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Opinion

Exploring the potential of artificial intelligence in feed formulation to advance poultry health and One-Health

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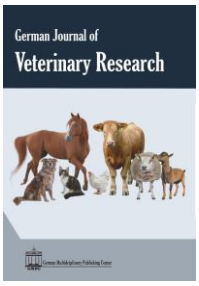

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Abstract

Feed accounts for over 60% of broiler production costs, with energy being the most significant factor. Traditional feed formulation methods focus on balancing nutrients to meet average flock needs but often fail to address the dynamic requirements of modern poultry production. Variability in growth rates, health, and environmental conditions can lead to feed utilization and performance inefficiencies. Artificial intelligence (AI) offers a transformative opportunity in poultry nutrition, enabling more precise and adaptable feed formulations. By leveraging large datasets and advanced algorithms, AI can accurately predict nutrient requirements and optimize feed in real-time, allowing continuous adjustments based on environmental changes and flock health. Essential support systems, including precision feed manufacturing tools, advanced sensors, and new energy systems like productive energy, are crucial to realizing the full potential of AI. These technologies will enhance feed formulation precision and align with One-Health principles, promoting sustainable practices that improve animal health and reduce environmental impact. AI will play a vital role in improving poultry production efficiency, productivity, and sustainability as it advances.

Keywords: Artificial intelligence, Feed formulation, Precision nutrition, Precision farming, One-Health, Computer vision

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Introduction

Feed represents about 65% of broiler production costs, with the energy value of the feed representing the most substantial factor. Given the narrow margins in poultry production, optimizing feed formulation is crucial for economic viability, maintaining bird health, and ensuring sustainable practices. The challenge in the industry is balancing cost and performance effectively while navigating constraints in feed mill operations and ingredient availability.

Traditional feed formulation methods have primarily focused on balancing nutrients to meet the average needs of broiler flocks (Sakomura et al., 2015), aiming to simplify production at feed mills and distribution logistics. However, these methods often do not address the dynamic and complex requirements of modern poultry production (Liu et al., 2024). Variability in bird growth rates, health status, and environmental and housing conditions lead to differences in feed utilization efficiency and performance outcomes (Martinez et al., 2022a). As a result, there is a growing need for more flexible and precise feed formulation strategies.

Artificial intelligence (AI) has emerged as a promising tool to enhance feed formulation processes (Akintan et al., 2024). AI offers the potential to revolutionize poultry nutrition by enabling more precise and adaptable formulations that account for a wide range of factors influencing bird health and performance (Liu et al., 2024). By leveraging large datasets and advanced algorithms, AI can predict nutrient requirements with accuracy and responsiveness (Wang et al., 2023) that traditional methods cannot match. AI can also provide precise predictions of how different feeds could impact flock performance (Wang et al., 2023), even if a single diet is used across multiple farms.

Using AI to optimize poultry feed formulation

AI-powered predictive models may analyze vast amounts of data from various sources, including historical production data from the same house, current flock performance and health, and environmental factors. These models would accurately forecast nutrient requirements, adjusting for variables such as age, health status, and environmental conditions. This precision ensures that even if a limited number of diets are produced, their impact on performance, health, and economics may be accurately predicted.

One of the most significant advantages of AI in feed formulation is its capacity for real-time adaptation (Alhotan, 2021) while improving logistics and supporting the supply chain. AI systems would dynamically adjust feed formulations based on continuous input from sensors and monitoring tools on the farm and feed mill (Ittiphalin et al., 2017). For instance, if environmental conditions such as temperature or humidity change, AI would recalculate the nutrient composition of the feed to support optimal health and minimize the risk of enteric (Martinez, 2022) or respiratory (Ghavi et al., 2021) processes. This adaptability level would help maintain performance across different flocks and conditions more consistently or precisely predict their performance results (Vedenov and Pesti, 2008).

Several support systems are essential to maximize the potential of AI in feed formulation. First, precision feed manufacturing and quality tools are needed to gather and integrate all data from each feed batch (Ittiphalin et al., 2017). Second, precision nutrition tools. A new energy system, such as Productive Energy (Hilton, 2020), which is sensitive to body composition (Maharjan et al., 2021a) and heat production changes (Martinez et al., 2022a) and correlates well with performance (Suesuttajit et al., 2022) and processing weights (Martinez et al., 2024), is necessary to formulate diets accurately and to make profit sensitive to diet energy (Martinez et al., 2024). Similarly, more complex and flexible factorial models (Sakomura et al., 2015) are needed to determine amino acid requirements. Third, precision processing and product quality systems. Tools to track the growth of processing parts (Martinez et al., 2022b, c, d), meat quality (Maharjan et al., 2020, 2021b), and product safety (Lyte et al., 2021) will allow to connect the dynamics of breast meat growth and the final product with all AI-driven systems. Fourth, precision health tools. Advanced sensors for monitoring aspects such as intestinal (Martinez et al., 2023a, b), respiratory, hepatic, leg, and bioacoustic health need to be developed based on nano-biosensing technologies (Devi et al., 2022), coupled with computer vision systems (van der Eijk et al., 2022). Fifth, precision environment and biosecurity (Devi et al., 2022) tools, as both factors are linked with performance and health. Response predictive models based on these systems will add to the strength and usefulness of AI.

AI-driven systems will excel in integrating data from multiple on-farm sources, such as feed intake, water consumption, bird weight data, and health metrics, to refine and optimize feed formulations continuously. Despite the potential for a diverse range of feed formulations, AI will ensure that the impact of each diet on flock performance is accurately predicted. By continuously comparing the actual feed provided with the flock's requirements, AI will predict performance outcomes with high precision. This approach will allow poultry companies to make informed decisions and optimize performance, even when using standardized diets across multiple farms.

Conclusion

Integrating advanced technologies into feed formulation and logistics holds substantial promise for poultry production. By enhancing the precision of feed formulations, streamlining the production of multiple diets, and accurately predicting flock performance, these technologies offer significant improvements in managing feed costs, boosting efficiency, and optimizing bird health and productivity.

As technological capabilities evolve, the potential applications in poultry nutrition will continue to expand, providing opportunities for even greater precision and efficiency. These advancements align with One Health principles, supporting sustainable practices and improving the overall efficiency of poultry production. Ongoing developments in this area will be instrumental in advancing poultry nutrition and developing future production practices.

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