FULL REPLACEMENT OF FISH MEAL WITH BLACK SOLDIER FLY LARVAE MEAL AND ITS IMPACT ON PERFORMANCE, DIGESTIBILITY AND HEALTH IN ASIAN SEABASS (*Lates calcarifer*)

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Introduction

Black Soldier Fly Larvae Meal (BSFM) from Hermetia illucens has emerged as a promising substitute for fish meal in aquafeeds. However, it remains unclear whether BSFM can fully replace fish meal and its potential effects on the growth performance of Asian Seabass. This study aimed to evaluate the impact of different BSFM inclusion levels (5%, 10%, and 15%), corresponding to 33%, 66%, and 100% fish meal replacement, in formulated diets for Asian Seabass.

Materials & Methods

The study utilized circular tanks with a water volume of 1,000 L in a recirculated aquaculture system (RAS) (**Fig. 1**). A total of 1,320 Asian Seabass were individually weighed and randomly distributed into 12 tanks, with each of the 4 dietary treatments tested in triplicates across the tanks, resulting in each tank containing 110 fish. The fish were fed manually to satiation twice a day, 6 days a week, over 28 days. They were then weighed again on the final day of the trial. The mean values of the initial and final fish body weights were used to compute both the body weight gain (BWG, in g) and the thermal-unit growth coefficient (TGC) for each tank. Feed intake data was used to compute both the FCR (feed conversion ratio) and DFI (daily feed intake, g day^{-1}). Three experimental diets with different BSFM inclusion levels and one formulated control diet containing 15% fish meal were tested (**Table 1**). The diets were manufactured at the R&D feed mill of the Marine Aquaculture Centre (Singapore) using a twin-screw extruder (Evolum 25, Clextral, Firminy, France). For gut enzyme analysis, intestinal enzymes were extracted, protein concentration measured and enzyme activities (trypsin, chymotrypsin, leucine aminopeptidase and lipase) assessed. Activities were expressed as units per milligram of protein.

Fig. 1. RAS used in the study.

Fig. 2. Evolum 25 twin-screw extruder.

Table 1. Formulation of control, INS33, INS66 and INS100 diets.

	Control	INS33	INS66	INS100
Ingredients (g kg^{-1})				
Fish meal	150	100	50	
BSFM		50	100	150
Soy Protein Concentrate	227.2	255.2	252.8	218
Soybean meal	190.2	218.5	224	249.7
Wheat gluten	160	160	160	158
Wheat flour	110	73.6	72.9	77
Sardine oil	55	57.6	55	55
Tuna oil	59.1	55	55	55
MCP	20	20	20	20
L-Lysine	10	0.9	1.2	8
DL-Methionine	10	0.7	0.7	0.8
Vitamin premix	5	5	5	5
Mineral premix	2.5	2.5	2.5	2.5
Yttrium oxide	1	1	1	1
Proximate composition (g kg^{-1} DM)				
Protein	567.2	567.3	570.3	537.2
Lipids	120.7	118.8	109.6	114.5
Fiber	17.4	27	33.7	40.2
NFE	216.9	207.4	207.3	230.9
Yttrium	10.3	7.7	7.7	7.3
GE	22.2	22.1	22	21.9

Results: Fish performance

The different inclusion levels of BSFM in the experimental diets did not have an impact on the survival rate of the fish ($P > 0.05$) (**Table 2**). However, differences were observed in BWG, TGC, FCR, and DFI ($P < 0.05$). Fish fed the formulated control diet had the highest BWG. As BSFM increased from 33% (INS33) to 66% (INS66) and 100% (INS100), BWG progressively decreased. Similar trends were observed for TGC and DFI, with both decreasing as the inclusion levels of BSFM increased. The FCR of fish fed with INS33 and INS66 did not differ significantly ($P > 0.05$); however, fish fed with the formulated control diet had the best FCR, while fish fed with INS100 had the worst FCR ($P < 0.05$) (**Figure 3**).

Table 2. Mean values (n = 3) of performance

	Control	INS33	INS66	INS100
IBW (g)	90.3 ± 0.4^{a}	90.6 ± 0.8^{a}	90.0 ± 0.3^{a}	90.4 ± 0.7^{a}
FBW (g)	234.4 ± 4.3^{a}	196.5 ± 3.4^{b}	171.6 ± 8.6^{c}	141.1 ± 10.7^{d}
Surv (%)	98.5 ± 1.9^{a}	99.7 ± 0.5^{a}	99.4 ± 0.5^{a}	99.4±0.5^{a}

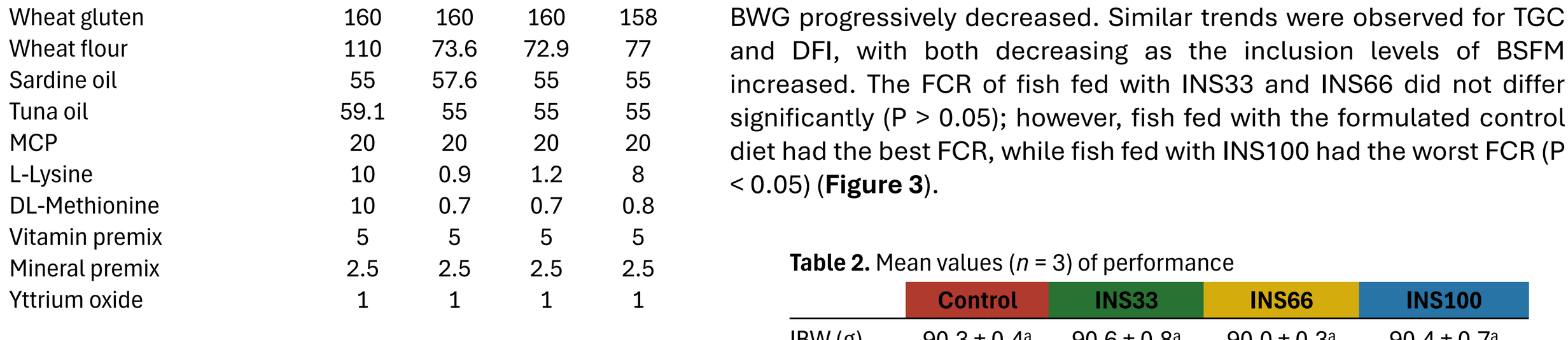

Fig. 3. Body weight gain, TGC, FCR and DFI of Asian Seabass fed with control, INS33, INS66 and INS100 formulated diets.

Results: Digestive enzyme activity

There was no significant difference in the chymotrypsin and lipase activity in the gut of Asian seabass fed diets with different inclusion levels of BSFM ($P > 0.05$). However, trypsin and leucine aminopeptidase activity was higher in the gut of Asian seabass fed with control feed as compared to INS100 feed ($P < 0.05$).

Conclusion

The results showed that growth performance decreased with increasing inclusion rates of BSFM, in replacement of fishmeal. To understand better the inclusion limits, further studies should investigate the impact of varying BSFM inclusion levels on its digestibility in Asian Seabass. Additionally, comprehensive gut and brain transcriptomics analyses will be performed to explore potential interactions between feed intake and overall fish performance. These additional studies will help determine the feasibility and benefits of incorporating BSFM into commercial aquaculture feeds.