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## EDITED BY

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## REVIEWED BY

John Moreki,  
Botswana University of Agriculture and Natural  
Resources, Botswana  
Andrea Moradei,  
Università degli studi di Milano, Italy

## \*CORRESPONDENCE

Wisje Lusja Toar

✉ wisje\_toar@unsrat.ac.id

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# Grasshopper-enriched poultry feed: a new approach to sustainable nutrition

Wisje Lusja Toar<sup>1\*</sup>, Carlos Palacios Riocerezo<sup>2</sup>,  
Jaime Nieto de la Losa<sup>2</sup>, Jimmy Posangi<sup>3</sup>, Laurentius Rumokoy<sup>4</sup>  
and Julio Lopez Aban<sup>5</sup>

<sup>1</sup>Laboratory of Animal Feed Technology, Department of Nutrition, Faculty of Animal Sciences, Sam Ratulangi University, Manado, Indonesia, <sup>2</sup>Area of Animal Production, Faculty of Sciences Environmental and Agronomy, University of Salamanca, Salamanca, Spain, <sup>3</sup>Laboratory of Medicine Pharmacology, Department of Medicine Pharmacology, Faculty of Medicine, Sam Ratulangi University, Manado, Indonesia, <sup>4</sup>Laboratory of Animal Production and Reproduction, Department of Animal Production, Faculty of Animal Sciences, Sam Ratulangi University, Manado, Indonesia, <sup>5</sup>Grupo de Enfermedades Infecciosas y Tropicales (e-INTRO), Instituto de Investigación Biomédica de Salamanca – Centro de Investigación de Enfermedades Tropicales de la Universidad de Salamanca (IBSAL-CIETUS), Facultad de Farmacia, Universidad de Salamanca, Salamanca, Spain

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## 1 Introduction

The abundance of natural resources—particularly grasshoppers found across the world—has been well documented (Afdila et al., 2020; Wei et al., 2023). These insects belong to the suborder *Caelifera*, which includes various families. The largest family within *Caelifera* is *Acrididae* (Le Gall et al., 2019). Insect resources yield valuable opportunities based on their nutritional value (Nieto et al., 2023). Recent scientific research reported by Aguilera et al. (2021) highlights insects as sustainable, protein-rich, and nutritionally dense food sources. For instance, insect meals found high levels of protein, essential fats, and unique compounds like chitin. This study emphasized that these nutritional attributes, combined with insects' low environmental impact, make them excellent candidates for future animal feed systems. The availability of raw materials for feed is essential for the successful production of feed to meet livestock needs. Grasshoppers can be considered a viable option for poultry feed production. This initiative aims to address the nutritional requirements of poultry, ultimately boosting poultry production. Moreover, enhancing the utilization of natural resources can lead to food conservation for humans. This factor is crucial to consider given the human population in the world. Thus, it is essential to ensure a sustainable supply of natural feed ingredients for poultry, such as grasshoppers, which offer high biological value without competing with food meant for humans. Initiatives to source sustainable feed ingredients, such as incorporating grasshoppers, will strengthen poultry production to meet human food demands. Currently, the livestock industry has not widely adopted insects, especially grasshoppers, as a natural resource for poultry feed. The purpose of this article is to briefly discuss the important potential role of grasshoppers as a breakthrough raw material in feed technology and as a subject that has not been widely

explored in the poultry feed industry recently. Many of the primary raw materials used as key protein sources in poultry feed, such as fish, soybeans, nuts, and corn, directly compete with human food sources. At the same time, it is undeniable that global food security continues to be an elusive goal for millions of people worldwide. One such alternative is the use of insects, such as grasshoppers, as feed ingredient. These insects offer several advantages, including being a cheap protein source (Alshelmani et al., 2021) that can be used as a raw material in poultry feed ingredient. The cultivation of insects is considered environmentally sustainable, as it generates significantly lower greenhouse gases (GHs) and requires substantially less land area. Grasshoppers thrive in a variety of environments, are easy to cultivate, and their organic material is not harmful to poultry (Latchininsky et al., 2011). Therefore, this paper aims to highlight the potential of grasshoppers as a sustainable and underutilized protein source for poultry feed, with notable nutritional and environmental benefits.

## 2 An overview of grasshoppers

Grasshoppers, particularly those belonging to the *Acrididae* family, represent a major taxonomic group within the suborder *Caelifera*. Members of this family are morphologically characterized by cylindrical bodies and elongated hind legs, which are structurally adapted for efficient jumping (Song et al., 2018). A key diagnostic feature distinguishing *Acrididae* from other grasshopper families is their relatively short antennae (Kumar and Usmani, 2014). *Acrididae* species are known to inhabit a wide range of ecological zones, including grasslands, forests, and deserts, and tend to thrive in environments with abundant vegetation (Song et al., 2018). As predominantly herbivorous insects, their diet consists largely of grasses, leaves, and other plant matter, although some species are also known to consume flowers and seeds. This dietary adaptability facilitates their mass-rearing on diverse plant substrates, making them a promising candidate for development as a sustainable alternative protein source.

