ISIR Journal of Agriculture and Biology (ISIRJAB)
Published by ISIR Publisher
Vol. 1, Issue 1, Sep - Oct 2026
ISSN: XXXX-XXXX

Growth Performance of African Catfish (Clarias gariepinus) Fed varying Levels of Black Soldier Fly Larvae (Hermetia illucens) Meal as a Fishmeal Replacement

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Received: 20 July 2026 | Accepted: 28 August 2026 | Published: 29 September 2026 | PP: 63-67

Abstract

The increasing cost and limited availability of conventional fishmeal have stimulated interest in alternative protein ingredients for aquaculture feeds. This study evaluated the growth performance of African catfish (*Clarias gariepinus*) fed diets containing varying levels of black soldier fly larvae meal (BSFLM). One hundred and fifty *Clarias gariepinus* juveniles with an initial mean body weight of 5.46 ± 0.02 g were used in a completely randomized feeding experiment involving five dietary treatments, each replicated three times. The treatments were T_0 (control; 100% fishmeal), T_1 (25% BSFLM and 75% fishmeal), T_2 (50% BSFLM and 50% fishmeal), T_3 (75% BSFLM and 25% fishmeal), and T_4 (100% BSFLM). Fish were fed twice daily at 5% body weight for eight weeks. Growth was assessed using weight gain (WG), length increase (LI), mean weight gain (MWG), percentage weight gain (PWG), and specific growth rate (SGR). Growth parameters varied significantly among dietary treatments ($P < 0.05$). At week 8, T1 recorded the highest WG (110.98 ± 3.67 g), LI (11.40 ± 1.65 cm), MWG (11.03 ± 1.77 g), PWG (71.85 ± 4.56%) and SGR (2.99 ± 0.34% day^{-1}), whereas T4 recorded the lowest values for these parameters. T_1 also produced the highest numerical growth response at weeks 2, 4 and 6. The results indicate that moderate replacement of fishmeal with BSFLM supported growth of *Clarias gariepinus*, while complete replacement under the dietary conditions used in this study resulted in poorer growth performance. The study provides evidence that BSFLM can serve as a partial fishmeal replacement in African catfish diets.

Keywords: African catfish; *Clarias gariepinus*; black soldier fly larvae meal; *Hermetia illucens*; fishmeal replacement; growth performance; aquaculture feed.

1. INTRODUCTION

Feed constitutes one of the major operating costs in intensive aquaculture, and the cost and availability of high-quality protein ingredients remain important constraints to profitable fish production. Fishmeal has traditionally been valued in aquaculture because of its protein quality,

amino-acid profile, digestibility and palatability. However, increasing demand for fishmeal from different animal-production sectors and concerns about resource sustainability have encouraged research into alternative protein ingredients.Insect-derived ingredients have emerged as promising alternatives because insects can convert organic substrates into nutrient-rich biomass. Among the species receiving considerable attention is the black soldier fly, *Hermetia illucens*. Black soldier fly larvae contain substantial quantities of protein and lipid and can be produced using organic substrates, making them attractive from both nutritional and circular-bioeconomy perspectives (Makkar *et al*., 2020; Macwan *et al.,* 2024).

African catfish, *Clarias gariepinus*, is an important cultured species because of its rapid growth, adaptability and tolerance of intensive production conditions. Consequently, it is an appropriate species for evaluating alternative protein ingredients.

Previous studies have demonstrated the potential of BSFLM in African catfish diets. Adeoye *et al. (*2020) reported that BSFLM could be incorporated into diets for African catfish, with moderate inclusion levels supporting acceptable growth and physiological performance. Maranga *et al.* (2022) likewise reported favourable growth responses in African catfish fed BSFLM-containing diets. Bartucz *et al.* (2023) further demonstrated the potential of BSFLM as a feed resource for African catfish.

Nevertheless, the response to insect meal is influenced by inclusion level, nutrient composition, processing, digestibility and the nutritional balance of the complete diet. High inclusion may alter dietary fibre, lipid, protein and energy concentrations and may therefore affect growth.The present study evaluated the effect of graded BSFLM replacement of fishmeal on the growth performance of *C. gariepinus* over an eight-week feeding period.

