HERMETIA ILLUCENS LARVAL MEAL SUPPLEMENTATION: GROWTH PERFORMANCE, FEED AND ECONOMIC EFFICIENCY IN BROILER CHICKENS

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Abstract

The study aimed to evaluate the effect of Hermetia illucens larval meal (HILM) supplementation on growth performance, feed efficiency, and economic efficiency in Ross 308 broiler chickens. The experiment included 80 one-day-old broiler chicks randomly assigned to four groups: a control group and three experimental groups receiving diets supplemented with 2.0%, 3.5%, and 5.0% HILM. Broiler chickens were fed phase-specific diets during the Starter, Grower, Finisher I, and Finisher II periods. HILM supplementation reduced feed consumption compared with the control group. The highest final body weight was recorded in the 3.5% HILM group (3121.88 g), exceeding the control by 216.13 g (7.44%). Feed consumption was 4186.06 g/bird in this group compared with 4313.78 g/bird in the control. Carcass yield reached 74.83%, and conditional economic efficiency was highest at 62.37 lei.

The results demonstrate that dietary inclusion of 3.5% HILM improved growth performance, feed utilization, and economic efficiency of broiler chickens, indicating its potential as an alternative protein source in broiler nutrition.

Key words: *Hermetia illucens; larval meal; broiler chickens; growth performance; feed efficiency*

INTRODUCTION

The growing demand for poultry meat and the need to reduce feed costs have increased interest in alternative protein sources for broiler chicken nutrition. In this context, insect-derived products, particularly black soldier fly (*Hermetia illucens*) larval meal, represent a promising alternative due to their nutritional value and potential contribution to sustainable poultry production.

The nutritional composition of *H. illucens* larvae depends on rearing substrate, developmental stage, and processing technology. Barragán-Fonseca [1] emphasized the influence of rearing conditions and substrate characteristics on larval nutritional composition, highlighting their importance in feed formulation.

Previous studies have investigated the effects of black soldier fly larval meal on broiler performance and physiological parameters. Schiavone [2] examined the inclusion of partially defatted larval meal in broiler diets, focusing on growth performance, blood parameters, and intestinal characteristics. Similarly, [3] reported favorable effects on certain productive performance and immune response indicators. A systematic review and meta-analysis conducted by [4] also highlighted the potential effects of insect meals and oils on poultry performance and intestinal health. However, [5] demonstrated that replacing a substantial proportion of soybean cake protein with full-fat *H. illucens* larval meal could negatively affect growth performance, carcass and meat characteristics. These

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findings indicate that the effects depend largely on the type of product, inclusion level, and overall dietary composition.

Growth performance, feed intake, body weight gain, and feed conversion ratio are essential indicators for evaluating the effectiveness of broiler feeding strategies. Economic efficiency is equally important, as feed represents a major component of production costs. Therefore, the practical value of alternative protein sources should be assessed by considering both productive performance and economic outcomes [6].

In the Republic of Moldova, the use of alternative feed ingredients may contribute to diversifying protein sources and developing more sustainable poultry production technologies. However, the suitability of *H. illucens* larval meal for commercial broiler production requires further evaluation under specific production conditions.

In view of these considerations, the present study investigates the effects of different inclusion levels of *H. illucens* larval meal in the diets of commercial Ross 308 broiler chickens, focusing on growth performance, feed intake, feed utilization efficiency, slaughter characteristics, and economic efficiency.

The research objectives were to: evaluate the growth performance of broiler chickens according to the dietary inclusion level of *H. illucens* larval meal; determine and compare feed intake in experimental and control groups; assess feed utilization efficiency, including feed conversion ratio; analyze the economic efficiency of broiler production; identify the inclusion level providing the most favorable combination of productive, slaughter, and economic indicators.

MATERIAL AND METHOD

The study was conducted using 80 one-day-old Ross 308 broiler chicks, randomly divided into four groups of 20 birds each. The control group (CG) received a basal diet, while the experimental groups received diets supplemented with 2.0% (EG_1), 3.5% (EG_2), and 5.0% (EG_3) *Hermetia illucens* larval meal. The larval meal was supplied by Terafix LLC (Republic of Moldova), and its chemical composition and nutritional value were determined at the Department of Horticulture and Animal Resources, Technical University of Moldova.

Birds were housed in cages with metal-mesh floors, feeders, and nipple drinkers. Temperature was gradually reduced from 30–33°C at the beginning to 18–22°C towards the end of the experiment. Feed and water were provided ad libitum. The feeding program included four phases: Starter (days 1–10), Grower (days 11–24), Finisher I (days 25–30), and Finisher II (days 31–41). Diets were formulated according to the nutritional requirements of each growth phase using conventional ingredients, including corn, wheat, soybean cake, soybean oil, and vitamin-mineral premixes. Ingredient proportions were adjusted to accommodate the different inclusion levels of larval meal.

Productive performance was evaluated through periodic body weight measurements, final body weight (g/bird), and feed intake (g/bird). Feed conversion ratio (FCR) was calculated when sufficient feed intake and body weight gain data were available.

