Grouper: Jurnal Ilmiah Perikanan
Vol. 17 No. 2 (2026) pp. 417 - 428
pISSN: 2086-8480 | eISSN: 2716-2702
Journal Homepage: https://grouper.unisla.ac.id/index.php/grouper

Effect of Combined Trash Fish Meal and Moringa Leaf Meal on the Growth Performance of Pangasianodon hypophthalmus

Sofie Atin Khasannah[1*], Aceng Ruyani[2], Annisa Puji Astuti[1], Dewi Jumiarni[3], Deni Parlindungan[1]

[1]Science Education Program, Faculty of Teacher Training and Education, University of Bengkulu, Bengkulu, Indonesia
[2]Master of Science Education Program, Faculty of Teacher Training and Education, University of Bengkulu, Bengkulu, Indonesia
[3]Biology Education Program, Faculty of Teacher Training and Education, University of Bengkulu, Bengkulu, Indonesia

*Corresponding Author: atununib22@gmail.com

Submitted: 04 August 2026 Revised: 06 September 2026 Accepted: 18 September 2026

Keywords:
Feed Growth; *Moringa oleifera; Pangasianodon hypophthalmus*; performance; Trash fish.

ABSTRACT

This study aims to determine how the combination of trash fish meal and moringa leaf meal (Moringa oleifera) affects the growth performance of catfish (Pangasianodon hypophthalmus) using five treatments. The study employed an experimental completely randomized design (CRD), and the fish were reared for a duration of 21 days. Data collection included specific growth rate (SGR), survival rate (SR), and morphometric measurements (weight, length, width, and thickness). The data were statistically analyzed using Analysis of Variance (ANOVA) at a 95% confidence level, followed by the Least Significant Difference (LSD) test. The measurements showed the highest morphometric values and SGR (2.62%) in treatment P4, which consisted of 75% trash fish meal and 25% moringa leaves, indicating increased fish growth. Meanwhile, the highest SR value (73%) was found in treatment P1, consisting of 100% moringa leaves. In conclusion, treatment P4 provides the best formulation for enhancing fish growth, whereas treatment P1 is the optimal choice for maximizing the survival rate.

INTRODUCTION

Freshwater fish farming is one of the fisheries subsectors that contributes to the supply of animal protein for the public. The main challenge in fish farming is the high cost of feed, which accounts for the majority of production costs. Feed serves as a source of energy and nutrients to support the maintenance, growth, and reproduction of fish; therefore, feed formulations must meet nutritional requirements to ensure optimal growth and maintain fish resistance to health issues (Devani, 2019).

One way to reduce production costs is to use local raw materials as alternative feed ingredients. Bycatch is a low-value byproduct that is abundant and can be used as a source of animal protein in feed (Masitlha *et al.,* 2024). The nutritional content of bycatch fish includes crude protein 58.97%, fat 6.54%, crude fiber 1.64%, and ash 27.89%, making it suitable for use as a fish feed ingredient (Akbar *et al.,* 2019). Research conducted by Perveen *et al.,* (2026) indicates that fish waste can serve as an alternative feed ingredient that supports the metabolic processes and growth of farmed fish, as it contains protein, minerals, potassium, and calcium.

In addition to animal protein sources, plant-based feed ingredients are needed to ensure nutritional balance. Moringa leaves (*Moringa oleifera*) are known to contain protein, vitamins, minerals, and bioactive compounds that have the potential to enhance the growth and health of fish (Masita *et al.,* 2026). Moringa leaves (Moringa oleifera) have a complete nutritional profile, including protein, minerals, and iron, making them a potential feed

ingredient to support the metabolism and growth of farmed organisms (Laenggeng *et al.,* 2026). According to U & B (2019), *M. oleifera* leaf meal can replace fish meal at an inclusion level of up to 20% without reducing growth performance. Meanwhile, (Saleh *et al.,* 2025) report that using *M. oleifera* at levels of 5–30% in feed can enhance growth, improve physiological function, strengthen the immune system, and increase fish resistance to disease.

Although the benefits of rucah fish and moringa leaves have been widely reported, most studies still evaluate these two ingredients separately. Therefore, information regarding the effectiveness of combining rucah fish meal and moringa leaf meal in a single feed formulation remains limited. A study (Silitonga *et al.,* 2026) shows that feed made from rucah fish, tofu residue, and rice bran has a protein content of 22.68%, making it suitable for catfish farming while also reducing production costs. Additionally, the study (Naria *et al.,* 2022) reports that adding 30% moringa leaf flour resulted in the best growth and survival rates in farmed fish.

While previous studies have independently evaluated the use of either moringa leaf meal or fish waste as alternative feed ingredients, research assessing their combined application remains largely unexplored. To address this specific research gap, this study proposes a novel feed formulation that integrates both low-grade trash fish meal as a source of animal protein and moringa leaf meal as a source of plant protein into a single diet for catfish (*Pangasianodon hypophthalmus*). By combining these two previously separated ingredients, this study aims to evaluate their synergistic effect on fish growth performance, serving as a basis for developing a more economical, highly nutritious, and sustainable feed.

