Int.J.Curr.Res.Aca.Rev.2026; 14(11): 85-91

EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 14 Number 11 (November-2026)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2026.1411.010

Alternative Protein Sources in Broiler Diets and Their Effects on Growth Performance, Gut Health, Meat Quality and Sustainability

DIALLO Abdoulaye Aguibou[1], AKUESON Adoté Hervé Gildas[2*], DIALLO Mamadou Dian[3] and DIALLO Boubacar[4]

[1]Head of the Department of Animal Sciences, ISAV-VGE, Faranah, Republic of Guinea
[2]Lecturer and Researcher, ISAV-VGE, Faranah, Republic of Guinea
[3]Head of the Student Progress Monitoring Section, ISAV-VGE, Faranah, Republic of Guinea
[4]Head of the Department of Agriculture, ISAV-VGE, Faranah, Republic of Guinea

**Corresponding author*

Abstract

This structured review examines the effects of insect meals, microbial proteins, legumes, fermented co-products, and partial replacements for soybean meal in broiler diets. A targeted search of the scientific literature available through August 2026 prioritized meta-analyzes, systematic reviews, and controlled trials. Fifteen key publications were included in the main synthesis. The evidence suggests that growth performance and feed efficiency may improve, with the magnitude of the response depending on the inclusion level, dietary energy and protein balance, age, genotype, feeding duration, and health conditions. Findings were assessed using a common framework covering average daily gain, feed conversion ratio, digestibility, gut health, and meat quality. Assessment of alternative diets should consider digestibility, product quality, animal health, cost, and environmental footprint alongside growth and total output. Equations are provided to standardize the calculation of feed conversion, effect size, and heterogeneity. The main limitation was variation in protocols and reporting units, which prevented quantitative pooling across all interventions without access to the complete data. Randomized trials at ISAV-VGE in Faranah could test the most promising options under local conditions. Overall, gradual substitution based on digestible nutrients and accompanied by health monitoring appears to be the most robust approach.

Article Info

Received: 18 September 2026
Accepted: 28 October 2026
Available Online: 20 November 2026

Keywords

Animal nutrition, feed formulation, growth performance, digestibility, sustainability, structured review.

Introduction

Feed generally accounts for the largest share of broiler production costs. Volatile prices for maize, soybean, feed concentrates, and mineral supplements put pressure on poultry farms, while competition among food, feed, and industrial uses increases demand for the same resources. Feed formulation strategies must address productivity, animal health, profitability, and sustainability together (Belhadj Slimen *et al.,* 2023, Wangui *et al.,* 2025).

Research on insect meals, microbial proteins, legumes, fermented co-products, and partial replacements for soybean meal is expanding. These ingredients may be locally available, provide a use for co-products, or influence digestive function (Grigore *et al.,* 2025, Makkar *et al.,* 2014, Gasco *et al.,* 2019).

A low-cost ingredient can increase production costs if it reduces feed intake, digestibility, or product quality. Conversely, a more expensive additive may be cost-

effective if it improves feed conversion or reduces losses associated with poor health.

Comparisons across studies remain difficult. Control diets differ, doses are expressed in different units, and birds are studied at different physiological stages. Results also depend on the microbiological quality of the ingredients, drying or fermentation methods, and storage duration (Schiavone *et al.,* 2017, Bovera *et al.,* 2016). A synthesis must therefore distinguish average biological effects, the conditions under which they occur, and the sources of heterogeneity.

Current precision nutrition approaches account for available energy, digestible amino acids, functional fiber, and the fraction of dietary minerals that can be absorbed. They also consider changes in the microbiota, immune function, and emissions (Biasato *et al.,* 2018, Cullere *et al.,* 2016, Onsongo *et al.,* 2018). Diets with the same protein content may therefore differ in nutritional value because digestibility and nutrient balance determine how effectively birds use the feed.

