Alternative Feed Use in Poultry Chickens: Impacts on Feed Efficiency and Physiological Parameters—A Systematic Literature Review

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Abstract

Feed cost and supply instability remain major constraints in poultry production, particularly in smallholder and semi-intensive systems where local chickens are commonly raised. Alternative feeds derived from local resources and agro-industrial by-products have been promoted to reduce reliance on commercial rations, yet evidence regarding their effects on feed efficiency and physiological stability remains inconsistent. This systematic literature review synthesized controlled feeding trials evaluating the effects of alternative feeds on feed conversion ratio (FCR), growth performance, and physiological parameters in poultry chickens. A PRISMA-guided search was conducted using Scopus, Web of Science, PubMed, and Google Scholar, and 20 eligible studies were included in the qualitative synthesis. Evidence was categorized into agro-industrial by-products, plant leaf meals, high-fiber ingredients, fermented feeds, animal-based alternative proteins, antinutrient-rich plants, enzyme-supported diets, hybrid feeding strategies, and layer-phase alternative feeding. Feed efficiency responses were highly context-dependent. Neutral or improved FCR and stable growth were more likely when alternative feeds were used at moderate inclusion levels and supported by fermentation, enzyme supplementation, and adequate micronutrient premixes. In contrast, high inclusion of fibrous or antinutrient-rich ingredients frequently reduced efficiency and increased the risk of metabolic stress. Hybrid feeding strategies produced the most consistent outcomes.

Keywords: Alternative Feeds; Feed Efficiency; Growth Performance; Physiological Components; Poultry Chicken

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INTRODUCTION

Feed cost and supply instability remain major constraints in poultry production, particularly in smallholder and semi-intensive systems (Mujyambere et al., 2021; Wilson et al., 2022; Oktariansyah et al., 2025). Dependence on commercial feeds exposes farmers to price volatility and seasonal supply fluctuations, often exacerbated by limited financial resources (Wilson et al., 2022; Kanyama et al., 2024; Mwesigwa et al., 2015; Kpomasse et al., 2023). Therefore, feeding strategies must be nutritionally adequate while remaining economically resilient and adaptable to changing production conditions.

Poultry chickens, including indigenous populations and improved native strains such as the Indonesian KUB chicken, differ fundamentally from commercial hybrid broilers (Manyelo et al., 2020; Sartika et al., 2024; Oktariansyah et al., 2025). Unlike commercial strains selected for rapid growth or high egg output under controlled conditions, poultry chickens typically exhibit moderate growth, sustained reproduction, and greater adaptability to low-input environments (Menchetti et al., 2024; Sartika et al., 2024). Consequently, their nutritional requirements should be defined not only by productivity targets but also by the capacity of diets to sustain growth, reproduction, and health while maintaining physiological stability and long-term resilience (Alagawany et al., 2020; He et al., 2021; Manyelo et al., 2020; Kpomasse et al., 2023).

Commercial feeds remain the dominant nutritional strategy in modern poultry production because they provide standardized nutrient composition, reduce deficiency risks through premixes, and simplify feeding management (Alhotan, 2021; Vlaicu et al., 2024). These diets are typically formulated to meet phase-specific metabolizable energy targets derived largely from studies on commercial strains raised under controlled conditions (Wu et al., 2019; Bailey, 2020; Cao et al., 2024; Ramankevich et al., 2025). When applied to poultry chickens, however, such standardized programs may not fully match their physiological demands and nutrient partitioning (Igwemmar et al., 2020; Moss et al., 2021; Quintana-Ospina et al., 2023; Li et al., 2024). Consequently, alternative feeds derived from locally available materials and agro-industrial by-products are gaining attention due to their potential to reduce feed costs, enhance feed self-sufficiency, and support circular agroecosystems (Vlaicu et al., 2024; Getahun et al., 2025). These include plant residues, insect meals, fishery by-products, and processed ingredients such as fermented feeds (Olukomaiya et al., 2019; Vlaicu et al., 2024; Getahun et al., 2025).

However, their effective use remains biologically complex because nutrient density and digestibility vary considerably, requiring careful consideration of ingredient characteristics, processing methods, inclusion levels, and diet formulation (Yi et al., 2018; Zentek & Boroojeni, 2020; Georganas et al., 2023; Simoni et al., 2025; Oktariansyah et al., 2025).