Growth is an indicator of aquaculture success, reflecting increases in both fish size and biomass resulting from the utilization of feed nutrients (Ratulangi *et al.,* 2022). Growth efficiency is influenced by the fish's ability to digest and utilize the nutrients available in the feed (Mendrofa & Zebua, 2025). The patin fish (*Pangasianodon hypophthalmus*) was selected as the test organism because it grows rapidly, has high economic value, and is one of the leading freshwater aquaculture commodities in Indonesia (Ilham *et al.,* 2026). Therefore, this study was conducted to analyze the effect of combining bycatch fish meal and moringa leaf meal on the growth of patin fish as an alternative for an efficient and sustainable feed formulation. Specifically, the main objective of this study is to evaluate the optimum proportion of the combined trash fish meal and moringa leaf meal in feed to improve the growth performance and survival rate of *Pangasianodon hypophthalmus*.

METHOD

This study was an experimental study conducted from December 2025 to January 2026 at the Ruyani Life Sciences Learning Center (SBIH) in Bengkulu. The equipment used included a 69 x 92 cm rearing tank, a white container box, a fish net, calipers, a digital scale, a pH meter, a thermometer, a Total Dissolved Solids (TDS) meter, a Dissolved Oxygen (DO) meter, and a lux meter. The research subjects consisted of 75 60-day-old catfish (*Pangasianodon hypopthalmus*) fingerlings. The feed used was a commercial feed made from fish meal and moringa (Moringa oleifera) leaf meal.

The feed is produced independently using bycatch fish and moringa leaves (Moringa oleifera). To prepare the bycatch fish meal, fish are purchased from vendors in Kota Tuo, Bengkulu. The fish are then washed with water, boiled for 30 minutes, and drained to reduce moisture. The drained fish are sun-dried until completely dry. Once dry, they are ground into flour using a grinder. The processed fish meal is stored in a container and is ready for use. Meanwhile, the preparation of moringa leaf (Moringa oleifera) powder involves picking the leaves from Bengkulu University. Afterward, the leaves are separated from their stalks and sun-dried until completely dry. Once dry, the material is ground into powder using a grinder. The processed moringa (Moringa oleifera) leaves are stored in containers and are ready for use. The yield of rucah fish meal was 500 grams, and that of moringa (Moringa oleifera) leaf meal was 500 grams; the ingredients were then mixed according to the treatment compositions listed in Table 1.

Table 1. Treatment Composition

No	Treatment	Feed Composition
1	P1	100% moringa leaves (*M. oleifera*)
2	P2	75% moringa leaves (*M. oleifera*) + 25% fish meal
3	P3	50% moringa leaves (*M. oleifera*) + 50% fish meal
4	P4	25% moringa leaves (*M. oleifera*) + 75% fish meal
5	P5	100% fish meal

The study was conducted using a completely randomized design (CRD) with five treatments. Each treatment was housed in a single rearing tank stocked with 15 catfish (Pangasianodon hypopthalmus) fingerlings, resulting in a total sample size of 75 fish throughout the study. Rearing was conducted for 21 days, with feeding once daily at 3–5% of fish biomass. The amount of feed was adjusted based on the fish weight in each treatment. During the rearing period, uneaten feed and feces were removed daily, and 15% of the total rearing medium volume was replaced to maintain water quality.

Observations were conducted every three days to measure the fish's weight, length, width, and body thickness. Weight was measured using a digital scale, while length, width, and body thickness were measured using a caliper. At the start of the rearing period, each tank contained 15 fish; however, mortality occurred during the period, resulting in varying numbers of surviving fish across treatments. Measurements of weight, length, width, and body thickness were taken from five fish selected from the surviving fish in each treatment. Thus, the statistical analysis of the morphometric parameters used 25 individual data points from the five treatments, five fish per treatment. The Specific Growth Rate (SGR) was calculated based on the average weight of the surviving fish in each treatment, while the Survival Rate (SR) was calculated by comparing the number of fish alive at the end of the rearing period to the number of fish at the start of the study (15 fish) in each treatment.

Data on body weight, length, width, and thickness were analyzed using Analysis of Variance (ANOVA) at a 95% confidence level (\alpha = 0.05). Before conducting the ANOVA, the data were first tested for normality using the Shapiro-Wilk test and homogeneity using Levene's test as prerequisites for parametric analysis. If the ANOVA results indicated a significant difference ($P < 0.05$), the analysis continued using the Least Significant Difference (LSD) test at a 5% significance level to identify differences between treatments. All statistical analyses were performed using IBM SPSS Statistics version 25. While the SGR and SR values were calculated using the following formulas:

Survival *Rate* (SR)

To determine the survival percentage (Survival Rate, SR) of catfish (P. hypophthalmos) reared, the *formula proposed by Effendi* (Muchlisin *et al.,* 2016) *can be used.*

$$SR = x\ 100\%\frac{Nt}{No}$$

Description:
SR = Survival (%)
Nt = Number of fish alive at the end of the study (tail)
No **=** Number of fish at the beginning of the study (tail)

Specific *Growth Rate (SGR)*

The *Specific Growth Rate (SGR)* during the rearing of catfish *(P. hypopthalmus*) is calculated using the equation (Muchlisin *et al.,* 2016)

$$SGR = x\ 100\%\frac{Wt - Wo}{\Delta t}$$

Description:
SGR = *Specific Growth Rate* (% per day)
Wt = Weight of fish at the end of the rearing period (grams)
W0 = Weight of fish at the start of the rearing period (grams)

Δt = Duration of the rearing period (days)

RESULT AND DISCUSSION

Growth (weight, length, width, thickness)

Growth in living organisms is a biological process that occurs gradually and continuously. The growth process is characterized by an increase in body size and tissue age, which occur as cells continue to divide and proliferate (Rahmat , 2018). According to (Aulia *et al.,* 2025), growth in fish is the process of increasing body size, as indicated by increases in length and weight over a period of rearing. In this study, the parameters measured were body weight, body length, body width, body thickness, and daily growth rate. The growth rate of catfish is shown in Table 2.

