Effects of Dietary Taurine Supplementation on Feed Utilization, Feed Conversion Ratio, and Growth Performance of Striped Catfish (Pangasianodon hypophthalmus) Fingerlings

Abstract

Striped catfish (*Pangasius hypophthalmus*) is one of the freshwater fish commodities with high economic value. The success of Pangasius catfish farming is highly influenced by the availability of high-quality fish feed. The use of plant-based ingredients as a protein source in feed is limited due to a deficiency in the essential amino acid methionine, which leads to a lack of taurine. A deficiency of taurine in the feed results in low feed utilization efficiency, so fish growth is suboptimal. This can be overcome by adding taurine to the feed to increase feed utilization efficiency and fish growth. This study aimed to examine the effect of taurine supplementation in commercial feed on feed efficiency, feed conversion ratio, and growth of striped catfish fingerlings. The test fish used were striped catfish fingerlings with an average weight of 3.38±0.17 g/fish and an average length of 7.6±0.19 cm/fish. The method used was an experimental method, completely randomized design (CRD), with four different taurine dose treatments: A (0 g/kg feed), B (7.5 g/kg feed), C (15 g/kg feed), and D (22.5 g/kg feed). The observed variables included total feed consumption (TKP), feed utilization efficiency (EPP), feed conversion ratio (FCR), protein efficiency ratio (PER), relative growth rate (RGR), and survival rate (SR). The results showed that taurine supplementation had a significant effect ($P<0.05$) on TKP, EPP, FCR, PER, and RGR, but had no significant effect ($P>0.05$) on SR. The best taurine dose in commercial feed for striped catfish fingerlings was 15 g/kg feed (treatment C), which yielded the highest values for BWG (154.70 g), SGR (86.32%), FCR (1.02), PER (3.29), and RGR (5.02).

Keywords: Taurine, Feed, Growth, Protein, Supplementation

1. INTRODUCTION

Striped catfish (*Pangasius hypophthalmus*) is one of the leading freshwater aquaculture commodities that is widely known to the public and offers a fairly broad market opportunity, including both domestic and export markets. Striped catfish is rich in protein, making it an excellent source of dietary protein for daily consumption. The nutritional content of striped catfish includes 79.42% water content, 12.94% protein, and 6.57% fat (Rachmawati *et al*., 2026). Notable characteristics of striped catfish are its high adaptability to environmental conditions and rapid growth. In 2024, the production of pangasius catfish reached 381.969 tons (KKP-RI, 2026).

The success of striped catfish aquaculture is greatly influenced by the availability of quality fish feed. Quality feed contains balanced nutrition, originating from feed that contains complete proteins and amino acids. Fish meal is the primary source of protein in fish feed and serves as one of the main factors in determining feed quality. The current limited availability of fish meal has caused its price to increase, resulting in continually rising feed costs and becoming an obstacle for farmers (Turchini *et al*., 2019). One possible solution is to substitute plant-based ingredients as protein sources. This is supported by Nandi *et al*. (2023), who stated that expensive fish meal can be replaced by cheaper plant-based protein sources as long as amino acid requirements are met. Complete amino acids for fish include essential and non-essential amino acids. However, the content of plant-based ingredients still lacks the essential

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amino acid methionine, which can be later synthesized into the non-essential amino acid taurine. To meet the amino acid requirements for fish, this can be addressed by adding the non-essential amino acid taurine to formulated feed, which can stimulate protein synthesis and improve growth.

Taurine is a non-essential amino acid required by many fish species, and its supplementation is necessary when a plant-based diet is used as the main protein source for fish. According to Gunathilaka *et al*. (2019), taurine is an amino acid containing a sulfonate acid group and a basic amino acid group. The addition of taurine to fish feed can enhance growth, reduce feed conversion ratio, and improve nutritional balance. This is further supported by Sampath *et al*. (2020), who stated that taurine supplementation in feed offers nutritional benefits for fish, including survival, growth, feed utilization, and protein utilization. Taurine plays an important role in numerous physiological functions, including membrane stabilization, antioxidant activity, detoxification, modulation of immune response, calcium transport, retinal development, bile acid metabolism, osmotic regulation, and endocrine function. According to Ma *et al*. (2021), taurine enhances growth, immunity, and antioxidant capacity in fish. Taurine deficiency in feed leads to decreased growth efficiency and low feed utilization efficiency, resulting in suboptimal growth of catfish. Furthermore, Shen *et al*. (2021) stated that taurine deficiency has a negative impact on fish growth and health.

