The Use of Biochar in Broiler Production: A Review Paper

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ABSTRACT

Poultry production plays a vital role in global food security, providing a major source of protein through broiler and layer chicken farming. However, challenges such as feed efficiency, environmental sustainability, and waste management require innovative solutions. Biochar, a carbon-rich material derived from pyrolysis, has emerged as a promising feed additive and litter amendment in broiler production. This review explores the impact of biochar on poultry nutrition, gut health, and productivity. Studies indicate that biochar improves feed conversion efficiency, enhances gut microbial balance, and mitigates the harmful effects of mycotoxins in broiler diets. Additionally, its application in broiler litter reduces ammonia emissions, improves manure quality, and minimizes greenhouse gas production, contributing to sustainable poultry farming. Despite these benefits, some studies report conflicting results regarding weight gain and performance, emphasizing the need for further research to optimize biochar inclusion levels. This paper highlights biochar's potential as an innovative tool for enhancing poultry production while reducing its environmental footprint.

Keywords: Biochar, Poultry, Feed Additive, Sustainability, Mycotoxins, Waste Management

INTRODUCTION

Poultry production remains a cornerstone of the global food supply chain, playing a critical role in addressing the increasing demand for high-quality protein sources. As one of the fastest-growing agricultural industries, poultry provides a reliable and affordable means of meeting human dietary protein requirements through meat and egg production (De Jong et al., 2020). The poultry industry is broadly categorized into two key segments: broiler chicken production, which focuses on meat yield, and layer chicken production, which specializes in egg production (Fanatico et al., 2007). These two sectors significantly contribute to food security, economic stability, and employment generation across various regions (FAO, 2021).

The rising global population and evolving dietary preferences have intensified the need for efficient and sustainable poultry production systems. Broiler chickens, recognized for their rapid growth and superior feed conversion efficiency, serve as a vital protein source to meet this growing demand (Mottet & Tempio, 2017). However, increasing feed costs, particularly the scarcity and price volatility of maize, pose significant challenges (Padilla et al., 2019). Consequently, researchers have explored alternative feed ingredients such as sorghum. While sorghum is comparable in energy content to maize, its use is limited due to anti-nutritional factors like tannins and phytates (Mogire et al., 2021).

One promising approach to mitigating these limitations is the incorporation of biochar as a feed additive. Biochar, produced via pyrolysis of organic biomass under limited oxygen conditions, enhances gut health and nutrient absorption (Man et al., 2020). It binds toxins, including mycotoxins and anti-nutritional compounds, facilitating improved feed utilization (Lao & Mbega, 2020; Gebeyew et al., 2015).

Beyond feed, biochar presents environmental benefits in broiler litter management by reducing ammonia emissions and improving manure quality (Naseem & King, 2018; Agyarko-Mintah et al., 2017). This dual functionality positions biochar as a valuable tool for sustainable poultry production.

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METHODOLOGY

This review synthesized existing research on biochar use in broiler production using a systematic literature review approach. Scientific databases including Google Scholar, PubMed, ScienceDirect, Web of Science, and Scopus were searched using keywords such as "biochar in poultry," "biochar feed additive," and "broiler performance." Studies included were:

- Published in peer-reviewed journals within the past 10 years (with exceptions of older, highly relevant studies).
- Focused on biochar as a feed additive or litter amendment in broiler production.
- Provided quantitative or qualitative data on feed conversion, gut health, mycotoxin mitigation, or environmental impacts.

Biochar

Biochar is a carbon-rich substance produced from the pyrolysis of plant- or animal-based biomass (Biederman & Harpole, 2013; Beesley et al., 2011). It is porous, lightweight, and has a high absorption capacity, making it useful in various environmental and agricultural applications (Pandey et al., 2020; Oni et al., 2019).

Composition of Biochar

Biochar typically contains high carbon content, large surface area, cation exchange capacity, and a stable structure (Sahoo et al., 2021). Its properties vary depending on the feedstock and pyrolysis process. Feedstock-based classifications include:

- Wood-based (He et al., 2024)
- Manure-based
- Agricultural waste-based (Gao et al., 2019)
- Industrial waste-based

Process-based types include:

- Conventional pyrolysis biochar (Aller, 2016)
- Hydrothermal carbonization biochar
- Torrefaction biochar (Webber & Peter, 2018)
- Engineered/modified biochar (Wang et al., 2017)

Applications of Biochar

Environmental Applications: Biochar improves water retention, reduces soil contaminants, mitigates climate change through carbon sequestration, and purifies water (Wang & Wang, 2019; Bolan et al., 2021).

Industrial Applications: It serves in redox reactions for pollution reduction, catalysis in syngas upgrading, biodiesel production, and energy storage systems (Yuan et al., 2017; Cha et al., 2016).

Agricultural Applications: Biochar improves soil fertility, nutrient use efficiency, and soil structure. In livestock, it reduces emissions, enhances manure quality, and serves as a feed additive (Hossain et al., 2020;

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Awasthi et al., 2020).

Biochar as Feed Additive in Broiler Production

Though biochar's agricultural use is well studied, its role in animal feed is emerging. Nair et al. (2023) reported that biochar need not be activated for use as a feed additive. Benefits include:

- Enhanced feed conversion efficiency and weight gain
- Mycotoxin detoxification (Man et al., 2020)
- Reduction of tannin effects (Nair et al., 2023)
- Increased beneficial gut microbes (Lao & Mbega, 2023)

Table 1: Summary of Key Studies on Biochar Inclusion in Broiler Diets

Study	Inclusion (%)	Findings	Effect
Al-Jumaily & Al-Jumaily (2022)	2–4%	Increased body weight, improved FCR	Positive
Goiri et al. (2021)	Not specified	Lower weight gain, higher FCR	Negative
Nair et al. (2023)	0.5%	Reduced mortality, aflatoxin mitigation	Positive
Dim et al. (2018)	1–1.5%	Improved hematology, serum lipid	Positive
Mohammed (2018)	Up to 1.5%	Improved carcass traits, no sensory effect	Neutral

Biochar as A Broiler Litter Treatment

Biochar reduces greenhouse gas emissions and improves manure nutrient retention (Awasthi et al., 2020). Studies show reduced ammonia emissions and better litter quality (Linhoss et al., 2019; Kalus et al., 2020). Biochar also enhances biogas production in anaerobic digesters (Indren et al., 2019).

Knowledge Gaps and Future Research Directions

While many studies report biochar's benefits, some findings are inconclusive. Key areas for future research include:

- Standardizing optimal biochar inclusion levels in broiler diets
- Long-term effects on broiler health and productivity
- Economic feasibility and scalability of biochar production
- Synergies between biochar and alternative grains like sorghum

CONCLUSION

Biochar holds promise as a sustainable solution in broiler production. It improves feed efficiency, reduces mortality, mitigates environmental pollutants, and enhances litter quality. However, mixed findings in growth performance and limited long-term data highlight the need for further research. Its dual use as feed additive and litter amendment underscores its versatility in addressing both nutritional and environmental challenges in poultry farming.

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