Table 2. Growth rate of catfish (*P. hypopthalmus*)

Growth Parameters	Treatment					Highest Treatment
	P1	P2	P3	P4	P5	
Weight (grams)	0,8	1,43	1,59	3,03	0,66	P4
Length (cm)	1,76	3,29	4,21	4,85	1,71	P4
Width (cm)	0,25	0,72	0,85	1,02	0,42	P4
Thickness (cm)	0,35	0,63	0,63	0,92	0,63	P4

Note: P1 (Treatment 1), P2 (Treatment 2), P3 (Treatment 3), P4 (Treatment 4), P5 (Treatment 5)

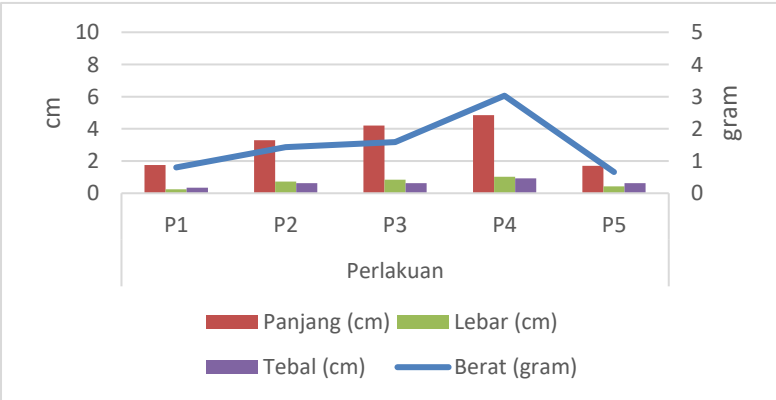


Figure 1. Growth rate of catfish (*P. hypopthalmus*)

Based on the results presented in Table 2 and Figure 1, the growth rate of Pangasianodon hypopthalmus differed among treatments. The results were derived from growth parameters, including weight, length, width, and body thickness, with the highest values observed in the P4 treatment (25% moringa leaves + 75% rucah fish) across 15 fish per treatment. This indicates that the P4 treatment yields a better growth response than the other treatments. The increase in body length is typically continuous and relatively stable over time, whereas the increase in body weight does not always follow a steady pattern, as it can be influenced by various factors affecting fish metabolism (Prasetiyo *et al.,* 2023).



Figure 2. *Pangasianodon hypopthalmus*

Specific Growth Rate (SGR)

Specific growth rate is the daily growth rate, expressed as the percentage of fish weight gain per day. The specific growth rate at the time of observation is shown in Figure 3.

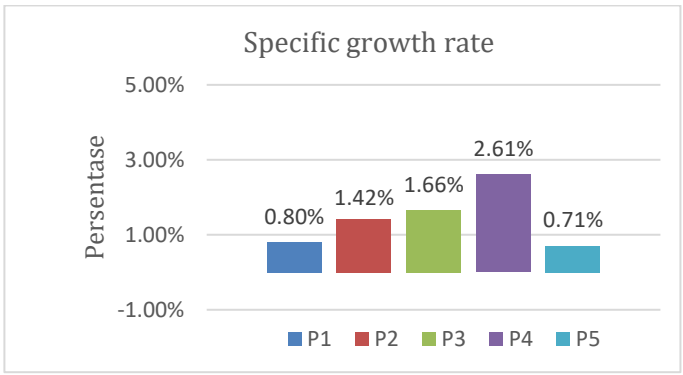


Figure 3. Specific growth rate

Based on the research results presented in Figure 3, treatment P4 (25% moringa leaf flour + 75% fish meal) produced the highest specific growth rate (SGR) of 2.62%, followed by treatment P3 at 1.66% and P2 at 1.42%, while treatments P1 and P5 yielded SGR values of 0.80% and 0.71%, respectively. The differences in SGR values among treatments indicate that feed formulation affects fish's ability to utilize nutrients for growth. The high SGR value in treatment P4 is believed to be related to the balanced protein and nutrient content of the combination of moringa leaf meal and low-grade fish meal, resulting in more efficient feed utilization.

This is consistent with findings that (Juliantara *et al.,* 2020) the specific growth rate of fish is influenced by internal and external factors, particularly feed quality, with protein and fat content playing a crucial role in determining fish growth and body composition. In addition to protein and fat content, energy balance and nutrient availability in the feed play a crucial role in supporting optimal nutrient utilization, thereby enhancing the growth of farmed fish (Candebat *et al.,* 2026).

