emissions is especially important in tropical regions where environmental pressures are high.

Additionally, by minimizing waste and dependency on artificial additives, the exploitation of polysaccharides obtained from agricultural by-products enhances resource efficiency. By reusing by-products like barley β-glucans or plant husk cellulose, this strategy fosters a circular economy in the agricultural sector and helps establish a more sustainable agricultural value chain (Skendi *et al* 2020).

Polysaccharides also help to conserve biodiversity by reducing the need for antibiotics and delaying the development of antibiotic resistance. Willing *et al*. (2011) claim that this protects ecosystems and species from the harmful effects of resistant bacteria and maintains ecological equilibrium. Additionally, as the manure from these diets provides a balanced nutritional profile, reducing dependency on artificial fertilizers and promoting sustainable crop production, adding by-products high in polysaccharides to poultry diets enhances soil health

Polysaccharides offer long-term financial benefits by enhancing poultry health and reducing veterinary expenses. If polysaccharide-rich plants are sourced locally, small-scale farmers would find these sustainable practices more accessible, which would support economic sustainability in tropical regions. Furthermore, by increasing resilience against heat stress and disease, polysaccharides help poultry farming systems adapt to the challenges posed by climate change, ensuring consistent output and food security (Mlambo *et al* 2022).

The role of Polysaccharides in Poultry Production

Enhanced Growth Performance and Feed Efficiency

Polysaccharides like β-glucans, mannans, and xylo-oligosaccharides have shown promising results in promoting growth performance and feed efficiency among broilers. Studies reveal that including polysaccharides in poultry diets can lead to improved body weight gain and feed conversion ratio Schwartz and Vetvicka, 2021, Amer *et al*. 2022. In the tropics, where high temperatures can negatively impact poultry birds growth, polysaccharides have been observed to act as prebiotics, fostering beneficial gut microbiota that enhance feed utilization. The beneficial bacteria break down complex carbohydrates, making nutrients more available to the host, which is crucial in tropical conditions where feed quality might vary (Dryden 2021).

Improved Gut Health and Immune Response

A healthy gut is vital for poultry birds to combat pathogens and absorb nutrients efficiently, and polysaccharides significantly impact gut health. They stimulate the production of short-chain fatty acids (SCFAs) in the gut, which helps in maintaining an optimal pH level and creates an unfavorable environment for pathogenic bacteria. In tropical climates, where birds are more susceptible to infections due to humidity and heat stress, polysaccharides serve as a preventive measure by enhancing gut immunity (Ahmad *et al* 2022).

β-glucans, for instance, are known for their immunomodulatory properties, which enhance macrophage activity and promote antibody production. This effect has been particularly beneficial in tropical regions, where poultry birds face a higher risk of bacterial and viral infections (Hafez and Attia 2020, Schwartz, and Vetvicka, 2021). Studies show that diets supplemented with β-glucans can increase the production of immunoglobulins (IgA and IgG) in broilers, thus strengthening their immune response (Schwartz, and Vetvicka, 2021, Amer *et al*. 2022).. This improvement in immune status is critical in the tropics, where broilers are exposed to a range of stressors, including higher pathogen loads.

Antioxidative Properties and Stress Reduction

Heat stress in the tropics can impair poultry productivity by inducing oxidative stress, which damages cells and impairs immune function. Polysaccharides, particularly from natural sources like mushrooms and seaweeds, contain antioxidants that can counteract oxidative damage. This antioxidative property not only protects poultry bird's tissues from damage but also contributes to improved feed efficiency, as birds can metabolize nutrients more effectively without the burden of oxidative stress (Oke *et al*. 2024). For instance, fucoidans from brown algae and pectins from citrus peels have been shown to reduce markers of oxidative stress in poultry, thereby helping birds cope better with high temperatures. Studies conducted in tropical settings reveal that broilers fed polysaccharide-enriched diets exhibit lower levels of malondialdehyde (MDA), a marker of lipid peroxidation, indicating reduced oxidative stress (Al-harrasi *et al*.2022).