In tropical production systems, seasonal availability, storage conditions, and antinutritional factors can substantially alter the response. Studies by Józefiak *et al.,* (2016), Abdollahi *et al.,* (2016), and Ayalew *et al.,* (2022) show that effectiveness depends on both the quality of processing and the ingredient itself. Diets formulated for Faranah should therefore rely on laboratory analyzes of local ingredient batches to verify values obtained from feed composition tables.

This review examines evidence on insect meals, microbial proteins, legumes, fermented co-products, and partial replacements for soybean meal in broiler diets. It identifies the most consistent effects on performance and health, examines economic and environmental trade-offs, and proposes a validation protocol suited to conditions in Faranah. The guiding hypothesis is that diets balanced for digestible nutrients yield more reproducible effects than substitutions based on inclusion percentage alone (Akintan *et al.,* 2024, Siwach *et al.,* 2025).

Materials and Methods

Review Design and Literature Search

A structured scoping review was conducted in line with the transparency principles of PRISMA 2020. The search combined terms relating to the species, the type of feed or additive, performance, digestibility, product quality, and environmental impacts. Recent publications were prioritized, with selected foundational studies retained to help interpret the underlying mechanisms. The review was designed to map the evidence and did not seek to conduct an exhaustive meta-analysis.

Eligibility Criteria and Data Extraction

Eligible publications included controlled in vivo trials, meta-analyzes, and reviews reporting at least one measurable outcome or a directly applicable finding about an underlying mechanism. Studies that lacked a diet description or a comparator, or reported only in vitro conditions without a link to live animals, were excluded from the main synthesis. Each publication was coded for population, intervention, dose, duration, comparator, outcomes, direction of effect, and moderating factors.

Indicators and Equations

$$FCR = \text{Feed intake} / \text{Output or body weight gain} \quad (1)$$

$$ADG = (\text{Final body weight} - \text{Initial body weight}) / \text{Duration} \quad (2)$$

$$SMD = (\bar{X}\ (\text{intervention}) - \bar{X}\ (\text{control})) / \text{Pooled standard deviation} \quad (3)$$

$$RR = [a/(a+b)] / [c/(c+d)] \quad (4)$$

$$I^2 = \max\{0, (Q - df)/Q\} \times 100 \quad (5)$$

$$\text{Net benefit} = \text{Value of output} - \text{Feed costs} - \text{Additional costs} \quad (6)$$

A future meta-analysis should use a random-effects model to account for differences in species, doses, study durations, and feed matrices. The present review therefore maps the evidence qualitatively because a pooled estimate would give a misleading impression of precision.

Critical Appraisal and Risk of Bias

Each source was assessed using criteria adapted for animal studies. These covered the description of randomization, identification of the experimental unit, use of a comparator, baseline comparability, completeness of reporting, measurement precision, and consistency between the data and the conclusions.

PRISMA 2020 guided transparent reporting of the synthesis (Page *et al.,* 2021), and the SYRCLE risk-of-bias domains served as a reference for animal trials (Hooijmans *et al.,* 2014). Articles that fell short on several criteria were given limited weight when drawing conclusions.

Results and Discussion

Included Publications and Intervention Categories

Direction of Effects

Most studies reported a favorable or conditionally favorable response for at least one outcome. The most consistent findings concerned nutrient use efficiency and outcomes directly related to the mechanism under study. Effects on product quality and mortality were less consistent, partly because detecting them requires larger samples and longer observation periods.

Mechanisms of Action

The intervention first affects the physicochemical composition and palatability of the diet. It then alters feed intake, digestibility, and fermentation, which in turn influence energy and nitrogen availability. Responses in the microbiota, metabolism, and immune system ultimately shape performance, product quality, and environmental footprint. A disruption at any point in this pathway can explain the absence of a measurable production response.

Biological Interpretation

The available evidence supports the potential of insect meals, microbial proteins, legumes, fermented co-products, and partial replacements for soybean meal (Belhadj Slimen *et al.,* 2023, Grigore *et al.,* 2025, Gasco *et al.,* 2019).

The effect of a given ingredient depends on the amount birds consume, its digestibility, and the ability of the whole diet to meet their nutrient requirements. Better-controlled studies report positive responses when replacement diets are formulated to provide comparable nutrient supplies, with ingredient weight alone offering a poor basis for substitution.

