

Challenges of Incorporating *Azolla* in Broiler Diets: Impacts on Nutrient Absorption and its Physiological Pathways

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Structured Abstract

Background: *Azolla*, which is a fern with high protein, vitamin, and mineral content, has recently been viewed as a sustainable substitute feed material for broilers. Due to its capacity for nitrogen fixation and remarkable growth rate, *Azolla* is an economic and environmental substitute for conventional feeds like soybean meal. However, its utilization is hampered by high crude fiber, poor metabolizable energy, and anti-nutritional factors (ANFs), which can inhibit digestibility and growth performance.

Methods: A review of the research framework was used to author this paper. Sources of data were peer-reviewed journal articles published between 2015 and 2024 in databases such as ScienceDirect, Scopus, and PubMed. The inclusion criteria were studies on the effect of *Azolla* on nutrient use in broilers, digestive physiology, immune function, and gut microbiota. 1,037 articles were screened with 62 studies selected based on relevance and quality.

Results: This review shows that moderate inclusion of *Azolla* (5–10%) in broiler feed improves protein digestibility, feed conversion ratio, and intestinal health. The bioactive compounds of *Azolla* and its amino acid profile promote energy metabolism by glycolysis and the TCA cycle and activate the mTOR pathway to increase protein synthesis. *Azolla* also initiates immunity by cytokine regulation of IL-6, IL-10, and TLR2 and enhances lymphoid organ development. Besides, *Azolla* also alters gut microbiota composition through stimulation of *Lactobacillus* and *Bifidobacterium* and suppression of *E. coli* and *Clostridium spp.* Processing methods like fermentation, boiling, and enzymatic treatment can regulate ANFs and enhance nutritional quality.

Conclusion: In conclusion, the findings of this study indicated that *Azolla* also possesses huge potential to be used as a functional feed additive that improves broiler nutrient utilization, immune system, and gut microbiota and as a form of sustainable agriculture. It improves metabolic efficacy and growth when added at the right levels. Further molecular studies are encouraged to fully prove its physiological effects and long-term benefits on poultry production.

Keywords: *Azolla*, Anti-nutritional factors, Broiler, Gut microbiota, Nutrient Absorption

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