Efficacy of black soldier fly larvae as a protein source in aquaculture feed for the climbing perch

In Laos, demand for food fish has been increasing in recent decades, with the promotion of aquaculture playing a key role in the government's national population development strategy. However, aquaculture feed procurements have been entirely dependent on imports from neighboring countries, resulting in high costs causing limitation of broad extension of aquaculture in the country. In addition, protein content in aquaculture feeds is highly dependent on fishmeal (FM), and price fluctuations in FM largely affect the current/future price of feeds. With this background, the identification of substitutional protein sources becomes important in reducing feed costs and dependence on FM. Here, we evaluated the efficacy of black soldier fly (*Hermetia illucens*, referred to as BSF) larvae (Fig. 1a) as a protein source in aquaculture feed for the climbing perch (*Anabas testudineus*) (Fig. 1b).

The BSF larvae were cultured beforehand with feeding on fruit residues and beer draff. Three different feeds (with/without BSF larvae) were prepared as follows: feed T1 (the control feed) with the highest crude protein (CP 32.5%) using only FM as animal protein source; T2 as the lower protein feed (CP 30.0%) using FM/BSF mixed meals; and T3 as the lowest protein feed using only BSF (CP 25.0%) (Table 1).

After 123 days of culture trials using the above feeds, major growth indices (total length, body weight, survival rate, and feed conversion ratio) in fish given the feeds T2/T3 were not significantly different from those of fish given the T1, although the CP levels in the T2/T3 were lower than that in the T1 (Table 2). In addition, the protein efficiency ratio (PER) was significantly higher in fish given the feed T3 than that of fish given the T1/T2, and the protein retention (PR) was higher in fish given the T3 than that of fish given the T1 (Table 3). These results strongly indicate that the protein in BSF larvae is more assimilative for the climbing perch than that in FM.

The above results show that BSF larvae are a promising feed protein source for climbing perch aquaculture and have the potential to reduce dependency on FM, leading to feed cost reduction. Better protein assimilation of BSF larvae by the climbing perch is probably attributable to the feeding habit of the climbing perch, which is an insectivore. Therefore, the efficacy of BSF larvae on other fishes with different feeding habits should be validated separately.

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Fig. 1. Black soldier fly larvae (a) and the climbing perch (b)

Table 1. Proximate contents of the experimental feeds T1-T3 (% dry matter)

Feed	T1	T2	T3
Crude protein	32.5	30.0	25.0
Crude fat	6.7	7.6	8.9
Crude ash	11.1	9.5	7.3
Crude starch	22.8	28.0	27.7

Table 2. Growth performance of the climbing perch given the experimental feeds T1, T2 and T3

Growth index	T1	T2	T3
Total length at stocking (mm)*	46.3 ± 7.4	46.3 ± 7.4	46.3 ± 7.4
Total length at harvest (mm)**	159.9 ± 13.6	164.1 ± 11.7	160.9 ± 12.8
Body weight at stocking (g)*	2.2 ± 1.2	2.2 ± 1.2	2.2 ± 1.2
Body weight at harvest (g) **	85.1 ± 25.5	92.0 ± 22.3	83.5 ± 22.2
Survival rate (%)***	82.2 ± 2.0	81.7 ± 9.1	81.7 ± 2.9
Feed Conversion Ratio***	3.4 ± 0.2	3.2 ± 0.4	3.2 ± 0.1

Values are the mean ± standard deviation, *n = 180, **n = 60, ***n = 3

Table 3. Proximate contents of fish body reared by the feeds T1, T2 and T3 (moisture, crude protein, crude ash), and indices of protein assimilation (protein efficiency ratio, protein retention)

Contents	At stocking	At harvest		
		T1	T2	T3
Moisture	77.6 ± 0.2 (6)	63.4 ± 1.5 (18)	62.8 ± 1.0 (18)	63.1 ± 0.8 (18)
Crude protein	14.9 ± 0.3 (6)	18.1 ± 0.3 (6)	17.8 ± 0.8 (6)	17.2 ± 0.6 (6)
Crude fat	2.8 ± 0.1 (6)	12.0 ± 0.9 [a] (12)	12.3 ± 1.7 [a] (12)	14.4 ± 2.2 [b] (12)
Crude ash	3.8 ± 0.6 (6)	5.4 ± 1.0 [a] (18)	5.7 ± 0.7 [a] (18)	4.1 ± 0.8 [b] (18)
Protein assimilation indices		T1	T2	T3
Protein efficiency ratio		**0.9 ± 0.1 [a] (3)**	**1.1 ± 0.1 [a] (3)**	**1.3 ± 0.1 [b] (3)**
Protein retention		**16.4 ± 0.7 [a] (3)**	**18.8 ± 2.3 [a,b] (3)**	**21.9 ± 0.8 [b] (3)**

*Values are the mean ± standard deviation, *numbers in parentheses are the number of samples.
** Different capital letters indicate significant difference (Tukey's HSD test, $p < 0.05$).

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