Results should be reported with the mean, standard error, confidence interval, p-value, and effect size. Reporting these measures together helps distinguish statistical significance from biological importance. A modest difference may be economically meaningful at scale, while a statistically significant effect may have little practical value if it requires a costly dose or compromises product quality.

Performance and Health

An improvement in feed conversion ratio is often the most informative outcome because it indicates that birds achieve the same output with less feed (Bovera *et al.,* 2016, Biasato *et al.,* 2018). Proposed mechanisms include improved nutrient hydrolysis, reduced microbial competition, strengthened intestinal barrier function, and modulation of inflammation. Performance measures should be accompanied by monitoring of mortality, lesions, blood markers, and product quality.

Results should be reported with the mean, standard error, confidence interval, p-value, and effect size. Reporting these measures together helps distinguish statistical significance from biological importance. A modest difference may be economically meaningful at scale, while a statistically significant effect may have little practical value if it requires a costly dose or compromises product quality.

Sustainability and Economics

The environmental effect of replacing an imported ingredient with a local resource depends on drying, transport, processing, and losses. These factors should all be included in the assessment (Wangui *et al.,* 2025, Akintan *et al.,* 2024). The functional unit should be a kilogram of output, such as eggs, live weight gain, milk, or carcass weight, in preference to a kilogram of feed. Economic analysis should account for price, feed conversion, mortality, and product value. Results should be reported with the mean, standard error, confidence interval, p-value, and effect size. Reporting these measures together helps distinguish statistical significance from biological importance. A modest difference may be economically meaningful at scale, while a statistically significant effect may have little practical value if it requires a costly dose or compromises product quality.

Applicability in Faranah

In Faranah, ingredient selection should begin with a seasonal inventory of available feed resources and an assessment of their composition and safety. At a minimum, feed analysis should cover dry matter, protein, energy, fiber, minerals, and antinutritional factors. Trials should use a randomized design, include at least four replicates per treatment, and cover the production phase of interest. ISAV-VGE could use this approach to test hypotheses derived from the review.

Results should be reported with the mean, standard error, confidence interval, p-value, and effect size. Reporting these measures together helps distinguish statistical

significance from biological importance. A modest difference may be economically meaningful at scale, while a statistically significant effect may have little practical value if it requires a costly dose or compromises product quality.

Table.1 PECO Framework for the Structured Review

Component	Operational definition
Population	Broiler chickens
Intervention	Insect meals, microbial proteins, legumes, fermented co-products, and partial replacements for soybean meal
Comparator	Conventional diet or zero or low inclusion level
Outcomes	Average daily gain, feed conversion ratio, digestibility, gut health, and meat quality
Period	Publications available through August 2026

Table.2 Critical Appraisal Criteria for Primary Studies

Domain	Criterion for low risk	Treatment in the synthesis
Allocation	Randomization described	Greater weight in interpretation
Experimental unit	Bird, cage, or group clearly identified	Prevents pseudoreplication
Missing data	Attrition accounted for	Reduces bias in outcome estimates
Measurement	Standardized methods and blinded assessment where possible	Improves measurement reliability
Reporting	All stated outcomes reported	Reduces selective outcome reporting