Although numerous studies have evaluated alternative feed ingredients in poultry chickens, the available evidence remains fragmented and largely centered on productive performance, while physiological responses are less consistently assessed. Differences in feed types, inclusion levels, processing methods, genotypes, and production phases further limit generalizable conclusions. This systematic literature review therefore synthesizes current evidence on the effects of alternative feeds on feed efficiency and physiological parameters in poultry chickens, while identifying key factors driving variability among studies to support more biologically informed and sustainable feeding strategies.

RESEARCH METHOD

Protocol and Reporting Guidelines

This systematic literature review (SLR) was conducted from December 2025 to January 2026 at the Laboratory of Physiology, Department of Biology, Sriwijaya University. The review synthesized evidence on the effects of alternative feeds on feed efficiency and physiological parameters in poultry chickens following the PRISMA guidelines (Page et al., 2020). The PRISMA framework guided the formulation of research questions, identification, screening, eligibility assessment, and synthesis of studies (Barrington et al., 2024). A qualitative synthesis approach was applied to ensure reproducible, evidence-based findings relevant to adaptive feeding strategies (Bramer et al., 2018).

Research Questions and Review Framework

This review employed the PICO framework to define the scope and ensure consistency in study selection and interpretation (Amir-Behghadami & Janati, 2020). The research questions addressed: (i) the effects of alternative feeds on feed efficiency and production performance, (ii) their influence on physiological parameters, and (iii) factors explaining heterogeneity across studies, including feed type, inclusion level, processing, production phase, genotype, and management context.

Literature Search Strategy

Literature was retrieved from Scopus, Web of Science, PubMed, and Google Scholar to ensure comprehensive coverage. Search strategies used Boolean operators, truncation, and quotation marks (Bramer et al., 2018). The core search string included combinations of poultry terms, alternative feed types, and performance indicators. Titles and abstracts were screened, followed by full-text assessment based on predefined criteria. Eligible studies were included in the qualitative synthesis.

Study Selection Process

Study selection followed PRISMA 2020 guidelines (Page et al., 2020). The initial search identified 55 records; after removing 12 duplicates, 43 records were screened. Eighteen were excluded due to irrelevance, leaving 25 for full-text assessment. Of these, 20 studies met the eligibility criteria and were included in the final synthesis. The selection process is presented in Figure 1 (PRISMA flow diagram; Page et al., 2020).

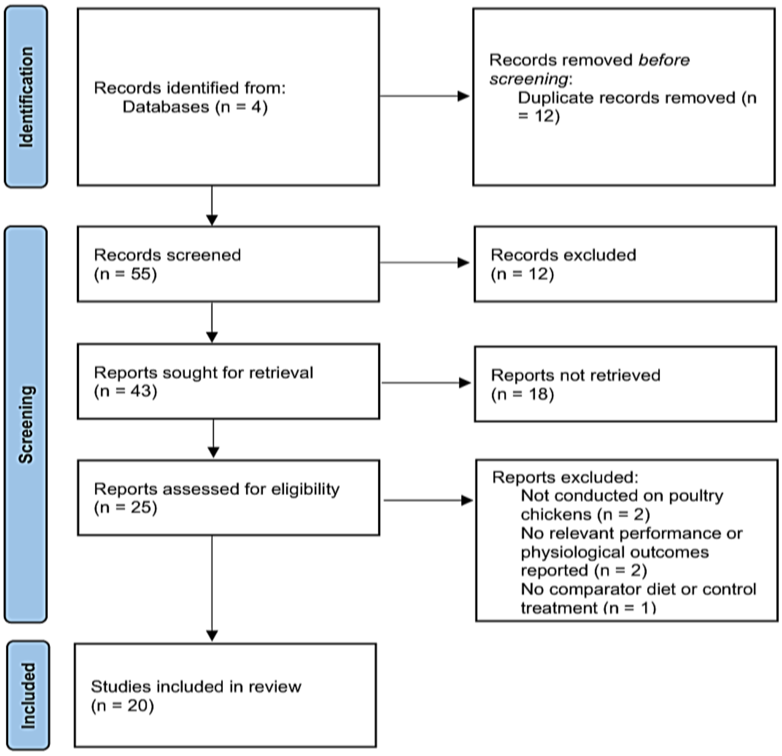

Figure 1. PRISMA flow diagram of study selection process

Eligibility Criteria

The eligibility criteria are presented in Table 1.