Enhanced Nutrient Absorption

In addition to enhancing growth and immune function, polysaccharides have been shown to improve nutrient absorption by increasing the absorptive surface area of the intestines. Mannan-oligosaccharides (MOS), for example, enhance the intestinal villus height and crypt depth, allowing for greater surface area for nutrient uptake. This effect is particularly advantageous in tropical regions, where feed ingredients may lack consistency in quality, and broilers need to maximize nutrient extraction from available feeds (Babatunde 2021). Studies also indicate that MOS prevents the attachment of pathogenic bacteria, such as *Escherichia coli* and *Salmonella*, by binding to their receptors, thus reducing the risk of infections that impair nutrient absorption (Asadpoor 2020). This is particularly beneficial in tropical environments where poor sanitation or water quality may expose broilers to higher levels of pathogens.

Reduction in Antibiotic Dependence

The use of polysaccharides as natural growth promoters provides an alternative to antibiotics, which have been widely used to prevent diseases and enhance growth in poultry birds. However, antibiotic use in poultry has raised concerns regarding antimicrobial resistance, especially in tropical regions where such resistance is rapidly rising due to high pathogen prevalence and inappropriate antibiotic usage. Polysaccharides like chitosan and galactooligosaccharides offer antimicrobial properties by disrupting bacterial cell membranes, thus reducing the need for antibiotics in broiler production (Goes 2024).

In tropical poultry production, where diseases are prevalent, polysaccharides provide a sustainable solution by reducing the incidence of enteric diseases and minimizing the need for antibiotics (Khan *et al*. 2022). This has positive implications not only for poultry birds health but also for public health, as it helps curb antibiotic resistance.

Impact on Carcass Quality and Meat Composition

Polysaccharides have been associated with improved meat quality, particularly in terms of lipid profiles and oxidative stability. For example, research shows that β-glucans and MOS can increase the levels of omega-3 and omega-6 fatty acids in poultry bird's meat, resulting in healthier meat products. This quality enhancement is beneficial for tropical producers, as it adds value to their products and meets consumer demand for healthier meat options (Ponnampalam *et al*. 2019).

Constraints and Possible solutions on the utilization of Polysaccharides in poultry production

1. Digestibility: The digestibility of polysaccharides can pose challenges, especially for non-starch polysaccharides (NSPs) that increase intestinal viscosity and can interfere with nutrient absorption. This issue is exacerbated in the tropics, where broilers already face metabolic stress from the environment. The inclusion of enzymes such as xylanase and β-glucanase in diets with high NSP levels can help break down these polysaccharides, reducing viscosity and enhancing nutrient availability (Nguyen *et al*., 2022). Enzyme supplementation has been shown to be effective in improving the digestibility of NSP-rich diets, allowing broilers in tropical climates to reap the benefits of these complex carbohydrates without compromising feed efficiency

2. Cost is another consideration in the use of polysaccharides for poultry birds diets in tropical regions. While naturally occurring polysaccharides from grains and legumes are relatively affordable, purified polysaccharides like beta-glucans and mannan oligosaccharides (MOS) can be costly, particularly in regions where these additives are imported (Fuso *et al*., 2023). Sourcing local, polysaccharide-rich plants could be a

solution to reduce costs, as could the development of cost-effective methods for processing these materials into broiler feed. Ensuring economic viability will be crucial for the widespread adoption of polysaccharide-enriched diets in tropical poultry farming.

3. Environmental factor: Environmental factors such as high humidity can accelerate feed spoilage, leading to mold growth and potential mycotoxin contamination. Mycotoxins are harmful to broiler health and can reduce productivity significantly. Proper feed storage and handling practices are essential to preserving the quality of polysaccharide-enriched diets and maximizing their benefits. These measures are particularly important in tropical climates where feed spoilage can occur more rapidly than in temperate regions, thus ensuring that the beneficial effects of polysaccharides on broiler health and performance are fully realized.

Polysaccharides have gained significant attention in broiler diets, especially in tropical regions, due to their potential to enhance growth performance, improve immune responses, and optimize nutrient absorption in poultry. This review provides an in-depth analysis of the effects of polysaccharides on poultry birds, with particular emphasis on their implications in the tropical climate.