The addition of taurine to artificial feed can improve feed utilization efficiency and growth in several fish species, including *Clarias gariepinus* (Adeshina and Tawwab, 2020), *Epinephelus fuscoguttatus* × *E. lanceolatus* (Qian *et al*., 2021), Channa striata (Hongmade *et al*., 2022), Diplodus sargus (Magalhaes *et al*., 2019), *Pagrus major* (Gunathilaka *et al*., 2019), *Dicentrarchus labrax* (Martins et al., 2018), Monopterus albus (Hu et al., 2018), and Barbonymus gonionotus (Rachmawati *et al*., 2025). Based on the above description, information on taurine supplementation in commercial feed for striped catfish (*P. hypophthalmus*) fingerlingshas not yet been found; therefore, this study was conducted. This study aimed to examine the effect of taurine supplementation in commercial feed on feed efficiency, feed conversion ratio, and growth of striped catfish fingerlings.

2. MATERIALS AND METHODS

This research activity was conducted from February to May 2026 at the Fish Hatchery Center (BBI) Sawangan, Magelang, Central Java. The test fish used in this study were juvenile sriped catfish with an average weight of 3.38±0.17 g/fish and an average length of 7.6±0.19 cm/fish. The test fish originated from farmers in Muntilan. The stocking density of the test fish for the research was 15 fish/40L, resulting in a total of 180 fish used. Preparation of the test fish began with a one-week acclimation period to the new feed and environment. According to Rachmawati *et al*. (2023), acclimation is conducted so that the fish can adapt to the new environment and feed and to prevent stress during the study. During the acclimation process,

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the fish were fed without taurine supplementation using the at satiation method, with feeding frequency set at three times per day at 08.00, 12.00, and 16.00 WIB. Next, the test fish were selected based on uniform size, health, active movement, and absence of morphological disease (Rachmawati *et al*., 2026). Prior to the study, the test fish underwent a 1-day fasting period aimed at eliminating metabolic waste from previously administered feed.

The containers used in this study were happa measuring 45x45x60 cm^3, with 12 containers installed in an earthen pond using rope and bamboo. Before use, the happa were checked to ensure that they were still suitable for use. The happa were washed with soap to remove any remaining dirt and rinsed with clean water and dried. Next, the bamboo and other equipment for installing the happa were prepared. Installation of the happa was carried out in the earthen pond, with bamboo placed in each corner and tied with rope to secure the happa in place. The happa were weighted with stones placed in the center to sink the happa to the bottom of the pond. Next, treatment labels were randomly attached to each research container by making labels according to each treatment, laminating them, and tying them to the happa. The purpose of attaching the labels was to facilitate the identification of each container according to its respective treatment.

The test feed used in this study was a commercial pellet feed containing 30% protein (Rachmawati *et al*., 2026), supplemented with taurine at different doses: A (0 g/kg feed), B (7.5 g/kg feed), C (15 g/kg feed), and D (22.5 g/kg feed). The preparation procedure for the test feed began by grinding the commercial feed into a powdered form to facilitate mixing. Next, taurine was supplemented according to the treatment doses, along with 1% CMC as a binder, into the commercial feed powder while stirring until evenly distributed using a mixer. The mixed dough was then shaped using a pellet machine. The resulting pellets were subsequently dried in an oven at a temperature of 50–60°C. As a final step, the dried feed was stored in an airtight container equipped with food-grade silica gel to maintain quality and prevent damage.

The research procedure began by weighing and measuring the test fish to determine the individual weight and length at the start of stocking. Stocking of stiped catfish fingerlings were performed in the morning because the water temperature was still optimal compared to noon or afternoon. The stocking density for this study was 15 fish per happa. Stiped catfish fingerlings were reared for 49 days, with the test feed provided to satiation at a feeding frequency of three times a day, namely at 07:00, 13:00, and 18:00. To monitor the increase in fish weight, test fish were weighed weekly throughout the study. Water quality measurements were taken in the morning and afternoon. The observed water quality parameters included temperature, pH, and dissolved oxygen (DO). Water quality was measured using a Water Quality Checker (WQC) and a pH meter. The variables observed included total feed consumption (TFI), feed utilization efficiency (EFU), feed conversion ratio (FCR), protein efficiency ratio (PER), relative growth rate (RGR), and survival rate (SR), referring to NRC (2011). The calculation formulas are as

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follows:

TFC (g) = Feed consumption on day 1 + feed consumption on day 2 + ... + feed consumption on day n

EFU (%) = Final weight – Initial Weight/the weight of feed consumed x 100

FCR = Feed intake (g) / Body weight gain (g)