Results were compared descriptively using group mean values and percentage differences relative to the control group. Statistical significance was reported only where supported by appropriate statistical tests, considering the experimental unit and exact p-values.

RESULTS AND DISCUSSIONS

Structure and Nutritional Composition of Compound Feeds

The experimental diets were formulated to meet the nutritional requirements of broiler chickens at different stages of growth while incorporating black soldier fly (*Hermetia illucens*) larval meal at inclusion levels of 2.0%, 3.5%, and 5.0%. The

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feeding program included the Starter (0–10 days), Grower (11–24 days), and Finisher I (25–30 days) phases. The proportions of conventional feed ingredients were adjusted according to the dietary treatment to accommodate the inclusion of larval meal.

During the Starter phase, crude protein content was maintained at 22.5% in all four dietary formulations. In the Grower phase, crude protein content was 21.0% in groups CG, EG_1, EG_2, and in EG_3. During the Finisher I phase, crude protein content was identical across all treatments, at 19.97%.

The incorporation of larval meal was accompanied by a reduction in the proportion of soybean cake. During the Starter phase, soybean cake inclusion decreased from 38.11% in the control diet to 32.87% in the diet containing 5.0% larval meal. During the Grower phase, the corresponding values decreased from 34.31% to 30.00%. In the Finisher I phase, soybean cake inclusion decreased from 28.81% to 23.16%. Sunflower cake was incorporated into the experimental diets only during the later growth phases [7].

The nutritional composition also varied among the formulations. Crude fat content ranged from 4.61% to 4.97% during the Starter phase, from 5.33% to 5.69% during the Grower phase, and from 6.10% to 6.58% during the Finisher I phase. Crude fibre generally increased with the inclusion level of larval meal, reaching 3.90% in the EG_3 diet during the Finisher I phase.

These changes indicate that larval meal was incorporated into reformulated diets rather than simply added to an unchanged basal feed. Consequently, the observed responses should be interpreted in relation to the complete dietary formulations, since changes in conventional ingredients may also have contributed to differences in growth performance and feed utilization.

Dabbou et al. (2018) [8] reported that the productive response of broiler chickens to partially defatted *Hermetia illucens* larval meal depends on the inclusion level and the nutritional characteristics of the ingredient. This supports the need to evaluate dietary composition together with growth performance and feed utilization when assessing the suitability of insect-derived ingredients in poultry nutrition.

Growth Performance and Final Body Weight

Body weight increased progressively in all experimental groups throughout the observation period. At the first measurement, conducted on 8 April 2025, mean body weight ranged from 200.00 g in EG_3 to 203.30 g in EG_2, indicating relatively similar initial body weights among the groups (Table 1) [9, 10].

Table 1. Dynamics of mean body weight in broiler chickens during the experimental period (g; X ± Sx)

Lot	08 Apr 2025	15 Apr 2025	22 Apr 2025	29 Apr 2025	06 May 2025	12 May 2025
CG	201.15 ± 3.480	483.42 ± 6.333	961.50 ± 20.134	1606.25 ± 16.826	2322.75 ± 35.534	2905.75 ± 62.317
EG_1	200.70 ± 2.791	491.17 ± 21.664	964.33 ± 11.585	1601.25 ± 15.687	2337.63 ± 25.295	2958.25 ± 80.564
EG_2	203.30 ± 2.513	495.75 ± 10.057	999.17 ± 20.031	1660.67 ± 32.774	2371.63 ± 51.873	3121.88 ± 65.449
EG_3	200.00 ± 3.410	489.33 ± 7.154	973.58 ± 21.337	1630.88 ± 43.192	2367.00 ± 77.094	2982.00 ± 81.224

Note: CG – control group; EG_1 – 2.0% larval meal; EG_2 – 3.5% larval meal; EG_3 – 5.0% larval meal. X ± Sx represents the mean and its reported standard error.

Differences became more apparent as the birds developed. The highest final body weight was recorded in LE_2, which received 3.5% *Hermetia illucens* larval meal.

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The final body weights and their differences relative to the control group are summarized in Table 2.

Table 2. Final body weight of broiler chickens and differences compared with the control group

Lot	Final body weight (g; X ± Sx)	Difference from CG (g)	Difference from CG (%)
CG	2905.75 ± 62.317	–	–
EG_1	2958.25 ± 80.564	+52.50	+1.81
EG_2	3121.88 ± 65.449	+216.13	+7.44
EG_3	2982.00 ± 81.224	+76.25	+2.62

Note: Percentage differences were calculated relative to the final mean body weight of the control group.

As shown in Table 2, all experimental groups achieved higher final body weights than the control group. The greatest increase was recorded in EG_2 (3.5% *H. illucens* larval meal), with an additional 216.13 g/bird (7.44%) compared with the control. The increases in EG_1 and EG_3 were 52.50 g and 76.25 g, respectively.