Sustainability of Polysaccharides in Poultry Nutrition in Relation to the Environment

Poultry nutrition sustainability, which includes not only the economic feasibility and efficiency of raising chickens but also its environmental impact and the long-term health of the ecosystem, is greatly enhanced by polysaccharides, especially in tropical regions where environmental challenges demand creative solutions.

1. Decrease in Greenhouse Gas Emissions: Polysaccharides added to poultry diets can aid in the reduction of greenhouse gas emissions. Because polysaccharides improve feed efficiency, broiler growth rates can be achieved with less feed (Chen *et al*., 2020). Enhancing feed conversion ratios (FCR) lowers the carbon footprint of feed production and transportation, which in turn lowers emissions overall. In tropical areas, where feed supplies might be expensive and limited, this is especially crucial.

2. Resource Efficiency: Polysaccharides help with resource efficiency, particularly those that come from agricultural byproducts. Making use of these by-products encourages a more sustainable use of resources by lowering waste and the requirement for artificial feed additives (Faustino *et al*., 2019). The sustainability of the whole agricultural value chain can be improved by repurposing cellulose from plant husks or β-glucans from barley as functional feed components.

3. Soil Health and Crop Integration: The sustainable usage of polysaccharides also extends to the broader agricultural system. By integrating polysaccharide-rich by-products into chicken diets, farmers can develop a symbiotic relationship between crop production and poultry farming. Because manure from poultry fed polysaccharides often has a more balanced nutritional profile, this integration promotes soil health by lowering dependency on synthetic fertilizers and promoting sustainable crop production (Baptista *et al*., 2023).

4. Conservation of Biodiversity: Poultry farming can benefit biodiversity by lowering the demand for antibiotics by using natural growth stimulants such polysaccharides. Antibiotic overuse has been connected to the emergence of resistant bacteria, which can have an impact on ecosystems and wildlife (Dolejska 2020). Polysaccharide-based sustainable poultry nutrition techniques reduce the spread of antibiotic resistance, preserving ecological equilibrium.

5. **Economic Sustainability**: Polysaccharides provide an affordable substitute for synthetic chemicals and antibiotics from an economic standpoint. The long-term advantages of high-purity polysaccharides include lower veterinary expenses and better poultry health, which raise profitability even though the initial expenditures may be higher (Ahmad *et al*. 2021, Rani *et al*. 2023). Small-scale farmers in tropical areas may find sustainable techniques more affordable if polysaccharide-rich plants and byproducts are sourced locally.

6. Climate Change Resilience: Polysaccharides help make poultry agricultural systems more resilient to the negative consequences of climate change. They enable broilers better resist heat stress and disease problems, which are common in tropical regions, by enhancing immune function and gastrointestinal health (Apalowo *et al*., 2024). This resilience is vital for maintaining regular chicken production against variable environmental conditions, ensuring food security and economic stability in vulnerable places.

CONCLUSION

In Nigeria's tropical climate, polysaccharides present a viable way to improve poultry production while tackling important concerns including feed efficiency, immunological support, and sustainability. In addition to promoting gut health and food absorption, their function as prebiotics helps lower greenhouse gas emissions by increasing feed conversion ratios. By using agricultural by-products, the incorporation of polysaccharides into poultry diets encourages resource efficiency, promoting a circular economy and lowering reliance on artificial additives.

The economic benefits of lower veterinary costs and increased productivity highlight the potential for polysaccharides to contribute to the sustainability of poultry farming, especially in resource-constrained settings. Additionally, polysaccharides help poultry to become more resilient to environmental challenges and heat stress, which is essential for sustaining productivity in tropical regions. They also help fight antimicrobial resistance by reducing the need for antibiotics, which supports both animal health and environmental biodiversity.

All things considered, adding polysaccharides to poultry diets is a calculated move toward sustainable poultry farming. In addition to tackling the pressing issues brought on by the tropical climate, it also supports international sustainability objectives, guaranteeing food security and financial stability despite shifting climatic conditions. Leveraging the advantages of polysaccharides can open the door to a more resilient and sustainable agricultural future as Nigeria's chicken industry grows.

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