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Water quality change, growth performance, health status in response to dietary inclusion of black soldier fly larvae meal in the diet of Nile tilapia, *Oreochromis niloticus*
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Table 2. Amino acids (AA) profile (g/kg diet) of the black soldier fly larvae meal (BSFM) and experimental diets containing different levels of BSFM

Items	BSFM	BSFM levels (%)						
		0	5%	10%	15%	20%	25%	30%
Essential amino acids (g/kg diet)								
Arginine	23.70±0.56	27.45±0.34	27.26±0.29	27.11±0.30	26.91±0.55	25.66±1.02	25.31±0.93	24.77±1.56
Lysine	23.80±2.36	27.30±0.93	27.10±0.45	26.83±0.73	26.66±1.20	26.25±0.33	25.99±0.49	25.77±0.99
Histidine	14.20±0.90	14.77±0.51	14.91±1.21	15.11±3.44	13.99±1.43	15.97±0.85	15.22±0.44	15.91±0.78
Phenylalanine	18.80±0.84	24.95±0.69	24.33±0.95	23.99±0.77	23.22±0.29	23.11±1.83	23.09±0.54	22.99±0.55
Leucine	26.05±2.01	36.20±0.65	36.11±0.28	35.89±0.44	35.66±0.65	35.38±0.34	35.11±1.22	35.11±.099
Isoleucine	30.05±2.33	18.85±1.45	18.21±0.46	18.11±0.56	19.88±0.72	20.44±0.35	20.33±0.65	20.41±1.00
Valine	30.05±0.92	20.65±0.47	20.99±0.24	22.11±0.54	22.99±0.76	24.22±0.27	24.99±0.54	21.99±0.09
Threonine	23.40±0.97	17.60±0.77	16.31±0.49	18.55±0.56	17.99±0.47	17.81±0.43	19.11±1.32	18.91±0.93
Tryptophan	6.70±1.45	5.00±0.56	4.81±1.09	4.73±2.56	4.71±1.40	4.65±0.05	4.61±0.08	4.58±0.019
Methionine	7.45±0.83	9.50±0.49	9.10±0.57	9.00±0.54	8.55±0.72	8.72±0.65	8.77±0.72	7.85±0.44
Non-essential amino acids (g/kg diet)								
Alanine	34.15±0.65	27.70±1.43	27.11±0.92	26.77±0.89	26.71±0.61	26.58±0.92	26.31±1.82	26.11±0.95
Aspartate	44.20±2.30	50.60±1.60	57.99±0.98	55.61±0.69	51.55±1.99	47.99±2.46	51.11±0.92	46.99±1.55
Glutamate	50.05±1.98	65.71±2.32	61.66±1.54	59.44±1.09	57.99±2.27	58.11±3.98	56.88±2.04	56.19±3.10
Glycine	25.70±0.79	22.80±0.35	22.21±0.59	21.86±1.00	21.55±0.32	20.99±0.56	21.77±0.49	21.44±1.32
Proline	34.59±1.48	28.44±1.09	26.44±0.82	26.11±0.79	25.88±1.27	26.19±0.23	25.61±0.68	24.99±0.23
Serine	28.91±0.91	17.00±0.54	15.99±0.82	16.11±0.54	16.33±0.69	15.78±0.37	15.59±0.34	15.88±0.59
Tyrosine	26.18±0.48	19.00±0.99	17.88±0.34	17.59±0.59	17.11±0.83	18.09±1.04	18.00±1.35	17.22±1.03
Cystine	30.35±.006	0.87±0.19	0.88±0.06	0.91±0.89	0.92±0.11	0.94±0.16	0.955±0.03	0.96±0.05

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Table 2 has been removed from the manuscript because the authors identified an error in the amino acid profiles of all diets and ingredients. This occurred due to a lack of standardization in the analytical device used. Unfortunately, the authors no longer have samples available for reanalysis.

Experimental design and diets

Seven experimental diets were formulated to be iso-proteic (~30% crude protein) and isocaloric (~475.59 Kcal/100 g DM). An FM-based diet was used as a control diet, and six other diets were formulated to include dry BSFM at substitution levels of 5, 10, 15, 20, 25, and 30% of FM. BSFM was obtained from a private farm, in the Burj Al-Arab, Alexandria Governorate, Egypt. The BSFM was dried in an oven at 60°C for 48 hours and ground to powder for proximate analysis. The studied level was selected to optimize the inclusion levels of BSFM in the diet of Nile tilapia according to the lower and higher previously recommended levels (Dietz and Liebert, 2018; Tippayadara et al., 2021).

