Black Soldier Fly Larvae Meal vs. Soy Protein Concentrate Meal: A Comparative Digestibility Study in Barramundi

Jessalin Ng Kai Lin, Ben Woon Rong Neo, Weiqiang Chung,, Lydia Shun En Tan, Co Sin Lee, Richard Le Boucher
Precision Aquaculture Department, Temasek Life Sciences Laboratory, 1 Research Link National University of Singapore 117604, Singapore

Introduction

Increasing demand for aquafeeds, together with growing competition for conventional ingredients and the need to reduce emissions and address environmental challenges, is driving innovation in sustainable protein sources for food and feed. In this context, **black soldier fly larvae meal (BSFM) has emerged as a promising and reliable protein ingredient for aquaculture**.

Methodology

A total of **1,800 barramundi (48.2 g)** were randomly distributed into **12 tanks** equally and acclimatized for 15 days on a commercial diet before being fed experimental diets **for 51 days**. The 1,000 L circular tanks were supplied with seawater at 30.3 ± 0.5°C in a RAS with a flow rate of 1,500 L hr^{-1}. Salinity, pH, nitrate, nitrite, total ammonia, and alkalinity in the biofilter were monitored daily. Dissolved oxygen levels and temperature were assessed in each tank using standard electrochemical probes.

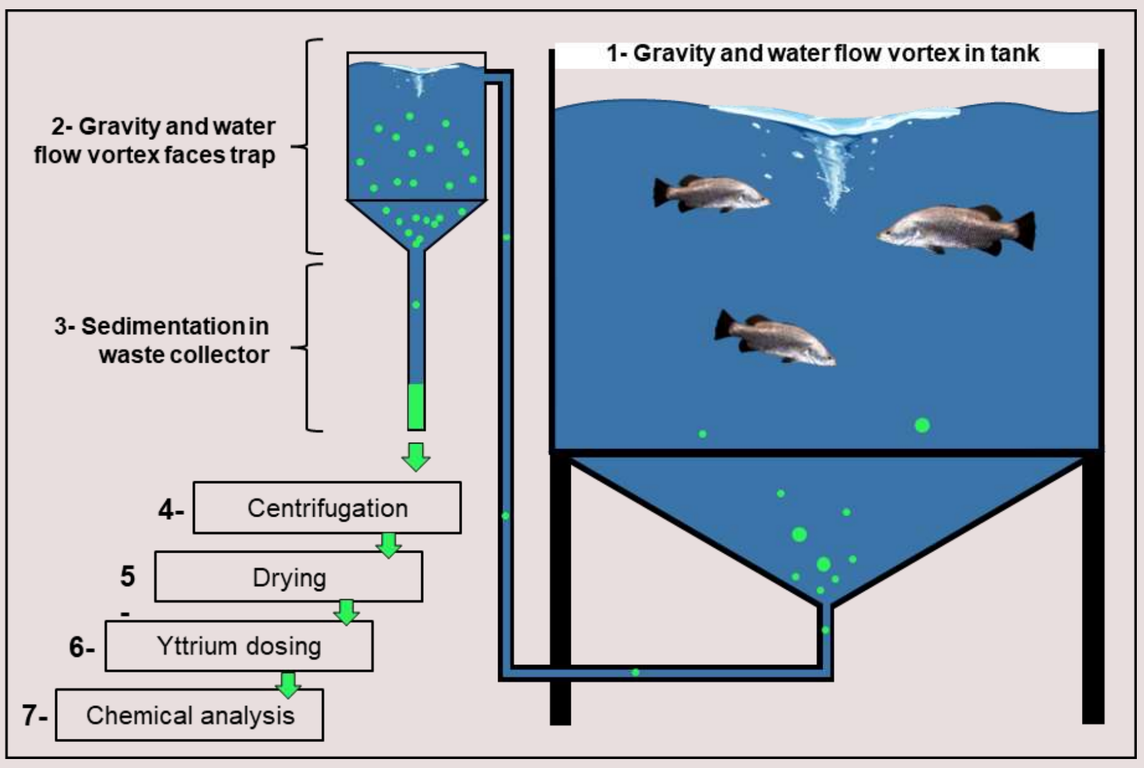
Three experimental diets and one commercial feed designed for barramundi (Lucky Star EP6, Taiwan) were tested. BSF and SPC experimental diets (Table 1) were the control diet, in which 30% of defatted BSFM and SPCM (Table 2) were respectively incorporated. The experimental diets were formulated using Wittaya software (Table 3).

Fish were **manually fed to satiation** twice daily, 6 days per week. Feeding ceased when feed intake declined and the first pellets reached the tank bottom. Uneaten pellets were siphoned and subtracted from the total feed to determine tank feed intake. **Faeces were collected from a swirl separator**, which was cleaned daily. Samples were centrifuged at 3,000 rcf for 15 min.

TABLE 1: Formulation (g kg^{-1}) of control, black soldier fly (BSF), and soy protein concentrate meal (SPC) diets.