2. MATERIALS AND METHODS

2.1 Experimental fish

One hundred and fifty African catfish juveniles (*Clarias gariepinus*) with an initial mean body weight of 5.46 ± 0.02 g were used for the experiment. The fish were obtained and transported to the experimental facility according to the procedures described in the original study.

2.2 Experimental treatments

Five dietary treatments were used: T_0: control diet contained 100% fishmeal, T_1: 25% BSFLM + 75% fishmeal, T_2: 50% BSFLM + 50% fishmeal, T_3: 75% BSFLM + 25% fishmeal and T_4:100% BSFLM.Each treatment had three replicates. The treatment definitions are retained exactly as reported in the source study.

2.3 Feeding trial

The feeding experiment lasted eight weeks. Fish were fed twice daily at a feeding rate of 5% body weight. Feed quantity was adjusted according to the fish biomass during the experimental period.

2.4 Growth measurements

Fish were weighed and measured at scheduled intervals during the feeding trial. The evaluated parameters included weight gain, length increase, mean weight gain, percentage weight gain and specific growth rate.

2.5 Statistical analysis

The experimental data were subjected to analysis of variance. Treatment means were compared at the 5% probability level, and values with different superscripts were considered significantly different ($P < 0.05$).

3. RESULTS

3.1 Growth performance at week 2

At week 2, growth differed significantly among treatments ($P < 0.05$). T_1 recorded the highest WG (12.87 ± 1.03 g), LI (3.73 ± 0.76 cm), MWG (6.45 ± 0.31 g), PWG (44.75 ± 0.82%) and SGR (2.96 ± 0.51% day^{-1}). T_4 recorded the lowest values.

3.2 Growth performance at week 4

At week 4, T1 again recorded the highest WG (28.66 ± 1.44 g), LI (4.88 ± 1.15 cm), PWG (56.91 ± 2.02%) and SGR (2.82 ± 0.71% day^{-1}). T_4 recorded the lowest WG (14.91 ± 1.04 g) and LI (2.83 ± 0.02 cm).

3.3 Growth performance at week 6

At week 6, T_1 maintained the highest numerical response, recording WG of 58.32 ± 3.02 g, LI of 8.40 ± 1.01 cm, MWG of 8.54 ± 1.00 g, PWG of 61.33 ± 4.04% and SGR of 2.91 ± 0.87% day^{-1}. T_4 recorded the lowest values.

3.4 Growth performance at week 8

The final growth results are presented in Table 1.

Table 1. Growth performance of *C. gariepinus* fed graded BSFLM diets at week 8

Treatment	WG (g)	LI (cm)	MWG (g)	PWG (%)	SGR (%)
T_0	80.77 ± 8.77^{c}	9.03 ± 1.56^{b}	8.83 ± 2.65^{b}	54.66 ± 2.87^{b}	2.02 ± 0.78^{b}
T_1	110.98 ± 3.67^{d}	11.40 ± 1.65^{c}	11.03 ± 1.77^{d}	71.85 ± 4.56^{d}	2.99 ± 0.34^{b}
T_2	89.88 ± 3.88^{c}	9.56 ± 0.40^{b}	9.07 ± 3.67^{c}	61.88 ± 1.06^{c}	2.61 ± 0.76^{b}
T_3	77.88 ± 2.43^{b}	7.59 ± 0.77^{a}	7.79 ± 0.09^{b}	54.33 ± 2.90^{b}	1.98 ± 0.34^{a}
T_4	66.71 ± 1.88^{a}	7.40 ± 1.05^{a}	6.68 ± 0.88^{a}	34.04 ± 3.90^{a}	1.53 ± 0.66^{a}

Different superscripts within columns indicate significant differences ($P < 0.05$).

4. DISCUSSION

The present study demonstrates that BSFLM can support growth of *Clarias gariepinus*, but the response was strongly dependent on replacement level. The 25% BSFLM treatment (T_1) produced the strongest growth response, whereas complete replacement (T4) resulted in the poorest performance.The superior performance of T1 is consistent with reports that moderate inclusion of BSFLM can provide a nutritionally useful alternative to fishmeal in African catfish diets. Adeoye *et al*. (2020) reported favourable responses to BSFLM inclusion in African catfish, while Maranga *et al.* (2022) also demonstrated growth potential of BSFLM-containing diets.