Survival *Rate*

Survival is expressed as the percentage of fish surviving during the rearing period, divided by the number of fish stocked (15 fish per treatment). The survival rate of catfish (*Pangasianodon hypophthalmus*) fry during the 21-day rearing period is presented in Figure 4.

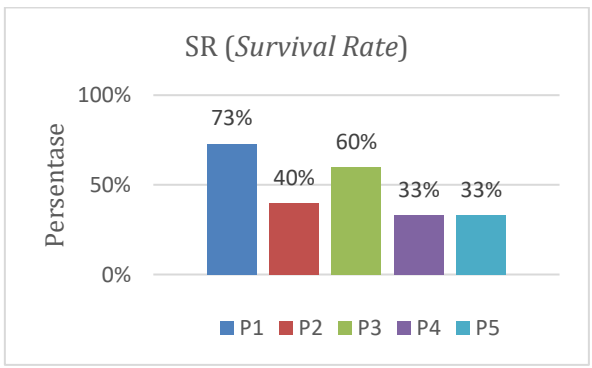


Figure 4. SR (*Survival Rate*)

Based on Figure 4, the survival rate of catfish (*PangasiBased on Figure 4, the survival rate of catfish (Pangasianodon hypophthalmus*) fry during the 21-day rearing period varied among treatments. Treatment P1 (100% moringa leaf meal) yielded the highest survival rate of

73%, followed by P3 (50% moringa leaf meal + 50% fish meal) at 60%, P2 (75% moringa leaf flour + 25% fish meal) at 40%, and P4 (25% moringa leaf flour + 75% fish meal) and P5 (100% fish meal) at 33% each. These values indicate that the fish were able to adapt to the rearing environment and utilize the provided feed to maintain their survival

According (Mulyani et al. (2014) Idris *et al.,* (2025)), a survival rate of ≥50% is considered good, 30–50% moderate, and <30% low. Thus, treatments P1 and P3 are classified as good, while P2, P4, and P5 are classified as moderate. Fish mortality that occurred during the study is suspected to have been influenced by stress during the measurement process, as reported by Idris *et al.,* (2025) who state that handling fish during measurements can trigger stress leading to death.

Statistical analysis (ANOVA, LSD)

Statistical analysis using a variety of ANOVA at a 95% confidence level (α = 0.05) was conducted to determine the effect of feed composition treatments on fish growth, as measured by fish weight, length, width, and thickness. If the ANOVA results indicate a significant difference between treatments (P < 0.05), further tests will be conducted using BNT/LSD. In this data analysis, 5 fish were used per treatment. This is because, at the end of the maintenance phase, there were 5 fish in treatments P4 and P5. Data from 5 fish in each of the 5 treatments were collected, using average treatment parameters with values that were similar or close to each other.

Catfish (*P. hypopthalmus*) Body Weight

Measurement of the body weight of catfish (*P. hypopthalmus*) using a digital scale. The average measurement results are shown in Table 3.

Table 3. Average Catfish Weight Gain by Treatment

Treatment	N	Average weight (grams) ± SD
P1 (100% moringa leaves)	5	0.24 ± 0.13^{ab}
P2 (75% moringa leaves + 25% fish meal)	5	0.04 ± 0.28^{a}
P3 (50% moringa leaves + 50% fish meal)	5	0.52 ± 0.13^{b}
P4 (25% moringa leaves + 75% fish meal)	5	$0.54 \pm 0.32^{*b}$
P5 (100% fish meal)	5	0.12 ± 0.26^{a}

Note: SD: standard deviation, *: highest weight.

Analysis of variance showed that the feed formulation had a significant effect on catfish weight gain (F = 4.562; p = 0.0088). The calculated F-value was higher than the table F-value (4.562 > 2.866), indicating a difference in growth response among treatments; therefore, a Least Significant Difference (LSD) test was conducted at the 5% level. The test results showed that P3 (50% moringa leaf flour + 50% fish meal) and P4 (25% moringa leaf flour + 75% fish meal) were in the same notation group (b), indicating comparable weight-gain responses. Conversely, P2 (75% moringa leaf meal + 25% low-grade fish meal) and P5 (100% low-grade fish meal) were classified in group a, with lower weight gain, while P1 (100% moringa leaf meal) was in group ab, showing no significant difference from the other two groups.

These differences are believed to be related to the adequacy and balance of nutrients in each feed formulation. Naria *et al.,* (2022) reports that moringa leaf powder contains 27.1 g of protein per 100 g and is rich in carbohydrates, fats, vitamins, and minerals that play a role in supporting the growth of farmed organisms. The results of Aulia *et al.,* (2025) study also support the findings of , which achieved the highest average absolute weight of 15.02 g by supplementing the diet with 10 g/kg of fermented moringa leaves.

The findings of Xu *et al.,* (2026) the study indicate that feed formulations with a balanced nutrient profile can improve protein utilization efficiency, thereby optimizing body tissue deposition and sustaining fish growth. Thus, the combination of moringa leaf meal and

bycatch fish meal in appropriate proportions is expected to improve feed quality, leading to more effective nutrient utilization and increased catfish body weight.

Body Length of Catfish (*P. hypopthalmus*)

Measurement of the body length of catfish (*P. hypopthalmus*) using calipers. The average measurement results are shown in Table 4.

