

# The Effect of Rabal Probiotic Supplementation at Different Doses on the Growth and Survival of Striped Catfish (*Pangasianodon hypophthalmus*) using a Recirculation System

## *Pengaruh Pemberian Probiotik Rabal pada Pakan dengan Dosis yang Berbeda terhadap Pertumbuhan dan Kelulushidupan Ikan Patin (*Pangasianodon hypophthalmus*) Menggunakan Sistem Resirkulasi*

Citra Taulani<sup>1\*</sup>, Mulyadi<sup>1</sup>, Iskandar Putra<sup>1</sup>

<sup>1</sup>Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Riau,  
Pekanbaru 28293 Indonesia

\*email: [citra.taulani2310@student.unri.ac.id](mailto:citra.taulani2310@student.unri.ac.id)

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### Abstract

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Striped catfish is a consumable fish with a good selling price and is a leading export commodity in Indonesia. Striped catfish (*Pangasianodon hypophthalmus*) often experience slow growth due to several factors that affect metabolic efficiency and nutrient intake. This study aims to determine the optimal dose of rabal probiotics to improve the growth and survival of catfish using a recirculation system. This study was conducted from April to June 2025 for 50 days at the Aquaculture Technology Laboratory, Faculty of Fisheries and Marine, Universitas Riau. The method used was an experiment with a completely randomized design (CRD), using four treatments (P<sub>1</sub> = control, P<sub>2</sub> = Rabal probiotic 30 ml/100g feed, P<sub>3</sub> = Rabal probiotic 35 ml/100g feed, P<sub>4</sub> = Rabal probiotic 40 ml/100g feed) and three replicates. The results showed that administering Rabal probiotics at different doses affected the growth and survival of *P. hypophthalmus* in including average weight and length growth, specific growth rate, feed efficiency, feed conversion ratio, and survival. The best treatment was found in treatment P<sub>4</sub> (40 ml/100 g feed), which showed significant growth (P<0.05), namely absolute length of 3.72 cm, absolute weight of 6.74 g, specific growth rate of 2.08%, FCR value of 1.43, feed efficiency of 69.93%, and survival rate of 85%.

**Keywords:** Probiotic Rabal, Recirculation, Striped Catfish

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### Abstrak

Ikan patin merupakan salah satu ikan konsumsi yang mempunyai harga jual yang bagus dan menjadi komoditas unggulan untuk ekspor di Indonesia. Benih ikan patin (*Pangasianodon hypophthalmus*) sering mengalami pertumbuhan yang lambat akibat beberapa faktor yang mempengaruhi efisiensi metabolisme dan asupan nutrisi. Penelitian ini bertujuan untuk mengetahui berapakah dosis terbaik probiotik rabal yang diberikan untuk meningkatkan pertumbuhan dan kelulushidupan ikan patin menggunakan sistem resirkulasi. Penelitian ini dilaksanakan pada bulan April – Juni tahun 2025 selama 50 Hari yang bertempat di Laboratorium Teknologi Budidaya Fakultas Perikanan dan Kelautan Universitas Riau. Metode yang digunakan adalah eksperimen dengan Rancangan Acak Lengkap (RAL), menggunakan empat perlakuan (P<sub>1</sub> = kontrol, P<sub>2</sub> = Probiotik rabal 30 ml/100g pakan, P<sub>3</sub> = Probiotik rabal 35 ml/100g pakan, P<sub>4</sub> = Probiotik rabal 40 ml/100g pakan) dan tiga kali ulangan. Hasil penelitian menunjukkan Pemberian Probiotik Rabal dengan Dosis Berbeda terhadap Pertumbuhan dan Kelulushidupan Ikan Patin berpengaruh terhadap pertumbuhan

bobot rata-rata, pertumbuhan panjang rata-rata, laju pertumbuhan spesifik, efisiensi pakan, rasio konversi pakan dan Kelulushidupan. Perlakuan terbaik dijumpai pada perlakuan P<sub>4</sub> (40 ml/100 g pakan) yang memberikan pertumbuhan berbeda nyata ( $P < 0,05$ ) yaitu panjang mutlak 3,72 cm, bobot mutlak 6,74 gram, laju pertumbuhan spesifik 2,08%, nilai FCR 1,43, efisiensi pakan 69,93%, dan kelulushidupan sebesar 85%.

**Kata kunci:** Probiotik Rabal, Resirkulasi, Ikan Patin

## 1. Introduction

Striped catfish (*Pangasianodon hypophthalmus*) has high economic value in Indonesia. Market demand for pangasius continues to increase both domestically and internationally, making it a leading export commodity. Striped catfish production, which includes breeding, rearing, feed processing, and extensive cultivation areas, ensures that domestic consumption of catfish is met (Rahimatul, 2021). In addition, the development of striped catfish farming is also supported by stable selling prices and strong competitiveness in the international market (Suhara, 2019). However, a common problem in striped catfish breeding is the slow growth of fry, due to low metabolic efficiency and poor nutrient utilization from feed.

One solution to overcome catfish growth constraints is the use of probiotics in feed. Research by Ma'waddah et al. (2022) shows that adding Rabal probiotics derived from fermented milk, tape yeast, and corn husks can increase tilapia (*Oreochromis niloticus*) weight gain and survival rates. This shows that feeding probiotic-fermented feed can significantly improve fish growth performance.

Probiotics improve fish digestion by enhancing the activity of enzymes such as amylase, protease, lipase, and cellulase, thereby increasing nutrient absorption efficiency (Iribarren et al., 2012). Rabal probiotics contain yeast and lactic acid bacteria (LAB), which play an important role in improving feed and water quality (Violentina et al., 2022). Fermentation with LAB supplemented with molasses can produce lactic acid, which has antimicrobial properties and can inhibit the growth of pathogenic bacteria (Suardana et al., 2016). Thus, the use of probiotics not only has an impact on increasing fish growth but also provides health protection through improving the maintenance environment (Padang, 2023).