Table 1. Eligibility Criteria for Study Selection

Inclusion Criteria	Exclusion Criteria
Alternative feeds from poultry resources (plant-based, agro-industrial by-products, insect/fish by-products, fermented/processed poultry ingredients)	No alternative feed intervention/exposure evaluated
Includes a clear comparator diet (commercial feed or basal/conventional ration)	No control/comparator group
Reports ≥1 relevant outcome: FCR, feed intake, BWG/ADG, final BW, egg production (if available), mortality; and/or hematology/biochemistry	No extractable performance or physiological outcomes
Full-text peer-reviewed article	Conference abstracts without full data, inaccessible full text
English or Indonesian; within the defined search period (2010-2026)	Outside language/time limits, duplicates

Quality Assessment of Included Studies

Each study was evaluated based on several criteria, including clarity of experimental design, presence of a control or comparator diet, transparency of diet formulation, adequacy of reported performance outcomes, and completeness of physiological measurements. Studies were categorized into low, moderate, or higher risk of bias depending on the completeness of methodological reporting and the robustness of experimental design. Controlled feeding trials with clearly defined treatment groups, comparator diets, and measurable performance outcomes were considered to have a lower risk of bias. This quality assessment ensured that the synthesized evidence was derived from studies with adequate experimental control and reporting transparency.

RESULT AND DISCUSSION

Overview of included studies and evidence structure

This systematic literature review synthesized evidence from 20 controlled feeding trials evaluating alternative feed resources in poultry chicken production systems, including improved native lines where reported (Table 2). After database searching, duplicate removal, screening, and full-text eligibility assessment, 20 studies were retained for qualitative synthesis. The evidence was organized into major alternative feed categories, including agro-industrial by-products, plant leaf meals and forage resources, high-fiber ingredients, fermented feeds, animal-based alternative proteins, antinutrient-rich plant materials, enzyme-supported diets, hybrid feeding strategies, and layer-phase alternative feeding systems. These categories represent the primary nutritional strategies investigated for integrating alternative feeds into poultry chicken diets.

Table 2. Evidence Summary of Alternative Feed Categories in Poultry Chickens

Alternative feed category	Typical examples	Effect on FCR	Physiological effects	Optimal conditions / key requirements	Key references
Agro-industrial by-products (energy/fiber-rich)	Rice bran, cassava by-products, palm kernel-derived meals, tofu/soy residues	Mixed (neutral to high when fiber/variability high)	Mostly neutral if balanced; risk of subclinical stress when nutrient dilution occurs	Moderate inclusion; maintain energy density; manage fiber; add premix (vit/min); process if needed	Singh & Kim., 2021; Jha & Mishra., 2021; Getahun et al., 2025; Olowoyeye, 2025
Plant leaf meals / forages	Leaf meals, legumes, forage plants	Neutral to low (dose-dependent)	Neutral/beneficial at low inclusion; risk with antinutritional factors at high inclusion	Limit inclusion; drying/fermentation; avoid high tannin sources	Samtiya et al., 2020; Das et al., 2022; Fatmawaty & Harun, 2025
High-fiber ingredients (general class)	High-dietary fiber (DF) plant coproducts, fibrous residues	Often low if DF high; can be neutral at controlled level	May shift gut ecology; excessive DF reduces digestibility	Select DF type/level carefully; processing and enzyme support improve utilization	Jha & Mishra., 2021; Singh & Kim., 2021; Bedford et al., 2024
Fermented alternative feeds	Fermented plant materials, fermented by-products	Often high or neutral	Frequently beneficial/neutral (digestibility and stability improve)	Controlled fermentation quality; consistent protocol; safe inclusion levels	Samtiya et al., 2020; Predescu et al., 2024;
Animal-based alternative proteins	Insect meal, fish by-products, aquatic-derived proteins	Often high or neutral	Generally neutral/beneficial (protein quality, immune support)	Quality control; proper processing; avoid rancidity/contaminants; stable supply	Gasco et al., 2020; Elahi et al., 2022; Belhadj Slimen et al., 2023; Sajid et al., 2023; Iheukwumere et al., 2025
Unprocessed plant alternatives with high antinutrient	Raw/high-phytate or tannin-rich materials	Commonly low	Greater risk of reduced bioavailability and metabolic load	Processing (fermentation/heat/soaking) and targeted supplementation	Samtiya et al., 2020; Das et al., 2022; Katu et al., 2025
Enzyme-supported alternative diets	Alternative diets with phytase/xylanase/protease	Often high or neutral	Typically, neutral/beneficial (better nutrient release and gut function)	Match enzyme to substrate (NSP/phytate/protein); keep baseline nutrients adequate	Bedford & Apajalahti, 2022; Bedford et al., 2024