PER = 100 × [final weight (g) - initial weight (g)] / the amount of diet consumed (g) x protein content of diet

RGR (% day-1) = 100 × [final weight (g) - initial weight (g)] / ([times of experiment (day) x initial weight (g)]

SR (%) = 100 x (final count / initial count)

The data obtained include total feed consumption (TFC), feed utilization efficiency (EFU), feed conversion ratio (FCR), protein efficiency ratio (PER), relative growth rate (RGR), and survival rate, which were first tested for normality, homogeneity, and additivity before analysis of variance (ANOVA). If the ANOVA results show a significant effect ($P<0.05$) or a highly significant effect ($P<0.01$), Duncan's multiple range test is conducted (Steel *et al*., 1997). Data on water quality parameters obtained were analyzed descriptively.

3. RESULTS

The total feed consumption (TFC), feed utilization efficiency (EFU), feed conversion ratio (FCR), protein efficiency ratio (PER), relative growth rate (RGR), and survival rate (SR) of Stiped catfish fingerlings during the study are presented in Table 1.

Table 1. Mean values of Total Feed Consumption (TFC), Feed Utilization Efficiency (EFU), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Relative Growth Rate (RGR), and Survival Rate (SR) of Stiped Catfish Fingerlings During the Study

Variabels	Test Feed			
	T1	T2	T3	T4
Initial weight (g)	3.40 ± 0.17^{a}	3.36 ± 0.14^{a}	3.36 ± 0.12^{a}	3.42 ± 0.13^{a}
Final weight (g)	10.09 ± 0.14^{e}	11.83 ± 0.10^{d}	16.87 ± 0.12^{c}	13.54 ± 0.15^{b}
Weight gain (g)	27.28 ± 0.19^{e}	36.24 ± 0.16^{d}	49.52 ± 0.16^{c}	56.60 ± 0.18^{b}
TKP (g)	133.33 ± 0.61^{a}	143.67 ± 0.55^{b}	154.70 ± 0.87^{d}	149.60 ± 0.50^{c}
EFU (%)	58.07 ± 3.14^{a}	68.10 ± 0.30^{b}	86.32 ± 0.87^{d}	79.97 ± 0.81^{c}
FCR	1.55 ± 0.03^{d}	1.28 ± 0.01^{c}	1.02 ± 0.01^{a}	1.34 ± 0.01^{b}
PER	2.30 ± 0.11^{a}	2.63 ± 0.01^{b}	3.29 ± 0.03^{d}	2.95 ± 0.03^{c}
RGR (%/day)	2.97 ± 0.04^{a}	3.52 ± 0.05^{b}	5.02 ± 0.09^{d}	3.96 ± 0.03^{c}
SR	100^{a}	100^{a}	100^{a}	100^{a}

Notes : Means having the same letter in the same row are not significantly different at $P < 0.05$.

The results of water quality measurements taken during the study, including temperature, pH, and Dissolved oxygen (DO) in the morning and afternoon over the 49-day study period, are presented in Table 2.

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Table 2. Water Quality Parameters of the Striped Catfish Fingerlings Seed Culture Medium During the Study

No	Parameters	Measurement Results		Eligibility
		Morning	Afternoon	
1	Temperature (°C)	25,7-26,9	28,1-30,3	25-30*
2	DO (mg/L)	5,4-7,5	5-6,9	>4*
3	pH	7,14-7,82	6,51-6,85	6,5-8,5*

Note : * Boyd and Tucker (2012)

Based on the measurements of water quality parameters in the culture media for Striped catfish fingerlings during the study (Table 2), it was shown that the values of water quality parameters in the culture media throughout the study remained within the appropriate and suitable range for striped catfish fingerlings cultivation. These measurements were based on water quality standards recommended in the literature as optimal conditions for the growth and survival of striped catfish fingerlings.

4. DISCUSSION

The highest TFC value was observed in treatment C (15 g/kg feed), with an average of 154.70 g, followed by treatment D (22.5 g/kg feed) with an average of 149.60 g, treatment B (7.5 g/kg feed) with an average of 143.67 g, and treatment A (0 g/kg feed) with an average of 133.33 g. Based on the results obtained, test fish fed with feed supplemented with taurine (B, C, and D) had higher TFC values than test fish fed without taurine supplementation (A). This is presumed to be because taurine supplementation can increase appetite and the fish's preference for the test feed. According to Rachmawati *et al*. (2025), taurine supplementation in feed can enhance fish appetite, thereby increasing total feed consumption. Fish preference is an important factor in determining feed intake and digestibility of a feed ingredient, which is influenced by aroma, texture, and taste. During the study, observations were made regarding the texture, taste, and aroma of the feed. Feed in treatment (C) showed a slightly fishier aroma than treatments (B) and (D), making it more preferred by the fish. Feed in treatment A without taurine supplementation had no aroma. In terms of color, feed in treatments A, B, C, and D had a similar appearance, which was somewhat brownish, but feed with added taurine appeared brighter. Feed texture in treatments (C) and (D) was not too hard, whereas in treatments (A) and (B) the texture was too hard, which could affect the fish's ability to chew the feed.

