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PRELIMINARY ASSESSMENT OF BSF LARVAL-BASED DIETS ON GROWTH PERFORMANCE OF HYBRID AFRICAN CATFISH *HETEROCLARIAS*

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ABSTRACT

A six-week study was conducted to assess the growth performance of hybrid African catfish, Heteroclarias fed on black soldier fly (BSF) larval-based diets. The experiment was conducted in RAS, circular plastic tanks (350 L) in a completely randomized design. Four isonitrogenous (400 kg^{-1} crude protein) and isolipidic (140 g kg^{-1} crude fat) diets were formulated where fishmeal (400 kg^{-1}) was replaced at 0, 25, 50, and 75% with BSF larval meal. Fish oil was completely replaced with corn oil in the test diets. Fish (initial body weight of 200 ± 25g, 15 fish per tank, 4 treatments, 3 replicates,) were hand-fed at 3% body weight. The results showed fish fed with BSF 50 diet were more efficient at utilizing dietary nutrients for growth than other groups by having the highest final mean weight, weight gain and specific growth rate, which was similar to the fish fed the Control diet and BSF 25 diets but significantly higher ($p < 0.05$) than fish fed BSF 75. There is no significant difference ($p < 0.05$) in feed conversion ratio (FCR) among the dietary treatments. However, fish-fed BSF 50 had the lowest FCR while the highest was seen in fish-fed BSF 75. This preliminary assessment shows that fishmeal could be partially replaced with BSF larval meal up to 50% and fish oil could be completely replaced with corn oil without negatively affecting the healthy growth of hybrid African catfish Heteroclarias.

ÖSSZEFOGLALÁS

Hathetes kísérletet végeztünk hibrid afrikai harcsával (Heteroclarias), amelyben a fekete katonalégy (BSF) lárva liszt etetésének hatását vizsgáltuk a halak növekedési teljesítményére. A kísérletet recirkulációs rendszerben végeztük, kör alakú műanyag tartályokban (350 l), teljesen véletlenszerű elrendezésben. Négy izonitrogén (400 g kg^{-1} nyersfehérje) és izolipid (140 g kg^{-1} nyerszsír) receptúrát állítottunk össze, ahol a hallisztet (400 g kg^{-1}) 0, 25, 50 és 75%-ban BSF lárvaliszttel helyettesítettük. A halolajat teljesen kiváltottuk kukoricaolajjal a kísérleti takarmányokban. A halakat (kezdeti testtömeg 200 ± 25g, 15 hal akváriumonként, 4 kezelés, 3 ismétlés) kézzel etettük és az összbiomassza 3%-át kapták a halak naponta. Az eredmények azt mutatták, hogy a BSF 50 csoport esetében a kiegészítés pozitívan hatott a halak növekedésére, mivel ebben a

csoportban mértük a legnagyobb élsúlyt a vizsgálat végén, valamint a legkedvezőbb súlygyarapodást és fajlagos növekedési rátát is. Ez az érték hasonló volt a kontroll és a BSF 25 diétával etetett halakéhoz, de szignifikánsan magasabb volt ($p < 0,05$), mint a BSF 75 csoport halai esetében. A takarmányértékesítés tekintetében (FCR) nem találtunk szignifikáns különbséget ($p > 0,05$) a kezelések között. Azonban a BSF 50 csoport mutatta a legalacsonyabb FCR, míg a legmagasabb érték a BSF 75 csoportnál volt megfigyelhető. Ezek az eredmények azt mutatják, hogy a halliszt 50%-ig rész-ben helyettesíthető BSF lárvaliszttel, a halolaj pedig teljesen helyettesíthető kukoricolajjal anélkül, hogy negatívan befolyásolná az afrikai hibrid harcsa növekedését.

INTRODUCTION

Fish is an essential food source, providing over 15% of animal protein for human consumption, globally (FAO, 2024). While the supply of fish from capture fishery has remained stagnant since the 1990s, aquaculture production has been steadily growing and is currently the fastest-growing animal food production sector worldwide. Fishmeal and fish oil are the major ingredients in aquafeed. Fishmeal is high in protein with well-balanced amino acids. It is palatable and highly digestible. On the other hand, fish oil is an excellent source of valuable long-chain polyunsaturated fatty acids (LC-PUFA) such as eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) (Henry et al., 2015; Renna et al., 2017). However, the rising cost of fishmeal and fish oil due to overexploitation of its marine source is a major constraint to aquaculture growth, especially in developing countries. In recent decades, several research has been conducted to find alternative, cost-effective, sustainable ingredients that could wholly or partially replace fishmeal and fish oil.

There has been a renewed interest in using insects, especially larvae as ingredients in aquafeed due to their appreciably high protein and fat contents. These insects include the common housefly (*Musca domestica*), silkworm (*Bombyx mori*), field cricket (*Gryllus assimilis*), yellow mealworm (*Tenebrio molitor*) and the black soldier fly (*Hermetia illucens*) (Henry et al., 2015). Among these insects, the black soldier fly (BSF) larvae seemed to be the ideal ingredient as an alternative to fishmeal as it contains high protein content with well-balanced amino acids similar to the amino acid profile of fishmeal. It contains high levels of saturated fatty acids (SFA) and monounsaturated fatty acids (MUFA) but low levels of long-chain polyunsaturated fatty acids, especially EPA and DHA. However, because the fatty acid profile of the larvae reflects the fat content of their feed, it is possible to enrich the larvae to meet the fatty acid requirements of the target species (Makkar et al., 2014).