Table 4. Average Increase in Catfish Length by Treatment

Treatment	N	Average Length (cm) ± SD
P1 (100% moringa leaves)	5	0.18 ± 0.16[a]
P2 (75% moringa leaves + 25% fish meal)	5	0,80 ± 0,55[b]
P3 (50% moringa leaves + 50% fish meal)	5	1,10 ± 0,15[c]
P4 (25% moringa leaves + 75% fish meal)	5	1,34 ± 0,35[*c]
P5 (100% fish meal)	5	0.44 ± 0.19[ab]

Note: SD: standard deviation, *: highest weight.

Based on the research results, treatment P4 (25% moringa leaf meal + 75% fish meal) produced the highest average length gain in catfish, at 1.34 ± 0.35 cm, followed by treatment P3 (50% moringa leaf meal + 50% fish meal) at 1.10 ± 0.15 cm. Treatment P2 resulted in a length gain of 0.80 ± 0.55 cm, while P5 and P1 yielded 0.44 ± 0.19 cm and 0.18 ± 0.16 cm, respectively. The results of the analysis of variance (ANOVA) showed that the combination of moringa (*Moringa oleifera*) leaf meal and rucah fish meal had a significant effect on the length gain of catfish (*P. hypophthalmus*) ($P < 0.05$), with a calculated F-value of 10.746, which was greater than the table F-value of 2.866. The BNT/LSD test results showed that treatments P3 and P4 were not significantly different from each other, but both were significantly different from treatments P2 and P5, while treatment P1 exhibited a growth response that fell between those of the other two treatment groups.

The increase in length gain in the P3 treatment and especially in the P4 treatment indicates that feed formulations combining moringa leaf meal and fish by-product meal are capable of providing more appropriate nutrients to support the growth of catfish fry. According to Nurfatiha *et al.,* (2025), the average length growth of Siamese catfish fry increased as the rearing period progressed. The feed consumed is digested by the body and converted into energy, which is used for basal metabolism, movement, and the repair of damaged cells, with the remainder used for growth. Protein plays a crucial role in the formation of tissues and organs in animals, including fish.

This statement aligns with the results of this study, in which treatment P4 yielded the highest increase in length. These findings suggest that the combination of 25% moringa leaf meal and 75% fish meal is likely to provide optimal amounts of protein and other nutrients, thereby enhancing tissue formation. Conversely, treatments using either moringa leaf meal or rucah fish meal alone resulted in lower length gains, suggesting that a balanced nutrient composition in the diet plays a more significant role in supporting fish length growth than the use of a single feed ingredient.

Body Width of Catfish (*P. hypopthalmus*)

The body width of the catfish (*P. hypopthalmus*) was measured using a caliper. The average measurement results are shown in Table 5.

Table 5. Average Increase in Width by Treatment

Treatment	N	Average Width (cm) ± SD
P1 (100% moringa leaves)	5	0.16 ± 0.13[ab]
P2 (75% moringa leaves + 25% fish meal)	5	0,28 ± 0,04[a]
P3 (50% moringa leaves + 50% fish meal)	5	0.26 ± 0.05[ab]
P4 (25% moringa leaves + 75% fish meal)	5	0,30 ± 0,07[*a]

Treatment	N	Average Width (cm) ± SD
P5 (100% fish meal)	5	0.12 ± 0.04[b]

Note: SD: standard deviation, *: highest width.

The results of the analysis of variance (ANOVA) showed that the addition of a combination of moringa (*Moringa oleifera*) leaf meal and fish meal had a significant effect on the body width gain of catfish (*P. hypophthalmus*) ($p < 0.05$). Based on the Least Significant Difference (LSD) test results, treatments P2 (75% moringa leaf flour + 25% rucah fish meal) and P4 (25% moringa leaf flour + 75% rucah fish meal) produced higher body width gains and were not significantly different from each other. Both of these treatments differed significantly from treatment P5 (100% rucah fish meal), while treatments P1 (100% moringa leaf meal) and P3 (50% moringa leaf meal + 50% rucah fish meal) showed growth responses that fell between those of the other two groups.

These differences in body width growth responses indicate that variations in diet composition can alter one of the morphometric dimensions of catfish. Treatments P2 and P4 tended to produce better body width development than the other treatments, whereas using low-grade fish meal as the sole ingredient in P5 resulted in the smallest increase in body width. These findings indicate that a balanced composition of feed ingredients can support optimal body shape development in fish compared with using a single feed ingredient.

The results of Okomoda *et al.,* (2018) this study are consistent with the findings of *the* study, which state that morphometric variations in fish are influenced by fin characteristics and body characteristics, so that morphometric parameters can be used to describe differences in fish body shape. In this study, body width was one of the morphometric parameters used to indicate differences in growth responses resulting from the treatments administered. Therefore, changes in body width across treatments reflect not only increases in body size but also variations in fish morphology during the rearing period.

Body Thickness of Catfish (*P. hypopthalmus*)

Measurement of the body thickness of catfish (*P. hypopthalmus*) using a caliper. The average measurement results are shown in Table 6.