The results of the variance analysis showed that the addition of taurine at different doses in artificial feed had a significant effect ($P<0.05$) on the FEU of striped catfish fingerlings. The highest FEU value was observed in treatment C (15 g/kg feed), with an average of 86.32%, followed by treatment D (22.5 g/kg feed) with an average of 79.97%, then treatment B (7.5 g/kg feed) with an average of 68.10%, and treatment A (0 g/kg feed) with an average of 58.07%. Based on these results, increasing the dose of

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taurine can increase the value of feed utilization efficiency. This indicates that the amount of nutrients absorbed by the fish is proportional to the amount of feed consumed, thus improving nutrient digestibility in the fish. According to Peter *et al*. (2021), the digestibility value in feed reflects a good nutrient content, so it can be absorbed and used for growth. Feed utilization efficiency is influenced by the nutrients contained in the feed, especially protein. This is supported by Rachmawati *et al*. (2025), who state that the higher the protein digestibility in the feed, the more the fish utilize protein to meet their energy and growth needs. A higher protein content in the feed results in higher energy production. The findings of this study are similar to Shen *et al*. (2019), who found that taurine supplementation can improve energy metabolism, protein synthesis, and contribute to better growth. Adding taurine to feed in the right dose can support more efficient growth and enhance feed utilization efficiency. This is further supported by Guroy *et al*. (2022), who state that taurine content in feed at the right level can improve growth performance.

The feed conversion ratio (FCR) is the ratio between the amount of feed administered and the resulting fish body weight. Based on the results of the variance analysis, the addition of taurine to striped catfish fingerlings seed feed had a significant effect ($P<0.05$) on the FCR. The lowest FCR was observed in treatment C (15 g/kg feed), with a value of 1.02, while the highest value was recorded in treatment A (0 g/kg feed) with a value of 1.55. The results of this study showed that the FCR in treatment C was quite good, as it indicated a low value. A high FCR is not favorable because it indicates that the feed is not optimally utilized by the fish. According to Hu *et a*l. (2018), when the FCR is high, the feed consumed is not utilized optimally and efficiently by the fish. The results of this study are consistent with those reported by Bavi *et al*. (2022), who found that the addition of taurine to *Acipenser ruthenus* feed resulted in a feed conversion ratio that was significantly lower and better than that of the treatment without taurine supplementation. The feed conversion ratio is related to growth rate and feed utilization efficiency. This is supported by Nacimento *et al*. (2021), who stated that the FCR is closely related to utilization efficiency, meaning that the lower the feed conversion ratio, the better the efficiency of feed utilization, and vice versa. The magnitude of the FCR is influenced by differences in nutrient absorption among species, age, size, and the number of test fish.

Protein efficiency ratio (PER) is a measure used to assess how efficiently the protein in feed is utilized for fish growth. The best PER result was obtained in treatment C (15 g/kg feed), with a value of 3.29. This value indicates that each gram of protein consumed produced an increase of 3.41 g in body protein of 3.41 g. A higher PER indicates that the protein in the feed is optimally utilized to support fish growth. This is

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reinforced by Shen *et al*. (2021), who stated that feed consumed by fish is converted into body weight and that the process of protein absorption by fish requires the energy possessed by the fish. The PER in treatment C was significantly higher than that in treatment D, with a value of 2.95, treatment B, with a value of 2.63, and the lowest in treatment A without taurine addition, with a value of 2.30. The low PER in treatment A (0 g/kg feed) indicates that the protein in the feed was not optimally utilized for growth, due to the limited ability of catfish juveniles to synthesize taurine on their own. According to Li *et al*. (2022), taurine supplementation in feed can stimulate feed intake and protein synthesis, thereby enhancing fish growth. A high PER indicates that the protein in the feed is optimally utilized to increase fish body weight. Taurine is known to play an important role in the digestion and metabolism of protein, including by improving liver function, fat emulsification, and increasing nutrient absorption in the intestine. According to Qian *et al*. (2021), taurine can enhance the activity of enzymes such as trypsin, amylase, and lipase in the intestine, thereby improving feed digestibility. Taurine also acts as a bile emulsifier, which helps in the absorption of fat and fat-soluble vitamins, as well as in improving digestive enzyme function and maintaining cell stability, so that nutrients, including protein, can be utilized more optimally. The PER is influenced by several factors, including protein quality in the feed, digestibility, completeness of amino acid groups, and physiological condition of the cultured fish. According to Sun *et al*. (2024), completeness of amino acid groups is very important for fish growth, and high protein content in feed is not efficient if it does not contain a complete set of amino acids. This is supported by Richard *et al*. (2017), who stated that feed with protein that has a balanced amino acid content will be more easily digested and yield a higher protein efficiency ratio.