Table.3 Key Publications Included in the Synthesis

Author and year	Intervention	Main finding
Belhadj Slimen *et al.*, 2023	Insects	High protein density. Inclusion level and chitin content are important.
Wangui *et al.*, 2025	Proteins from circular production systems	Environmental benefits vary with energy inputs and processing methods.
Grigore *et al.*, 2025	Microbial proteins	Promising as part of a diet, depending on the amino acid profile.
Makkar *et al.*, 2014	Insect meals	Potential replacement for soybean meal and fishmeal.
Gasco *et al.*, 2019	Insects	Effects on performance, microbiota, and product quality.
Schiavone *et al.*, 2017	*Hermetia illucens*	Partial replacement was compatible with normal growth.
Bovera *et al.*, 2016	*Tenebrio molitor*	Performance and carcass quality were maintained at a moderate inclusion level.
Biasato *et al.*, 2018	*Tenebrio molitor*	Dose-dependent effects on gut morphology and microbiota.
Cullere *et al.*, 2016	*Hermetia illucens*	Carcass traits and meat quality were generally maintained.
Onsongo *et al.*, 2018	Insects	Partial replacement of soybean meal without major adverse effects.
Józefiak *et al.*, 2016	Insects	Responses varied with insect species and processing.
Abdollahi *et al.*, 2016	Palm kernel meal	Can be included when diets are formulated on a digestible amino acid basis.
Ayalew *et al.*, 2022	Alternatives to antibiotics	Probiotics and phytogenic feed additives support gut health.
Akintan *et al.*, 2024	Digital feed formulation	Formulation technologies can improve nutritional precision.
Siwach *et al.*, 2025	Plant residues	Potential sustainability benefits are limited by fiber and antinutritional factors.

Table.4 Sources of Heterogeneity and Measures to Address Them

Factor	Source of heterogeneity	Recommended measure
Dose	Nonlinear response	Test several inclusion levels
Physiological stage	Different nutrient requirements	Formulate diets for each phase
Processing method	Variation in digestibility	Analyse each ingredient batch
Basal diet	Substitution effect	Match dietary energy and digestible amino acid levels
Health and climate	Context-dependent response	Measure stress and morbidity

Figure.1 Distribution of Publications by Intervention Category

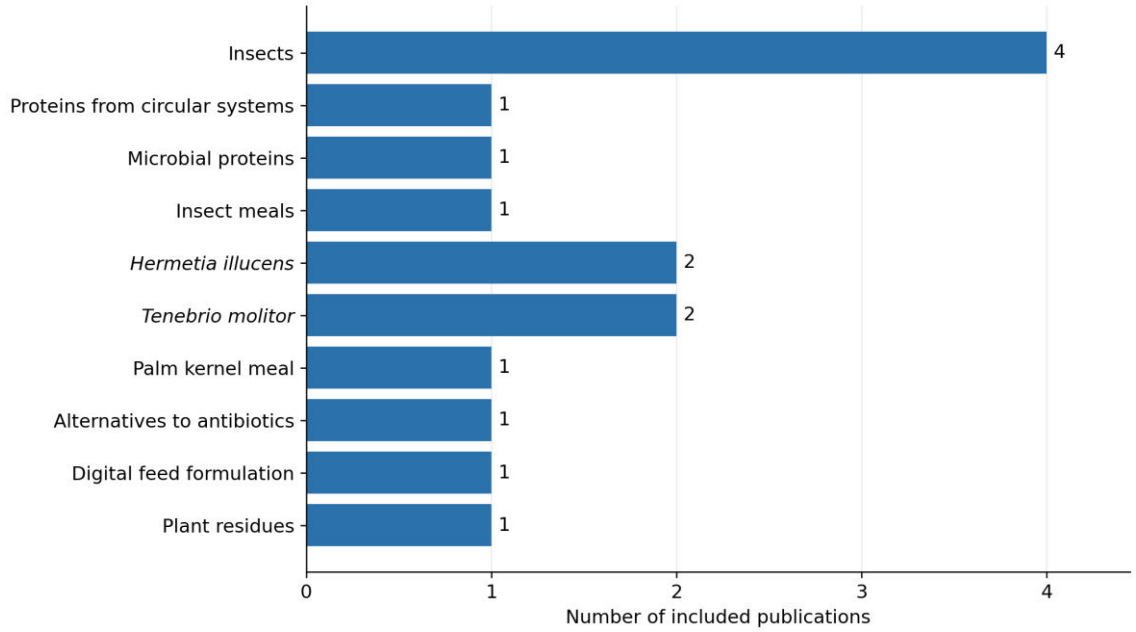


Figure.2 Qualitative Map of Favorable or Conditionally Favorable Effects Across Included Publications