Table 6. Average Increase in Catfish Thickness by Treatment

Treatment	N	Average Thickness (cm) ± SD
P1 (100% moringa leaves)	5	0,12 ± 0,04
P2 (75% moringa leaves + 25% fish meal)	5	0,20 ± 0,00
P3 (50% moringa leaves + 50% fish meal)	5	0,22 ± 0,04
P4 (25% moringa leaves + 75% fish meal)	5	0,28 ± 0,08*
P5 (100% fish meal)	5	0,22 ± 0,04

Description: SD: standard deviation, *: highest thickness.

Based on the measurement results, the highest average body thickness gain in catfish was observed in treatment P4 (25% moringa leaf meal + 75% fish meal), at 0.28 ± 0.08 cm, followed by treatments P3 (50% moringa leaf meal + 50% fish meal) and P5 (100% fish meal), which each produced a body thickness increase of 0.22 ± 0.04 cm. Furthermore, treatment P2 (75% moringa leaf meal + 25% low-grade fish meal) resulted in a body thickness increase of 0.20 ± 0.00 cm, while the lowest value was observed in treatment P1 (100% moringa leaf meal), at 0.12 ± 0.04 cm. Although treatment P4 showed the highest mean value descriptively, the results of the analysis of variance (ANOVA) indicated that the combination of moringa (*Moringa oleifera*) leaf meal and rucah fish meal did not have a significant effect on the body thickness gain of patin (*P. hypophthalmus*) ($F = 2.192$; $p = 0.0991$; $p > 0.05$). The calculated F-value being smaller than the table F-value ($2.192 < 2.759$) indicates that the differences in mean body thickness gain among treatments were not statistically significant; therefore, the analysis was not continued with the BNT/LSD test.

The results show that although the feed formulation containing 25% moringa leaf meal and 75% fish meal produced a higher trend in body thickness gain, this increase was not sufficient to statistically distinguish the growth responses among treatments. This indicates that catfish body thickness increased during the rearing period, with growth relatively uniform across all treatments. According to Yusuf, (2019), the development of certain body parts is not influenced by the environment in which the fish live, whereas other body measurements are. This statement aligns with the results of this study, as the body thickness parameter did not show any significant changes in response to differences in feed composition. Thus, body thickness is suspected to be one of the morphometric traits that respond more slowly to diet treatments than other growth parameters, so that the variation in values obtained for each treatment remained within the natural range of fish growth variation during the study period.

According to Idris *et al.,* (2025), feed plays an important role in meeting the basic energy needs of fish, supporting metabolic activity, supporting the reproductive process, and promoting fish growth. Based on the study's results, there is variation in fish growth parameters, including weight, length, width, and thickness. All growth parameters of catfish fed a diet containing rucah fish meal and moringa leaf flour (M. oleifera) increased during the study period. According to Kholis *et al.,* (2023), rucah fish has a protein content ranging from 40% to 65%. This indicates that Rucah fish feed has the potential to serve as the primary protein source in catfish (*P. hypopthalmus*) feed.

Moringa leaves (*M. oleifera*) are used as a source of vegetable protein and functional ingredients because they contain proteins, minerals, vitamins, and bioactive compounds (Pernanda *et al.,* 2026). In addition, Masitlha *et al.,* (2024) reported that moringa leaves (M. oleifera) content nutrients such as protein, fat, ash, fiber, and carbohydrates, which support their potential as feed. A study by (Widarti *et al.,* 2023) showed that adding moringa flour to catfish (Pangasius) feed affects growth rate and feed efficiency.

The These two feed nutrient components are believed to promote fish growth, consistent with the findings of Wulandari *et al.,* (2024), which states that variations in feed composition lead to differences in the amount of protein consumed by fish, thereby influencing growth. Below is an image of the feed used in this study.



Figure 3. Rucah fish meal feed



Figure 4. Moringa leaf flour feed (*M. oleifera*)

Water Quality

Regarding water quality, the results of the analysis of various water quality parameters are shown in Table 7.

Table 7. Water Quality Parameters

Parameter	Treatment				
	P1	P2	P3	P4	P5
Temperature (°C)	27-32	27-33	27-33	27-33	27-36
Light Intensity (Lux)	30-421	26-309	18-746	14-931	55-950

Parameter	Treatment				
	P1	P2	P3	P4	P5
DO (mg/L)	8,8-13,5	8,8-13,5	8,3-16,5	8,7-17,5	8,7-17,5
TDS (ppm)	0,054-0,116	0,063-0,108	0,062-0,101	0,061-0,108	0,053-0,106

Note: DO *(Dissolved Oxygen*), TDS (Total *Dissolved Solids)*

Based on water quality measurements in catfish (*Pangasianodon hypophthalmus*) rearing tanks, the following parameters were obtained: a temperature range of 27–36°C, light intensity of 14–950 lux, dissolved oxygen (DO) of 8.3–17.5 mg/L, and *total dissolved solids* (TDS) of 0.053–0.116 ppm. Temperature is one of the environmental factors that influences fish metabolism and growth. According to Bachtiar (2002), as cited in Nubatonis *et al.,* (2024), the optimal temperature range for catfish fry is 24–28°C. Although temperatures reached 36°C during the study, these conditions were still sufficient to support the fish's survival. In addition to temperature, dissolved oxygen (DO) plays a crucial role in supporting fish physiology. A study conducted by Aji *et al.,* (2025) states that the ideal DO level for catfish ranges from 4–7 mg/L. DO levels ranged from 8.3 to 17.5 mg/L, indicating sufficient dissolved oxygen to support metabolic processes and feed utilization.