Several studies have shown that using BSF larval meal as a component of aquafeed supports healthy growth of numerous fish species including African catfish *Clarias gariepinus* (Adeoye et al., 2020), rainbow trout *Oncorhynchus mykiss* (Renna et al., 2017), Nile tilapia *Oreochromis niloticus* (Devic et al., 2018), turbot *Scophthalmus maximus* (Kroeckel et al., 2012). However, little information is known on how hybrid African catfish, *Heteroclarias* responds to dietary fishmeal and fish oil replacement with BSF larval meal and corn oil regarding growth performance and nutrient utilization.

The objective of this study is therefore to assess the growth performance and nutrient utilization of hybrid African catfish, *Heteroclarias* fed on BSF larval-based diets.

MATERIALS AND METHODS

The experiment was conducted at the Fish Biology Laboratory, University of Debrecen, Hungary. It was conducted in a recirculatory system, in a completely randomized design. Hybrid African catfish, (*Heterobranchus longifilis* male × *Clarias gariepinus* female) with an initial body weight of 200 ± 25g were cultured for six weeks in circular plastic tanks, 350 L (4 treatments, 3 replicates, 12 experimental units, 15 fish per tank). Four isonitrogenous (40 g kg^{-1}) and isolipidic (14 g kg^{-1}) diets were formulated whereby fishmeal (400 g kg^{-1}) was replaced by BSF larval meal at 0, 25, 50, and 75%. Fish oil was completely replaced with corn oil. The ingredients were weighed and thoroughly mixed with a mixer while 6% water was sprayed on it to form a homogenous dough. The mixture was pelleted at 4.5 mm and dried in an oven at 50 °C for 48 h. The diets were stored in a clean plastic container at room temperature (24 °C). Fish were hand-fed 3% of body weight, 3 times daily for 6 weeks. Sampling was carried out weekly. Chemical analysis was performed to determine the proximate composition, according to the Hungarian Standard methods as described in Molnár et al. (2022).

The following indices were calculated as follows;

- Weight Gain (%) = (Initial mean weight - final mean weight) × 100
- Specific Growth Rate (SGR) = In [(mean final weight) – In (mean initial weight)] / (time /days) x 100
- Feed Conversion Ratio (FCR) = (weight of feed fed) / (weight gain of fish)
- Fulton conditioning factor (K) = W/L3 × 100 (where W is the wet weight (g), L is the standard length (cm).
- Feed intake (g) = Total feed intake per fish/no of days.

Data was checked for normality of distribution with the Kruskal-Wallis test. One-way analysis of variance (ANOVA) was applied to check the effects of the graded dietary BSF larval-meal inclusion on growth performance parameters. Homogeneity by Leven test, polynomial contrast to check the trend response, post-hoc by Turkey test. $P < 0.05$ is considered significant. All analyses were carried out using IBM SPSS version 29.

RESULTS AND DISCUSSION

Growth performance indices are presented as means ± standard error of the mean (Figure 1). All diets were accepted by fish. No mortality was recorded during the experiment. Fish fed the BSF 50 diet were more efficient at utilizing dietary nutrients for growth than other groups by having the highest final mean weight similar to fish fed the Control diet and BSF 25 diets but significantly higher ($p < 0.05$) than fish fed BSF 75 diet. This has been reflected in it having the highest weight gain and specific growth rate which was similar to fish fed the Control and BSF 25 diets but significantly different from fish fed BSF 75 diet which had the lowest mean of all the growth indices. In all, the trend response was quadratic. There is no significant difference ($p < 0.05$) in feed conversion ratio among the dietary treatments. However, fish-fed BSF 50 had the lowest FCR while the highest was seen in fish fed BSF 75.

Previous studies have shown no significant differences when fishmeal is substituted with alternative protein ingredients to a limited extent. Fishmeal is the main ingredient responsible for the palatability of feed (Kroeckel et al., 2012; Nephale et al., 2024). Substituting it at a high level could lead to low palatability and reduced feed intake. Although in the present study, feed intake was not significantly different ($p > 0.05$) among the dietary treatments, the feed intake was lowest in fish fed BSF 75.

The chemical composition of diets (data not included in this article) indicates a higher level of fibre and chitin contents with increasing levels of BSF larval meal inclusion. Previous studies have shown that while chitin is beneficial as an immunostimulant, it negatively affects nutrient uptake and digestibility in fish since most fish lack chitinase to break down dietary chitin (Kroeckel et al., 2012). This might have affected tissue accumulation of fish-fed BSF 75. The increased fibre content might have affected the relatively lower growth seen in fish-fed BSF 75 diets compared to the other groups.