The decline in growth at higher replacement levels may be associated with the changes in complete-diet nutrient composition. The experimental-feed analysis showed that crude protein declined from 44.24% in T_1 to 32.64% in T_4, while carbohydrate increased from 18.92% to 35.42%. Crude fibre was also elevated in the higher replacement diets. These changes indicate that increasing BSFLM replacement was accompanied by substantial changes in dietary composition. Therefore, the poorer growth observed at higher replacement levels cannot necessarily be attributed to BSFLM protein alone.

Insect meals can also contain chitin, depending on processing and larval characteristics. Increased chitin may influence nutrient utilization at high inclusion levels, although chitin was not directly measured in this experiment. Thus, chitin should be regarded as a possible explanatory factor rather than a demonstrated mechanism.The present findings support the broader conclusion that BSFLM has potential as a sustainable aquafeed ingredient, but optimal inclusion should be determined according to fish species, ingredient quality, processing method and complete-diet nutrient balance (Makkar *et al.,* 2020; Macwan *et al*., 2024; Siddiqui *et al.,* 2024).

5. CONCLUSION

The BSFLM replacement significantly affected the growth performance of *Clarias gariepinus*. The 25% BSFLM treatment (T_1) produced the highest numerical growth response at the end of the eight-week feeding trial, while the 100% BSFLM treatment (T_4) produced the lowest. Under the conditions of this experiment, partial replacement of fishmeal with BSFLM was more favourable than complete replacement. Further research should evaluate nutritionally balanced BSFLM diets, digestibility, amino-acid availability and chitin concentration.

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Reference

- Adeoye, A. A., Akegbejo-Samsons, Y., Fawole, F. J., & Davies, S. J. (2020). Preliminary assessment of black soldier fly (*Hermetia illucens*) larval meal in the diet of African catfish (*Clarias gariepinus*): Impact on growth, body index, and hematological parameters. *Journal of the World Aquaculture Society, 51*(4), 1024–1033.
- Albrektsen, S., Kortet, R., Skov, P. V., Ytteborg, E., Gitlesen, S., Kleinegris, D., & Øverland, M. (2022). Future feed resources in sustainable salmonid production: A review. *Reviews in Aquaculture, 14*(4), 1790–1812.
- Bartucz, T., Csókás, E., Nagy, B., Gyurcsák, M. P., Bokor, Z., Bernáth, G., Molnár, J., Urbányi, B., & Csorbai, B. (2023). Black soldier fly (*Hermetia illucens*) meal as direct

replacement of complex fry feed for rainbow trout (*Oncorhynchus mykiss*) and African catfish (*Clarias gariepinus*). *Life, 13*(10), 197.

- Limbu, S. M., Shoko, A. P., Ulotu, E. E., Luvanga, S. A., Munyi, F. M., John, J. O., & Opiyo, M. A. (2022). Black soldier fly (*Hermetia illucens*) larvae meal improves growth performance, feed efficiency and economic importance. *Journal of Fisheries, 21*, 23–32.
- Macwan, S., de Souza, T. S. P., Dunshea, F. R., DiGiacomo, K., & Suleria, H. A. R. (2024). Black soldier fly larvae (*Hermetia illucens*) as a sustainable source of nutritive and bioactive compounds, and their consumption challenges. *Animal Production Science, 64*, Article AN23192.
- Makkar, H. P. S., Tran, G., Heuzé, V., & Ankers, P. (2020). State-of-the-art on use of insects as animal feed. *Animal Feed Science and Technology, 212*, 1–17.
- Maranga, B., Kagali, R., Mbogo, K., Orina, P., Munguti, J., & Ogello, E. (2022). Growth performance of African catfish (*Clarias gariepinus*) fed on diets containing black soldier fly (*Hermetia illucens*) larvae under aquaponic system. *Aquaculture Studies, 23*(5).
- Siddiqui, S. A., Gadge, A. S., Hasan, M., Rahayu, T., Povetkin, S. N., Fernando, I., & Castro-Muñoz, R. (2024). Future opportunities for products derived from black soldier fly treatment as animal feed and fertilizer: A systematic review. *Environment, Development and Sustainability, 26*, 30273–30354.