Meanwhile, TDS values of 0.053–0.116 ppm indicate that the quality of the rearing medium remained good. Syakir *et al.,* (2024) explain that relatively stable TDS values indicate water quality adequate to support fish growth and health. These conditions are also supported by minimal accumulation of organic matter in the rearing medium, as according to Qothrunnada & Prabowo, (2023), uneaten or undigested feed residues can settle at the bottom of the water body and degrade water quality, thereby potentially inhibiting fish growth.

CONCLUSION

Based on the research results, the combination of fish meal and moringa (Moringa oleifera) leaf meal affected several growth parameters in Pangasianodon hypophthalmos. Treatment P4 (25% moringa leaf meal + 75% rucah fish meal) resulted in the highest increases in body weight, length, and width, as well as a Specific Growth Rate (SGR) of 2.62%. However, this treatment did not significantly affect body thickness, according to the ANOVA results ($P > 0.05$). However, this treatment did not significantly affect body thickness gain, as indicated by the ANOVA results ($P > 0.05$). The highest Survival Rate (SR) was obtained in treatment P1 (100% moringa leaf meal) at 73%, while P4 and P5 showed the lowest SR values at 33%. The results of this study indicate that the best feed formulation for enhancing growth does not necessarily result in the highest survival rate.

Future research is recommended to test feed efficiency parameters, such as the Feed Conversion Ratio (FCR), Feed Efficiency Ratio (FER), and Protein Efficiency Ratio (PER), to evaluate nutrient utilization more comprehensively, such studies could also employ a longer rearing period.

REFERENCES

Aji, R. W., Sumaryam, & Budiyanto, D. (2025). The effect of different percentages of natural silkworm (Tubifex sp.) feed and commercial feed on the absolute weight gain of pangasius hypophthalmus fry. *Journal of Fisheries and Animal Science*, *3*.

Akbar, tito, m., t, baginda, iskandar, m., & pujaningsih, retno, i. (2019). Microbiological status of fish meal treated with cherry leaf extract as an antibacterial agent at various storage durations. *Indonesian Journal of Fisheries Science*, *14*(3), 312–318.

Aulia, A. H., Tang, U. M., & Pamukas, N. A. (2025). Cultivation of catfish (Pangasianodon hypophtalmus) using an aquaponic system and fermented moringa leaf (Moringa oleifera) feed. *Journal of Aquatic Science*, *13*(2), 181–189.

Candebat, C., Marc, A. F., Das, S. K., & Nankervis, L. (2026). Interactive effects of dietary starch

level and ingredient grinding size on growth , intestinal health and liver condition of juvenile giant grouper (Epinephelus lanceolatus). *Aquaculture Nutrition*, 1–12. https://doi.org/10.1155/anu/3101205

Devani, V. (2019). Optimization of the nutritional composition of artificial fish feed using fuzzy linear programming. *Journal of Research Results and Scientific Works, 5*(1), 20–26.

Idris, F., Rahmatia, F., & Dhewantara, Y. L. (2025). Addition of moringa oleifera leaf powder to feed to improve growth and survival of pangasianodon hypophthalmus fingerlings. *Satya Minabahari Scientific Journal*, *10*(1), 10–22. https://doi.org/10.53676/jism.v

Ilham, D., Tarihoran, F., Leksono, T., & Sari, I. (2026). Isolation of lactic acid bacteria (lab) from fermented patin fish (Pangasius sp.) Sausages. *Indonesian Journal of Fish Processing Technology*, *02*(2022).

Juliantara, A., Gede, D., Edi, S., & Kawan, I. M. (2020). The effect of a combination of pelleted feed and natural feed on the growth of striped snakehead (Channa striata) Fry. *Gema Agro*, *25*, 128–137.

Kholis, N., Purwanto, H., Eka, Y., & Khalish, N. (2023). *The Utilization of Decayed Fish As an Alternative Ingredient in*. *4*(September), 148–156.

Laenggeng, A. H., Nurdin, M., Kundera, I. N., & Windarsih, Y. (2026). Effect of moringa oleifera leaf flour addition on iron (fe) and vitamin a levels of crackers as a healthy snack. *Biology, Medicine, & Natural Product Chemistry*, *15*(1), 1213–1221. https://doi.org/10.14421/biomedich.2026.151.1213-1221

Masita, Basir, B., & Nursyahran. (2026). The effect of the combination of petek fish meal and moringa leaf meal as feed raw mater. *Agrokompleks*, *26*(1), 73–84.

Masitlha, E. P., Seifu, E., & Teketay, D. (2024). Nutritional composition and mineral profile of leaves of Moringa oleifera provenances grown in Gaborone , Botswana. *Food Production, Processing and Nutrition*. https://doi.org/10.1186/s43014-023-00183-8

Mendrofa, K. H., & Zebua, E. K. (2025). Analysis of factors influencing tilapia aquaculture productivity in Indonesia: a literature review. *Veterinary Science*, *3*(1), 73.