Alternative feed category	Typical examples	Effect on FCR	Physiological effects	Optimal conditions / key requirements	Key references
Hybrid feeding strategies (commercial and alternative feeds)	Partial substitution programs	Usually neutral to high (more consistent)	Generally safer than full replacement	Phase-specific feeding; premix security; controlled substitution rate	Samtiya et al., 2020; Bedford & Apajalahti, 2022; Oktariansyah et al., 2025
Layer-phase alternative feeding (mineral sensitive)	Alternative diets during laying	Variable (depends on Ca–P control)	Risk of shell/bone issues if mineral imbalance	Strict Ca–P control; premix and mineral supplementation mandatory	Samtiya et al., 2020; Bedford & Apajalahti, 2022

Agro-industrial by-products such as rice bran, cassava residues, palm kernel meal, and soy/tofu by-products are widely used as alternative feeds due to their availability and cost advantages. FCR responses vary: efficiency declines with high fiber or inconsistent nutrient density but remains stable or improves when inclusion is moderate and diets are nutritionally balanced. These feeds are generally well tolerated, although excessive nutrient dilution may induce subclinical stress (Singh & Kim, 2021; Jha & Mishra, 2021; Getahun et al., 2025; Olowoyeye, 2025).

Plant leaf meals show dose-dependent effects, with low-to-moderate inclusion yielding neutral FCR, while higher levels reduce efficiency due to fiber and antinutritional compounds. Their use requires controlled inclusion, proper processing, and low-tannin sources (Samtiya et al., 2020; Das et al., 2022; Fatmawaty & Harun, 2025). High fiber reduces digestibility, whereas moderate levels may support gut function (Jha & Mishra, 2021; Singh & Kim, 2021; Bedford et al., 2024).

Fermented feeds generally improve efficiency by enhancing digestibility and reducing antinutritional factors, though outcomes depend on process quality (Samtiya et al., 2020; Predescu et al., 2024). Animal-derived feeds such as insect meals and fish by-products often improve FCR due to high digestibility and amino acid quality (Gasco et al., 2020; Elahi et al., 2022; Belhadj Slimen et al., 2023; Sajid et al., 2023; Iheukwumere et al., 2025).

Conversely, unprocessed plant feeds rich in phytate or tannins reduce efficiency and require processing or enzyme supplementation (Samtiya et al., 2020; Das et al., 2022; Katu et al., 2025; Bedford & Apajalahti, 2022; Bedford et al., 2024). Hybrid feeding systems combining commercial and alternative feeds tend to yield the most stable outcomes, though mineral balance must be maintained during the laying phase (Samtiya et al., 2020; Bedford & Apajalahti, 2022; Oktariansyah et al., 2025).

Alternative Feeds and Feed Efficiency Outcomes

Aligned with Table 2, the effects of alternative feeds on feed efficiency in poultry chickens depend on ingredient type, inclusion level, nutrient balance, and processing. FCR responses vary from improvement to decline, indicating effectiveness only when digestibility and nutrient density are maintained. Agro-industrial by-products (e.g., rice bran, cassava residues, palm kernel meal, tofu/soy by-products) show mixed outcomes: efficiency declines with high fiber or energy dilution but remains stable or improves with moderate inclusion and proper diet reformulation (Singh & Kim, 2021; Jha & Mishra, 2021; Getahun et al., 2025; Olowoyeye, 2025).

Plant leaf meals exhibit dose-dependent effects, with low inclusion maintaining FCR and higher levels reducing efficiency due to fiber and antinutritional factors; these effects can be mitigated through processing or enzyme supplementation (Jha & Mishra, 2021; Singh & Kim, 2021; Bedford et al., 2024). In contrast, fermented feeds generally improve efficiency by enhancing digestibility and reducing antinutritional constraints (Samtiya et al., 2020; Predescu et al., 2024).