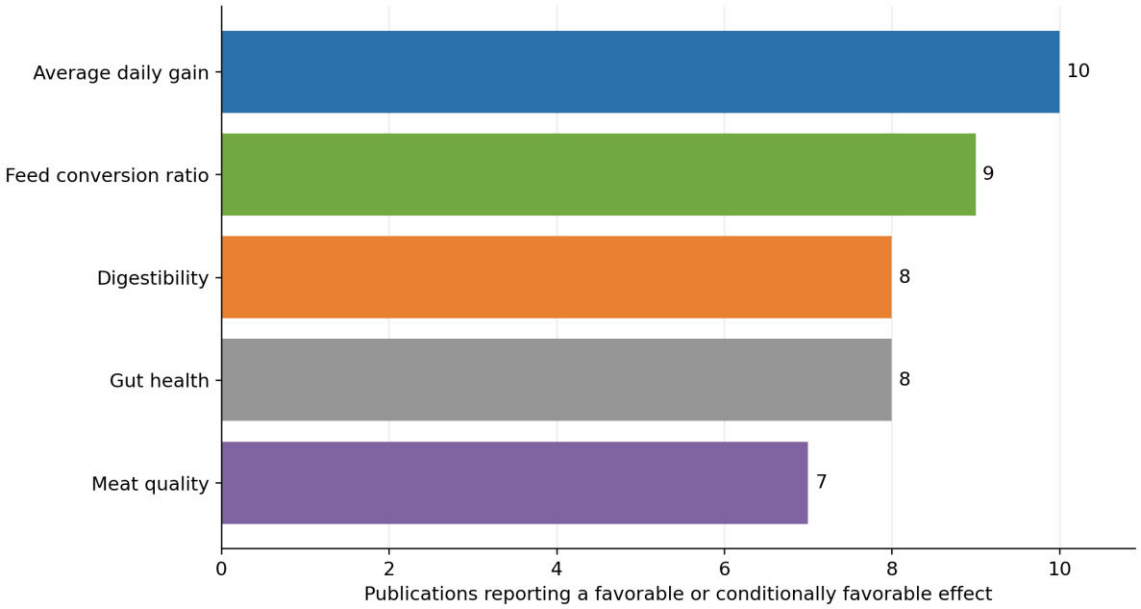
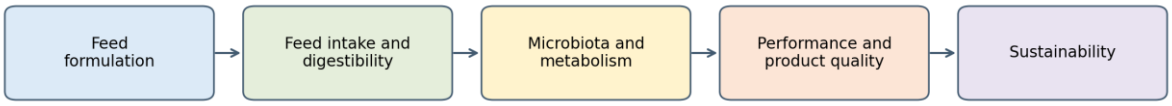


Figure.3 Causal Pathway Used to Interpret the Effects of Feed Formulations



Robustness, Remaining Limitations and Scope

The review addressed avoidable limitations by using an explicit PECO framework, eligibility criteria, and a critical appraisal checklist, by distinguishing quantitative findings from interpretation, and by avoiding an unsupported pooled estimate. The search was not conducted in parallel by two independent reviewers across all bibliographic databases, and numerical data could not be recovered for every trial.

The map of effect directions therefore gives no weight to the precision of individual studies and cannot substitute for a full meta-analysis. The conclusions describe the consistency of the evidence and the conditions under which positive outcomes are observed.

Results should be reported with the mean, standard error, confidence interval, p-value, and effect size. Reporting these measures together helps distinguish statistical significance from biological importance. A modest difference may be economically meaningful at scale, while a statistically significant effect may have little practical value if it requires a costly dose or compromises product quality.

Proposed Experimental Program

A local trial should compare a control diet with three experimental diets at graded inclusion levels. Treatments should be allocated at random, with blocking based on initial body weight or production level. Feed intake should be recorded for each experimental unit, performance measured regularly, and costs calculated using actual prices. A mixed-effects model would specify treatment as a fixed effect, block as a random effect, and time as a repeated measure. The protocol, exclusion criteria, and statistical analysis plan should be registered before data collection.