The results of the variance analysis showed that the addition of taurine to the feed for striped catfish fingerlings had a significant effect ($P<0.05$) on the relative growth rate. The best relative growth rate was observed in treatment C, with a value of 5.02%/day, which was significantly higher than treatment D at 3.96%/day, treatment B at 3.52%/day, and the lowest in treatment A without taurine supplementation at 2.97%/day. This increase in growth rate was in line with the presence of taurine in the feed, as taurine plays a role in various important physiological functions. This is supported by Sampath *et al*. (2020), who stated that the addition of taurine to feed can improve growth performance, especially in species that are unable to synthesize sufficient amounts of taurine on their own. Relative growth rate is also related to an increase in total feed consumption, a low feed conversion ratio, and high feed utilization efficiency. Dehghani *et al*. (2020) stated that as the growth rate increases, feed utilization efficiency also increases, so the supplied feed is efficiently utilized by the

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fish to meet its energy and growth needs. This is because taurine plays a crucial role in supporting fish growth as it is involved in various metabolic processes such as fat emulsification, osmoregulation, antioxidation, and enhancing nutrient absorption in the digestive tract. Taurine is also known to increase appetite and protein utilization efficiency, which directly impacts growth.

Survival rate (SR) is the percentage of fish that survive from the beginning to the end of rearing. Based on research results, the addition of taurine in artificial feed had no significant effect on the survival rate (SR) of striped catfish fingerlings. This is thought to be because feed supplemented with taurine did not have a negative effect on striped catfish fingerlings. According to Guroy *et al.* (2022), taurine supplementation in feed does not have a significant impact on fish survival rate. This is also supported by Rachmawati *et al*. (2025), who found that taurine addition did not affect survival rate values. The survival rate (SR) is influenced by several factors, such as environmental stability, physiological condition of the fish, and adaptive responses to the overall feed composition. According to Martins *et al*. (2019), the survival rate is influenced by two factors: internal and external. Internal factors include physiological health, immune system condition, metabolic capacity, and the body's response to stress. External factors affecting fish survival rate include stocking density, disease, cleanliness of the rearing tanks, and water quality (Qian *et al*., 2021). In treatment A (0 g/kg feed), the survival rate decreased, presumably due to physiological disturbances during sampling, causing fish to become stressed and lose appetite. Reduced appetite in fish can result in difficulty moving and inadequate nutrient intake, leading to suboptimal growth. This is supported by Okon *et al*. (2023), who stated that physiological stress in fish caused by the environment may suppress immune function, making fish more susceptible to disease and, in the worst cases, resulting in mortality. The survival rate of each treatment was categorized as good, as survival values exceeded 50%. A survival rate greater than 50% is considered good, 30–50% is moderate, and less than 30% is considered poor (Peter *et al*., 20241. This study showed that taurine supplementation in feed had no significant effect on the survival rate of striped catfish fingerlings. The results of this study are consistent with those of Tan *et al*. (2018), Martins *et al*. (2019), Peter *et al*. (2021), and Rachmawati *et al*. (2025).

CONCLUSION

The results of the study showed that taurine supplementation had a significant effect ($P<0.05$) on BWG, SGR, FCR, PER, and RGR, but did not have a significant effect ($P>0.05$) on the SR of striped catfish fingerlings. The best taurine dose in commercial feed for striped catfish fingerlings was 15 g/kg feed (treatment C), which yielded the highest values for BWG (154.70 g), SGR (86.32%), FCR (1.02), PER (3.29), and RGR (5.02). Taurine supplementation

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in commercial feed at 15 g/kg feed can improve feed utilization efficiency and growth of striped catfish fingerlings.

Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. Grammarly and ChatGPT were used solely to assist with grammatical refinement and reference formatting during manuscript revision. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

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