	Control	BSF	SPC
Fish meal, Skagen	500	350	350
BSFM[1]	—	300	—
SPCM[2]	—	—	300
Soybean meal	50	35	35
Wheat gluten meal	180	126	126
Wheat flour	161	113	113
Sardine oil	40	28	28
Tuna oil	40	28	28
Soy lecithin	10	7	7
Vitamin premix[3]	5	3	3
Mineral premix[3]	2	2	2
$CaH_4P_2O_8$	10	7	7
Yttrium oxide	1	0.7	0.7

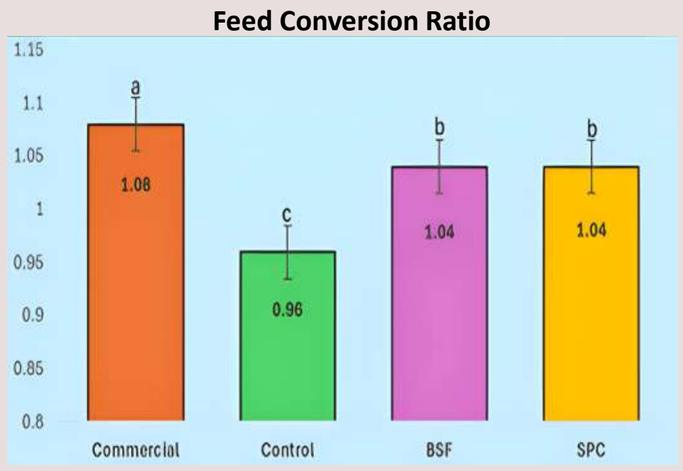
[1]Defatted black soldier fly (*H. illucens*) larvae meal (Inseact, Singapore). [2]Soy protein concentrate meal (2 X-Soy 200, C.J. Selecta, Brazil). [3]Vitamins and minerals were ANA Fish Vitamin Premix-199 and ANA Fish Mineral Premix-199 (Zagro, Singapore).



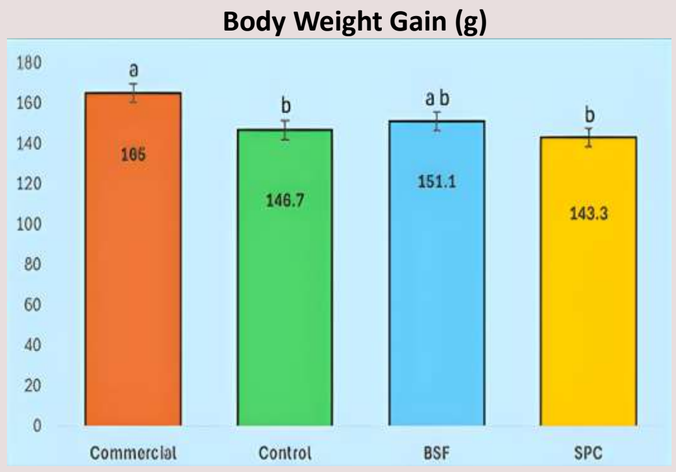
Results

- Fish body weight increased by threefold over the 51-day trial
- BSFM supplementation significantly increased TFI (P = 0.0125)
- BSFM supplementation produced a higher FCR compared to the control diet (P < 0.001).
- Inclusion of BSFM in the diet had no detrimental effect on survival rate, FBW, BWG, or TGC (P < 0.05).
- Compared to commercial feed, the performance of the experimental diet was generally similar. Only the FCR and TFI were lower in the experimental diets (P < 0.05).

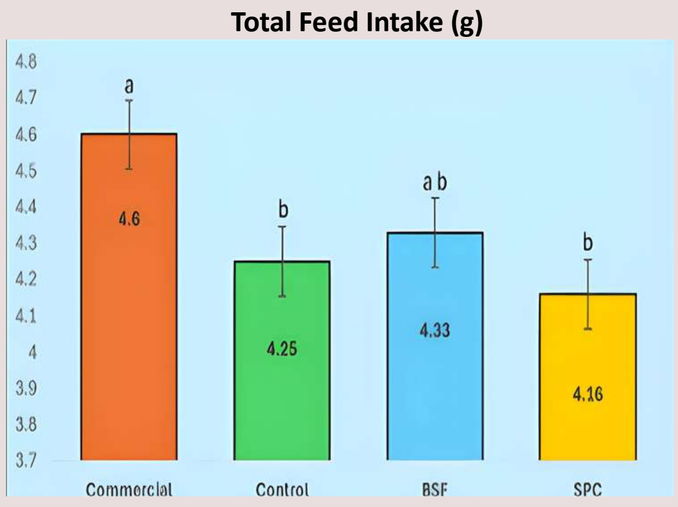
Feed Conversion Ratio



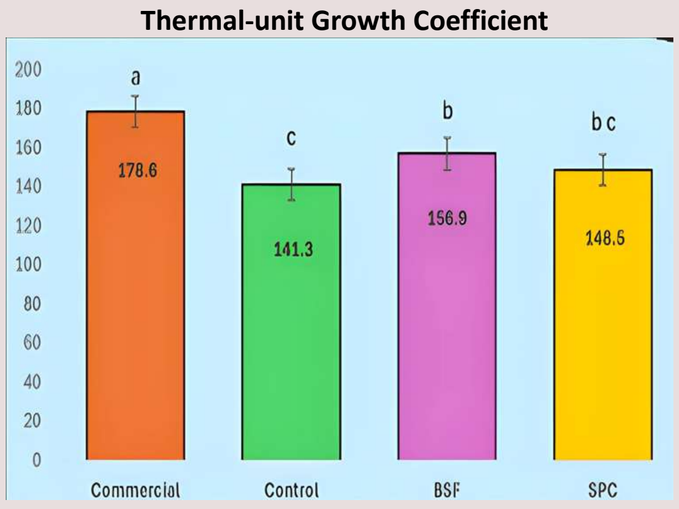
Body Weight Gain (g)