Results should be reported with the mean, standard error, confidence interval, p-value, and effect size. Reporting these measures together helps distinguish statistical significance from biological importance. A modest difference may be economically meaningful at scale, while a statistically significant effect may have little practical value if it requires a costly dose or compromises product quality.

In conclusion, the available literature indicates that insect meals, microbial proteins, legumes, fermented co-products, and partial replacements for soybean meal can improve broiler performance when diets are nutritionally balanced, feed safety is ensured, and formulations are suited to the birds' physiological stage. The most consistent effects are seen in outcomes directly related to digestibility and feed efficiency.

Economic and environmental benefits depend on context and should be assessed per unit of output. For ISAV-VGE in Faranah, the priority is to identify locally available resources, analyze their composition, and conduct adequately replicated randomized trials. This review provides the scientific framework, indicators, and equations needed for that validation.

References

Abdollahi, M. R., *et al.,* (2016). Palm kernel meal in broiler diets formulated on digestible amino acids. Animal Feed Science and Technology, 212, 69–76.

Akintan, O., *et al.,* (2024). Animal feed formulation—connecting technologies to build a resilient feed-food system. Animals, 14, 1497.

Ayalew, H., *et al.,* (2022). Potential feed additives as antibiotic alternatives in broiler production. Antioxidants, 11, 1109.

Belhadj Slimen, I., *et al.,* (2023). Insects as an alternative protein source for poultry nutrition: a review. Frontiers in Veterinary Science, 10, 1200031.

Biasato, I., *et al.,* (2018). Yellow mealworm larvae inclusion in broiler diets: effects on performance and gut morphology. Journal of Animal Science and Biotechnology, 9, 49.

Bovera, F., *et al.,* (2016). Use of Tenebrio molitor larvae meal as protein source in broiler diet. Journal of Animal Science, 94, 639–647.

Cullere, M., *et al.,* (2016). Black soldier fly as a dietary protein source for broiler quails. Animal, 10, 1923–1930.

Gasco, L., *et al.,* (2019). Insect and fish by-products as sustainable alternatives in animal feeds. Animal Frontiers, 9, 35–42.

Grigore, D. M., *et al.,* (2025). Toward sustainable broiler production: microbial protein sources as feed ingredients. Agriculture, 15, 1486.

Hooijmans, C. R., *et al.,* (2014). SYRCLE's risk of bias tool for animal studies. BMC Medical Research Methodology, 14, 43. https://doi.org/10.1186/1471-2288-14-43

Józefiak, D., *et al.,* (2016). Insects—a natural nutrient source for poultry. Annals of Animal Science, 16, 297–313.

Makkar, H. P. S., *et al.,* (2014). State-of-the-art on use of insects as animal feed. Animal Feed Science and Technology, 197, 1–33.

Onsongo, V. O., *et al.,* (2018). Insects for income generation through animal feed: black soldier fly meal in poultry diets. Journal of Insects as Food and Feed, 4, 253–260.

Page, M. J., *et al.,* (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ, 372, n71. https://doi.org/10.1136/bmj.n71

Schiavone, A., *et al.,* (2017). Partial or total replacement of soybean oil by black soldier fly larvae fat in broiler diets. Italian Journal of Animal Science, 16, 93–100.

Siwach, A., *et al.,* (2025). Sustainable poultry feed formulations from fruit and vegetable residues. Sustainable Chemistry and Pharmacy.

Wangui, C., *et al.,* (2025). One size does not fit all: systematic review, meta-analysis and life-cycle assessment of circular alternative proteins for poultry. Poultry Science.

How to cite this article:

DIALLO Abdoulaye Aguibou, AKUESON Adoté Hervé Gildas, DIALLO Mamadou Dian and DIALLO Boubacar. 2026. Alternative Protein Sources in Broiler Diets and Their Effects on Growth Performance, Gut Health, Meat Quality and Sustainability. *Int.J.Curr.Res.Aca.Rev.* 14(11), 85-91.
doi: https://doi.org/10.20546/ijcrar.2026.1411.010