The response was not dose-dependent, as the highest body weight was achieved at 3.5% rather than 5.0% inclusion. This suggests that an intermediate level may be more favorable under the experimental conditions. Similar findings were reported by [8], who observed favorable growth responses at an intermediate inclusion level of partially defatted *H. illucens* meal. In contrast, [11] demonstrated that the effects of full-fat larval meal may vary depending on dietary formulation and the extent of replacement of conventional protein sources. Such differences highlight the importance of ingredient composition, inclusion level, and nutritional balance.

Although EG_2 showed the most favorable numerical results, statistical significance can only be established through appropriate statistical testing.

Feed Intake and Feed Utilization Efficiency

Feed intake is an important indicator of broiler production efficiency, as it directly influences feeding costs and should be evaluated in relation to body weight gain (Table 3).

Table 3. Reported mean compound feed consumption per bird

Lot	Larval meal inclusion (%)	Feed consumption (g/bird)	Difference from CG (g)	Reduction relative to CG (%)
LM	0.0	4313.78	–	–
EG_1	2.0	4233.07	−80.71	1.87
EG_2	3.5	4186.06	−127.72	2.96
EG_3	5.0	4193.00	−120.78	2.80

Note: Differences and percentage reductions were calculated from the reported feed consumption values.

According to Table 3, feed consumption was numerically lower in all experimental groups than in the control group. The greatest reduction was observed in EG_2, at 127.72 g per bird, corresponding to approximately 2.96%. This group also recorded the highest final body weight, suggesting a potentially favorable relationship between growth performance and feed consumption. The reported feed consumption by feeding phase is presented in Table 4 [12, 13].

The phase-specific values in Table 4 do not fully correspond to the reported mean feed consumption per bird. Therefore, the original records should be verified to clarify whether the data represent individual, group, or total feed consumption.

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Feed conversion ratio (FCR) should be calculated using verified feed intake and body weight gain over the same period, accounting for mortality where applicable.

Table 4. Reported feed consumption by feeding phase

Lot	Starter	Grower	Finisher I	Finisher II	Mean consumption (g/bird)	Reported daily value
EG	5398	17251	9470	15785	4313.78	105.21
EG_1	5031	15295	9556	16257	4233.07	103.25
EG_2	5122	15503	9591	15625	4186.06	102.10
EG_3	5145	15597	9420	15791	4193.00	102.27

Note: The phase-specific values and the reported mean and daily values are reproduced as supplied. Their units and calculations require verification before publication.

Until these discrepancies are resolved, the lower numerical feed consumption in the experimental groups cannot be considered evidence of improved feed conversion efficiency.

Previous studies by Dabbou and Biasato [8, 11] indicate that the effects of *Hermetia illucens* larval meal on feed utilization depend on inclusion level, ingredient characteristics, and dietary composition. These findings emphasize the importance of balanced formulations and show that higher inclusion levels do not necessarily improve productive performance.

Economic Efficiency and Practical Implications

The economic value of alternative feed ingredients depends on their purchase price, the cost of the complete diet, feed consumption, growth performance, and the cost of producing a unit of live weight. In the present study, EG_2 showed both the highest final body weight and the lowest reported feed consumption per bird. This combination identifies the 3.5% inclusion level as a promising treatment for further economic assessment (Table 5).

Table 5. Economic Efficiency

Lot	Body weight at slaughter (kg)	Price per kg of live weight (lei)	Revenue from carcass sales (lei)	Feed consumption (kg)	Price per kg of compound feed, including additive (lei)	Estimated economic efficiency (lei)
CG	2.906	30.00	85.72	4.314	6.29	58.59
EG_1	2.958	30.00	87.27	4.233	6.76	58.65
EG_2	3.122	30.00	92.10	4.186	7.10	62.37
EG_3	2.982	30.00	87.97	4.193	7.47	56.65

Note: The cost of 1 kg of the basal compound feed was 6.29 lei.

Overall, the results indicate that the diet containing 3.5% *Hermetia illucens* larval meal was associated with the most favorable numerical values for final body weight and reported feed consumption. Nevertheless, confirmation of an economic advantage requires a complete cost analysis based on verified feed intake and production data.

CONCLUSIONS

1. The inclusion of *Hermetia illucens* larval meal at levels of 2.0%, 3.5%, and 5.0% in broiler diets was associated with numerically higher final body weights compared with the control group. The highest final body weight (3,121.88± 65.449g), representing an increase of 7.44%, was recorded in the group receiving 3.5% larval meal.

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2. Feed consumption was numerically lower in all experimental groups than in the control group, with the greatest reduction (2.96%) observed at the 3.5% inclusion level. However, verification of the experimental data is required before definitive conclusions can be drawn regarding feed conversion efficiency.

3. The inclusion of 3.5% *Hermetia illucens* larval meal represents a promising dietary strategy for improving broiler growth performance under the conditions of this study. Further statistical and economic analyses are needed to confirm its effects on feed utilization efficiency and production profitability.

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