The macro ingredients including FM, soybean meal, corn gluten meal, wheat bran, and BSFM meal were weighed and blended for 10 minutes. The blend material was then pressed in a small hammer mill (Bill bliss, horizontal, 18.5 kW, USA) with a 1 mm sieve. The fine ingredients were weighed together and entirely mixed for 10 min., additives were added then, oil was gradually added to the mix and further mixed for 10 min. Warm distilled water (300 ml kg⁻¹) was then added until a stiff dough was produced, then passed through a mincer (Oster, USA) with a 3.0 mm die, and the resulting pellets were dried in an oven at 65°C for 48 hours to get a moisture level of <10%. The parched diets were broken up into a convenient pellet size and stored at -20°C until further use. Fifty grams of each diet sample were honed using a hammer mill with a 1.5 mm sieve before further analysis. The ingredients and approximate composition of the experimental diets are conducted according to AOAC procedures (AOAC, 2016) presented in Table 1. ~~The amino acids (AA) profile was determined using the method explained by Cunico (1986) and presented in Table 2. In brief, a 0.1 g sample was digested in a specialized hydrolysis tube with 6 ml concentrated HCl and 15% phenol solution. The tubes were then sealed off and left to hydrolyze at 110°C for 24 h. Once hydrolysis was completed, the samples were transferred to Eppendorf tubes and refrigerated. The amino acid profiles were determined as described by Hopley (2016) and the results presented in Table 2. The daily amount of food was introduced by hand to *O. niloticus* fingerlings to obvious satiation twice daily (9:00 a.m. and 2:00 p.m.) for 84 days. Obvious satiation was considered to have occurred 30 minutes after the introduction of the diet, then the remaining feed was collected and dried to be excluded from the introduced feed.~~ doi: 10.2478/aoas-2023-0088

A fragment of text from Material and methods was removed due to the removal of Table 2:

Experimental design and diets

Seven experimental diets were formulated to be iso-proteic (~30% crude protein) and isocaloric (~475.59 Kcal/100 g DM). An FM-based diet was used as a control diet, and six other diets were formulated to include dry BSFM at substitution levels of 5, 10, 15, 20, 25, and 30% of FM. BSFM was obtained from a private farm, in the Burj Al-Arab, Alexandria Governorate, Egypt. The BSFM was dried in an oven at 60°C for 48 hours and ground to powder for proximate analysis. The studied level was selected to optimize the inclusion levels of BSFM in the diet of Nile tilapia according to the lower and higher previously recommended levels (Dietz and Liebert, 2018; Tippayadara et al., 2021).

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The improvement of growth performance in the current study could be due to the active ingredients in BSFM diets, such as essential amino acids as ~~indicated in the present study (Table 2) and in accordance with Spranghers et al. (2017)~~, besides a high level of omega-3, 6, and 9 (Liland et al., 2017). Furthermore, BSFM has a high protein content (60%) and a lipid content of 10–30%, as well as an amino acid profile that is more balanced than FM (Diener et al., 2009). Moreover, the improved FCR and feed utilization could be due to increased mucosal surface area associated with dietary insect meal (Priyadarshana et al., 2022; Talamuk, 2016). In addition, the enhancement in water quality as a result of the decrease in ammonia excretion in the present study may lead to improving growth performance, feed utilization, and survival. Reducing hazardous forms of ammonia in fish-rearing water could enhance growth performance and feed utilization (Fayed et al., 2019; Mansour et al., 2022, 2021). In addition, a rise in PER can be brought on by a decrease in ammonia nitrogen levels in the rearing water by a decrease in ammonia excretion from FM. doi: 10.2478/aoas-2023-0088

A fragment of text from Discussion was removed due to the removal of Table 2:

The improvement of growth performance in the current study could be due to the active ingredients in BSFM diets, such as essential amino acids as by Spranghers et al. (2017), besides a high level of omega-3, 6, and 9 (Liland et al., 2017). Furthermore, BSFM has a high protein content (60%) and a lipid content of 10–30%, as well as an amino acid profile that is more balanced than FM (Diener et al., 2009). Moreover, the improved FCR and feed utilization could be due to increased mucosal surface area associated with dietary insect meal (Priyadarshana et al., 2022; Talamuk, 2016). In addition, the enhancement in water quality as a result of the decrease in ammonia excretion in the present study may lead to improving growth performance, feed utilization, and survival. Reducing hazardous forms of ammonia in fish-rearing water could enhance growth performance and feed utilization (Fayed et al., 2019; Mansour et al., 2022, 2021). In addition, a rise in PER can be brought on by a decrease in ammonia nitrogen levels in the rearing water by a decrease in ammonia excretion from FM. doi: 10.2478/aoas-2025-0094

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The cited references have been removed.