Animal-derived alternatives such as insect meal and fish by-products support stable or improved FCR due to high digestibility and balanced amino acids (Gasco et al., 2020; Elahi et al., 2022; Belhadj Slimen et al., 2023; Sajid et al., 2023; Iheukwumere et al., 2025). Conversely, unprocessed plant feeds rich in phytate or tannins reduce efficiency unless treated (Samtiya et al., 2020; Das et al., 2022; Katu et al., 2025). Enzyme supplementation (e.g., phytase, xylanase, protease) further enhances nutrient availability (Bedford & Apajalahti, 2022; Bedford et al., 2024). Overall, hybrid feeding systems combining commercial and alternative feeds provide the most stable efficiency outcomes (Samtiya et al., 2020; Bedford & Apajalahti, 2022; Oktariansyah et al., 2025).

Growth and Productivity Outcomes

Growth and productivity generally followed feed efficiency trends. Alternative feeds associated with neutral or improved FCR—such as fermented feeds, animal-based proteins, enzyme-supplemented diets, and hybrid systems—tended to maintain body weight gain and final body weight when digestibility and nutrient density were preserved (Gasco et al., 2020; Bedford & Apajalahti, 2022; Predescu et al., 2024; Bedford et al., 2024; Oktariansyah et al., 2025).

Conversely, growth depression occurred when FCR declined, particularly with high inclusion of fiber-rich by-products, leaf meals, or unprocessed plant ingredients containing antinutritional factors. Reduced growth is linked to lower digestible energy, amino acid limitations, and impaired nutrient absorption rather than crude protein levels alone (Chrystal et al., 2019). This underscores the importance of controlled inclusion and proper processing (Samtiya et al., 2020; Das et al., 2022; Singh & Kim, 2021; Jha & Mishra, 2021; Katu et al., 2025).

Palatability and ingredient variability may also affect intake and growth, especially with poorly adapted novel feeds. During the laying phase, strict calcium–phosphorus balance and micronutrient supplementation are essential to maintain egg production and shell quality (Samtiya et al., 2020; Bedford & Apajalahti, 2022).

Biological Cost Behind Performance

Feed efficiency and growth performance are key indicators of nutritional success but may not fully reflect physiological impacts. Poultry chickens can maintain acceptable FCR or growth through compensatory mechanisms while still experiencing subclinical metabolic stress when nutrient density, bioavailability, or diet safety are compromised (Oktariansyah et al., 2025). Therefore, evaluation of alternative feeds should consider both performance and physiological compatibility.

Feeds associated with stable or improved FCR—such as fermented feeds, enzyme-supported diets, and animal-derived proteins—generally show neutral or beneficial physiological responses when nutrient balance and quality are maintained, as improved digestibility reduces metabolic load (Ravindran et al., 2021; Bedford & Apajalahti, 2022; Predescu et al., 2024). In contrast, fiber-rich by-products and unprocessed plant ingredients high in phytate or tannins may impair nutrient availability and increase metabolic stress if not properly processed (Samtiya et al., 2020; Das et al., 2022; Jha & Mishra, 2021; Singh & Kim, 2021).

Physiological risks are especially critical during the laying phase, where calcium–phosphorus balance and micronutrient supply are essential for egg formation and skeletal stability (Sinclair-Black et al., 2023). Thus, alternative feeding strategies should be evaluated not only by FCR or growth improvements but also by the absence of hidden physiological costs, with hybrid and technology-supported systems offering lower-risk options (Bedford & Apajalahti, 2022; Oktariansyah et al., 2025).

CONCLUSIONS

This systematic literature review indicates that alternative feeds can maintain feed efficiency and physiological stability in poultry chickens, although outcomes depend on ingredient type, inclusion level, processing method, and production phase. Agro-industrial by-products and plant-based resources often show variable feed conversion responses when dietary fiber is high or nutrient density is diluted, whereas fermented feeds, enzyme-supported diets, and animal-based alternative proteins more consistently support efficiency through improved digestibility. Growth performance generally follows FCR trends, although acceptable production outcomes may mask subclinical metabolic burdens when diets are nutritionally imbalanced or micronutrients are inadequate. Overall, hybrid feeding strategies combining commercial feeds with controlled alternative substitution provide the most reliable approach. These findings highlight the potential of locally available alternative feed resources to support more resilient and cost-efficient poultry production systems.

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