Muchlisin, Z. A., Afrido, F., Murda, T., Fadli, N., Muhammadar, A. A., Jalil, Z., & Yulvizar, C. (2016). The effectiveness of experimental diet with varying levels of papain on the growth performance, survival rate and feed utilization of keureling fish (Tor tambra). *Biosaintifika: Journal of Biology & Biology Education*, *8*(2), 172. https://doi.org/10.15294/biosaintifika.v8i2.5777

Naria, D. K., Lumbessy, S. Y., & Lestari, D. P. (2022). Utilization of young moringa leaf (moringa oleifera) flour as a raw material for commercial fish feed in common carp (Cyprinus carpio) Aquaculture. *Journal of Fish Nutrition*, *2*(1), 37–48. https://doi.org/10.29303/jfn.v2i1.1147

Nubatonis, D., Santoso, P., Jasmanindar, Y., Cendana, U. N., Penfui, J. A., & Kodepos, K. K. (2024). The effect of adding moringa leaf flour to feed on the growth of catfish (Pangasius sp.). *Journal of Fisheries and Marine Sciences*, *23*(2).

Nurfatiha, Sukendi, & Asiah, N. (2025). Differences in the timing of the transition from natural feed on the growth and survival of siamese catfish (Pangasianodon hypophthalmus) Larvae. *South East Asian Aquaculture (SEAQU)*, *2*(2), 45–53.

Okomoda, T. V., Chu, I., Koh, C., Hassan, A., Amornsakun, T., & Shahreza, S. (2018). Morphological characterization of the progenies of pure and reciprocal crosses of Pangasianodon and Clarias gariepinus (Burchell ,. *Scientific Reports*), *February*, 1–13. https://doi.org/10.1038/s41598-018-22149-4

Pernanda, A., Achmad, D. S., Jihan, N., & Piu, F. (2026). *Chemical Composition of Tilapia (Oreochromis niloticus) Feed Based on Chicken Feather Meal and Moringa Leaf Meal with*

the Addition of Turmeric as. *4*(April).

Perveen, Masood, Z., Batool, H., Riaz, A., Ali, W., Ali, K., Kabir, M., Aslam, M., & Said, M. Ben. (2026). *Scientific Reports Article in Press Impact of trace metals in fish waste-based organic fertilizer on growth promotion and nutritional components of spinach plant (Spinacia oleracea L .) IN IN*.

Prasetiyo, H., Marnani, S., & Sukardi, P. (2023). Microencapsulation of crude maggot extract as a feed substitute during the weaning period of nile tilapia (Oreochromis niloticus) Larvae. *Jurnal Kemaritiman: Indonesian Journal of Maritime*, *1*(2), 65–74.

Qothrunnada, A., & Prabowo, Chandra, A. (2023). He effect of different feed types on the growth rate of pangasius hypophthalmus fry. *Zira'ah Agricultural Science Journal*, *48*, 288–297.

Rahmat P.S. (2018). Student Development.

Ratulangi, Junaidi, M., Dwi, B., & Setyono, H. (2022). Growth performance of catfish (Clarias Sp .) in microbubble technology cultivation with different shing density. *Journal of Fisheries*, *12*(4), 544–554.

Saleh, S. Y., Younis, N. A., Sherif, A. H., & Gaber, H. G. (2025). The role of Moringa oleifera in enhancing fish performance and health : a comprehensive review of sustainable aquaculture applications. *Veterinary Research Communications*, 1–17.

Silitonga, Alfredo, J., & Roiska, R. (2026). Production process of artificial fish feed using bycatch, tofu residue, and poles bran at the tangkit baru village independent aquaculture group. *Agrinexa Informatics Journal*, *1*(1), 14–19.

Syakir, N., Aprilia, A., Men, L. K., Fitrilawati, & Setianto. (2024). Outreach on sustainable water management for catfish farming in cilayung village. *Journal of Community Service, 02*(01), 20–25. https://doi.org/10.24198/saintika.v2i1

U, Eteng, S., & B, Opeh, P. (2019). Growth performance of the african catfish, clarias gariepinus (burchell, 1822) juveniles fed diet containing moringa oleifera leaf meal. *International Journal of Fisheries and Aquaculture Research*, *5*(1), 17–21.

Widarti, Effendi, I., & Kurniawan, R. (2023). Addition of moringa leaves to feed to improve growth performance and feed use of striped catfish (Pangasianodon). *Transactions of the Chinese Society of Agricultural Machinery*, *54*(5).

Wulandari, C., Ruyani, A., Singkam, A. R., & Husein, A. S., (2024). The effect of additional feeding of silkworms on the growth of snakehead fish (*Channa striata)*. *15*(3), 337–343.

Xu, Z., Yang, H., Xiaoying, X., Li, W., Li, H., Zhang, W., Li, C., Zhang, H., & Zhang, Z. (2026). Comparative evaluation of feeding tiger puffer (takifugu rubripes) with trash fish and formulated feeds on growth performance , flesh quality , antioxidant , and immunity capacity. *Aquaculture Nutrition*, 1–17. https://doi.org/10.1155/anu/6685020

Yusuf, N. S. (2019). Phenotypic Characteristics Based on Truss Morphometrics of Siamese Catfish (Pangasianodon hypophthalmus) Fry at a Peatland Fish Farming Facility in Pulang Pisau Regency, Central Kalimantan. *Jurnal Agribisnis Perikanan,* 12(1), 26–33. https://doi.org/10.29239/j.agrikan.12.1.26-33.