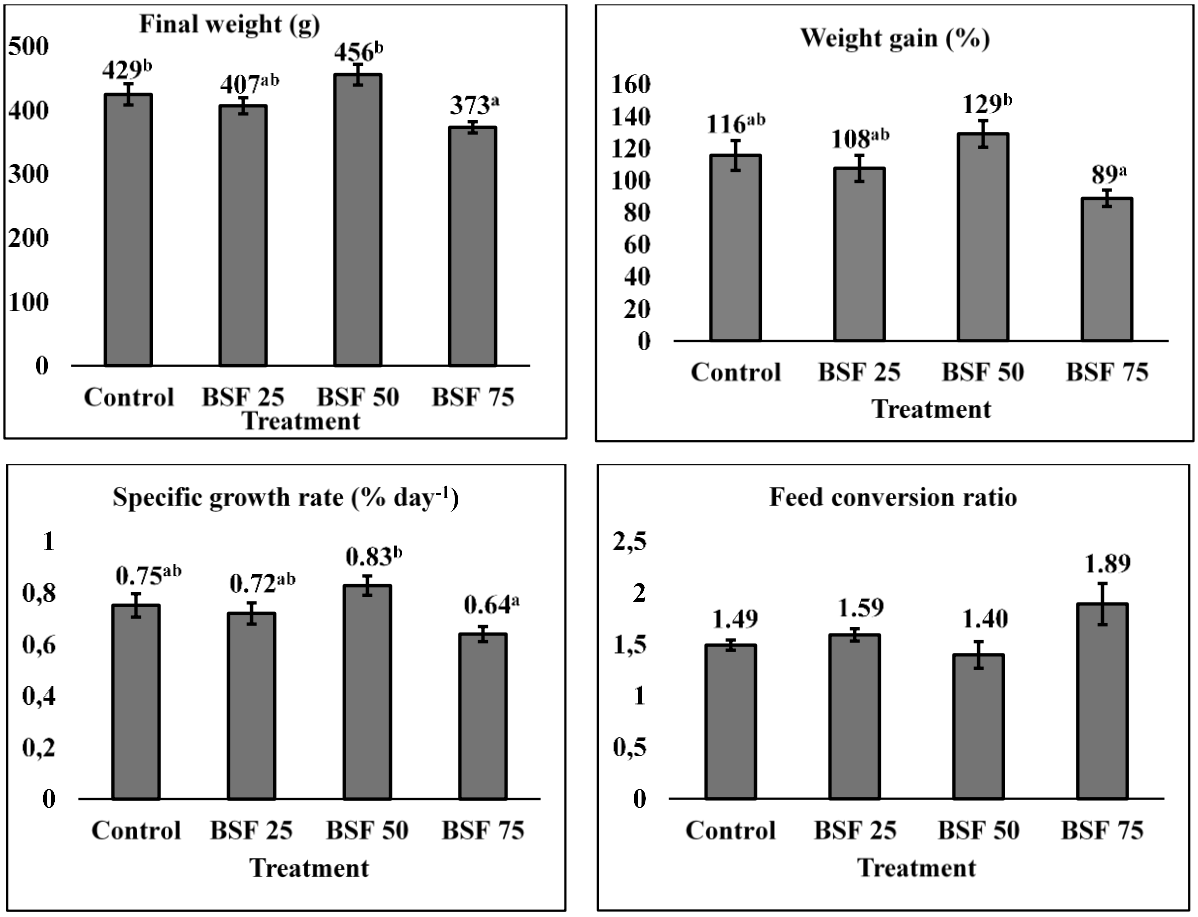

Figure 1 Growth performance indices of hybrid African catfish fed on graded levels of BSF larval diets. BSF25, BSF50, BSF75 – black solder fly larva-based diet applied in 25, 50 and 75 g/kg feed

The present study agrees with a previous report by Adeoye et al. (2020) and Renna et al. (2017) in which the replacement of fishmeal up to 50% supported the healthy growth of African catfish *Clarias gariepinus* and rainbow trout *Oncorhynchus mykiss*, respectively. In contrast, other researchers found that replacing fishmeal with BSF larval meal up to or above 75% did not negatively affect the healthy growth of African catfish *Clarias gariepinus* (Fawole et al., 2020).

Complete fishmeal substitution with BSF larval meal was reported for Atlantic salmon *Salmo salar* (Lock et al., 2016), and European sea bass, *Dicentrachus labrax* (Abdel-Tawwab et al., 2020). The differences could be attributed to the substrate the BSF larvae were reared on, the processing methods of the larvae, and the species and size of the experimental fish.

CONCLUSION AND RECOMMENDATION

This preliminary assessment of the effects of dietary replacement of fishmeal and fish oil with BSF larval meal and corn oil, respectively, shows that fishmeal could be partially replaced with BSF larval meal up to 50% and fish oil could be completely replaced with corn oil without negatively affecting the healthy growth of hybrid African catfish Heteroclarias.

Further studies need to be conducted to assess the long-term effects of fishmeal and fish oil substitution with BSF larval meal and corn oil, respectively, on growth, nutrient utilization and health profile of hybrid African catfish, Heterobranchus.

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