Grasshoppers hold great potential as a sustainable, nutritious, and cost-effective ingredient for poultry feed. Therefore incorporating them into animal feed could provide substantial benefits across livestock industries, as they are an excellent source of protein. A comparison between grasshopper meal and fish meal, as reported by Lee et al. (2024), indicates that grasshopper meal contains higher concentrations of several essential amino acids. Notably, the levels of arginine (5.28 vs. 3.91), histidine (4.17 vs. 1.47), phenylalanine (2.96 vs. 2.68), threonine (9.74 vs. 2.80), tryptophan (1.74 vs. 1.28), valine (4.25 vs. 2.59), glycine (5.39 vs. 4.34), and tyrosine (7.45 vs. 2.04) were all greater in grasshopper meal compared to fish meal. Several studies have demonstrated that replacing fish meal with grasshopper meal in chicken rations has positive effects. Incorporating grasshopper meal at a 25% inclusion rate improves daily body weight gain, while increasing it to 50% significantly enhances feed conversion efficiency (Nginya et al., 2019). Furthermore, the highest final body weight was achieved with full (100%) replacement (Amobi et al., 2020).

## 3 Nutritional and environmental benefits

The nutritional value of grasshoppers, particularly those from the *Acrididae* family, is characterized by their high-density protein content, comprising a significant portion of their dry weight (Khranova et al., 2021). These insects provide a complete amino acid profile, including essential amino acids like lysine, methionine, and threonine, which are essential for poultry growth and reproduction (Lee et al., 2024). Owing to its rich nutritional profile—particularly its high protein content and essential amino acids—these insects hold significant potential as a sustainable and effective raw material for formulating poultry feed, thereby reducing reliance on conventional protein sources. This potential is further supported by findings from previous studies of Nginya et al. (2019) reported that the crude protein content of grasshopper meal is 52.0%, compared to 56.6% in fishmeal, while more recent review by Ahmed and İnal (2025) indicates that the protein content of grasshoppers can reach up to 76%.

Moreover, protein in grasshoppers is highly digestible and bioavailable, meaning poultry can efficiently convert this protein into muscle mass and other necessary bodily functions (Oonincx and Finke, 2021). They also contain significant amounts of essential fatty acids, particularly omega-3 and omega-6, which play a vital role in enhancing poultry's immune system, improving reproductive health (Alagawany et al., 2019). Fats from grasshoppers offer a dense source of energy, essential for the caloric needs of poultry. The presence of these fats also helps improve the feed conversion ratio (FCR), meaning chickens require less feed to reach optimal growth, thereby reducing feed costs. Grasshoppers are a superior poultry feed ingredient due to their minimal GHGs emissions. Additionally, they can be cultivated in smaller, contained spaces, promoting efficient land use. This reduces the need for deforestation and prevents habitat destruction, which are common consequences of expanding traditional agriculture to meet protein demands.

## 4 Discussion

Grasshoppers—especially those from the *Acrididae* family—have been used as a food source for a long time and are often featured in traditional dishes (Peng et al., 2020) and have not been integrated into the poultry feed industry. As a beneficial species, this insect is known to feed on a diverse array of wild plants, including wild grasses and weed foliage. If these resources are utilized on a global scale, they could provide a valuable income stream and help conserve protein sources like fish and nuts, ideally reserved for human nutrition. In this context, using grasshoppers as a component of poultry feed is an innovative approach due to its potential to address various environmental, economic, and nutritional challenges. This insect offers high nutritional value and sustainability, making it a promising candidate for future poultry feed production. The potential for incorporating grasshoppers into the poultry feed industry is evaluated based on

several key factors: nutritional benefits, environmental impact, economic feasibility, effects on poultry health and performance, and future research and technological advancements. Moreover, the future potential and significant benefits of incorporating grasshoppers into poultry feed are closely tied to sustainability and environmental impact, especially regarding the reduction of GHG emissions and land use. Economic viability, alongside poultry health and performance, will play a pivotal role in the adoption of grasshoppers in poultry feed. Providing a high-quality nutritional value, grasshoppers are a promising feed source (Siddiqui et al., 2023). Despite its promising nutritional profile, it has not yet been widely integrated as a raw material within the poultry feed industry. Using these insects as a nutrient-rich raw material for poultry feed presents a smart strategy for feed formulation policies and for the livestock feed industry.

Grasshoppers are rich in high-quality protein, essential amino acids, fatty acids, vitamins, and minerals—nutrients vital for optimal poultry growth and productivity. Incorporating grasshoppers into poultry diets not only improves feed conversion efficiency and growth performance but may also enhances meat and egg quality due to their favorable lipid profile. Furthermore, grasshopper farming has a significantly lower environmental footprint compared to traditional livestock production, requiring less land, water, and feed while emitting fewer greenhouse gases. Utilizing grasshoppers as a feed ingredient contributes to circular economy practices by valorizing agricultural pests into valuable protein sources. Despite these advantages, further research is needed to optimize inclusion rates, ensure feed safety, and assess long-term effects on poultry health and productivity.

## Author contributions

WT: Writing – original draft, Writing – review & editing, Conceptualization. CR: Writing – review & editing. Jd: Writing – review & editing. JP: Writing – original draft. LR: Writing – review & editing, Writing – original draft. JL: Writing – original draft.

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