Total Feed Intake (g)



Thermal-unit Growth Coefficient



Apparent Digestibility Coefficients

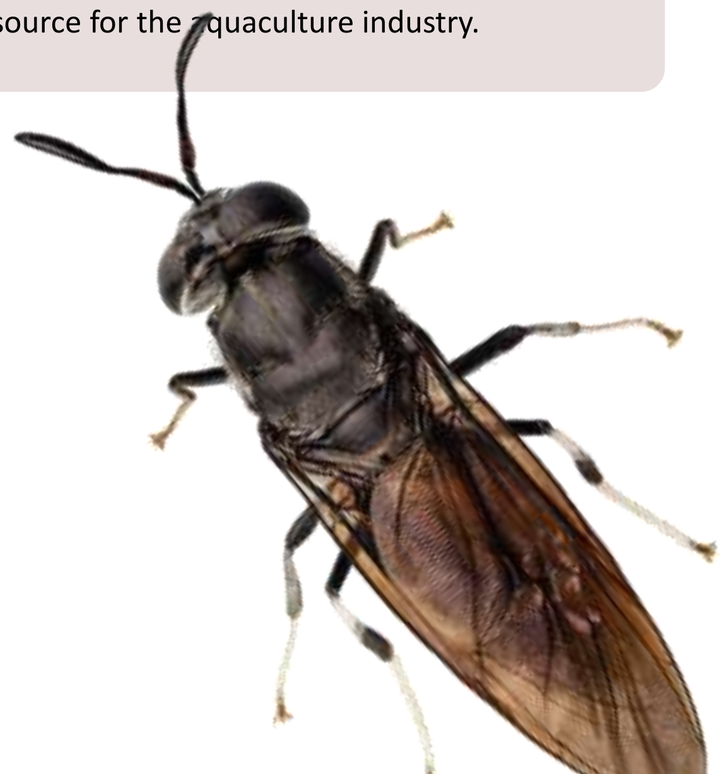
The **ADC of BSFM DM was 76.8% compared to SPCM DM (86.0%)**. The ADC of BSFM protein was notably high at 93.2%,with no significant difference compared to the apparent digestibility of protein in SPCM (99.9%). The digestive content for DM, CP, and GE in BSFM was determined to be 721.2 g kg^{-1}, 483.2 g kg^{-1} DM, and 17.2 MJ kg^{-1} DM, respectively.

	Control	BSF	SPC	SEM[2]
Diet ADC (%)				
DM	89.0[a]	85.3[a]	88.1[a]	2.63
CP	93.4[a]	93.3[a]	95.4[a]	2.15
CL	91.6[a]	90.2[a]	94.0[a]	2.79
GE	92.3[a]	89.9[a]	92.1[a]	2.24
Ingredient ADC (%)		BSFM	SPCM	
DM	—	76.8[a]	86.0[a]	4.79
CP	—	93.2[a]	99.9[a]	2.19
CL	—	85.8[a]	100.0[b]	3.64
GE	—	83.9[a]	91.4[a]	4.20
Digestible content[3]		BSFM	SPCM	
DM (g kg^{-1})	—	721.2	786.9	4.38
CP	—	483.2	658.3	1.41
CL	—	94.0	13.1	0.40
GE (MJ kg^{-1} DM)	—	17.2	18.8	0.86

Conclusion

- The high protein apparent digestibility coefficient (ADC) of BSFM observed in this study (93.2%) was comparable to, or higher than, values reported in other aquaculture species, including turbot (63.1%), seabream (84.4%), and rainbow trout (85%) [1–3].
- Dietary inclusion of 30% BSFM did not significantly affect barramundi growth performance, although it increased feed conversion ratio (FCR). This inclusion level is higher than the previously reported optimal level of approximately 15% for juvenile barramundi.
- Previous studies have shown that BSFM can partially, and in some cases fully, replace fishmeal with limited effects on fish performance, supporting its potential as a nutritionally suitable alternative when fishmeal availability is limited or prices are high.
- Given that BSFM is among the insect-derived ingredients approved for use in aquaculture feeds in the European Union, it is important to identify fish species that can efficiently digest and utilize this ingredient.
- Overall, the present results suggest that barramundi are promising candidates for the incorporation of BSFM into aquafeed formulations. In the context of increasing fishmeal prices and potential supply constraints, BSFM may represent a sustainable, good-quality, and cost-effective protein source for the aquaculture industry.





References

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