In addition to feed quality, the cultivation system also affects striped catfish growth and survival. One technology that is increasingly used is the recirculation system, a cultivation technique that efficiently uses water through filtration and treatment, allowing it to be reused (Timmons & Ebeling, 2010). This system offers several advantages, such as efficient water use, more optimal environmental control, and high productivity in limited land areas (Apriliani et al., 2024). Therefore, the combination of probiotic-based fermented feed and a recirculating system has the potential to be a more effective, efficient, and sustainable cultivation strategy for catfish development in Indonesia. This study aims to determine the optimal probiotic rabal dose to enhance the growth and survival of striped catfish in a recirculating system.

## 2. Material and Method

### 2.1. Time and Place

This research was conducted from April to June 2025, spanning 50 days, at the Aquaculture Technology Laboratory of the Faculty of Fisheries and Marine, Universitas Riau.

### 2.2. Methods

The method used refers to the research by Permatasari et al. (2023), namely: P<sub>1</sub> = feed without probiotic supplementation; P<sub>2</sub> = addition of 30 ml/100g of Rabal probiotic to the feed; P<sub>3</sub> = addition of 35 ml/100g of Rabal probiotic to the feed; P<sub>4</sub> = addition of 40 ml/100g of Rabal probiotic to the feed.

### 2.3. Procedures

#### 2.3.1. Container Preparation

This study used 12 buckets with a capacity of 100 litres equipped with a recirculation system. The containers were first washed using potassium permanganate (PK) as a disinfectant, then dried in the sun to prevent the presence of disease seeds. Once dry, the containers were filled with water and left to settle for 24 hours before the recirculation system was activated to increase the dissolved oxygen level. The recirculation system was operated using a 20-watt water pump that pumped water from the bottom of the Container to the filter media, then back to the maintenance container through the inlet channel (Darmawan et al., 2016). The filter media used consists of zeolite, sand, and palm fibre, in accordance with the recommendations of Amanda et al. (2022), who reported that this filter combination is effective in maintaining the quality of aquaculture water and supporting the growth and

survival of striped catfish fry. All containers are labelled and arranged randomly to ensure that each treatment receives equal treatment. The containers used are shown in Figure 1.

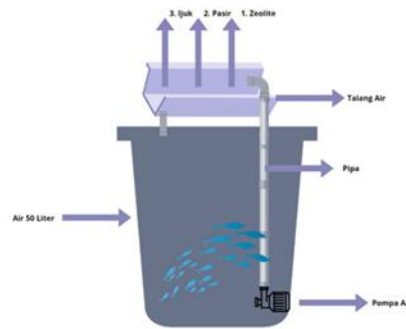


Figure 1. Containers used for Research

### 2.3.2 Production of Rabal Probiotics

Rabal probiotics are made by mixing 9 L of clean water, two bottles of Yakult, one crushed tape yeast, ½ litre of molasses, and pure coconut water in a jerry can as a fermentation container (Akuahacks, 2021). The mixture is homogenised until evenly distributed, then the Container is tightly closed for fermentation. Good fermentation is indicated by a change in the liquid's colour to brown or yellow, and a fruity or alcoholic aroma. The feed used is PF-800 brand commercial pellets. Probiotics are administered by soaking the pellets in the Rabal probiotic solution at the treatment dose for 15 minutes, allowing the probiotics to be well absorbed into the feed before the feed is given to the fish.

## 2.4. Measured Parameters

### 2.4.1. Absolute Length Growth

Absolute length growth is calculated using the formula Zonneveld et al. (1991), namely  $L = L_t - L_o$   
Explanation:

- L = Absolute length growth (cm)
- $L_t$  = Average length of test fish at the end of cultivation (cm)
- $L_o$  = Average length of test fish at the beginning of cultivation (cm)

### 2.4.2. Absolute Weight Growth

Absolute weight gain is calculated using Effendie's (2003) formula, namely:  $W = W_t - W_o$   
Explanation:

- W = Absolute weight gain of test fish (g)
- $W_t$  = Average weight of test fish at the end of cultivation (g)
- $W_o$  = Average weight of test fish at the beginning of cultivation (g)

### 2.4.3. Specific Growth Rate

The specific growth rate is calculated using the formula from Zonneveld et al. (1991), namely:

$$SGR = \frac{\ln W_t - \ln W_o}{t} \times 100 \%$$

Explanation:

- SGR = Specific growth rate (%/)
- $\ln W_t$  = Average fish weight at the end of the maintenance period (g)
- $\ln W_o$  = Average fish weight at the beginning of the maintenance period (g)
- t = Duration of maintenance (days)

### 2.4.4. Feed Conversion Ratio

The feed conversion ratio or food conversion ratio (FCR) is calculated using the formula from Effendie (2003), namely:  $FCR = \frac{F}{(W_t + D) - W_o}$

Explanation:

- FCR = Feed conversion ratio
- F = amount of feed given (g)
- $W_t$  = Biomass weight of test fish at the end of cultivation (g)
- D = Total weight of dead fish (g)
- $W_o$  = Biomass weight of test fish at the beginning of cultivation (g)

#### 2.4.5. Feed Efficiency

Feed efficiency was calculated using the formula from Zonneveld et al. (1991), namely:

$$EP = \frac{(W_t + W_d) - W_o}{F} \times 100 \%$$

Explanation:

- EP = Feed efficiency value (%)
- W<sub>t</sub> = Biomass weight of test fish at the end of cultivation (g)
- W<sub>d</sub> = Biomass weight of dead test fish (g)
- W<sub>o</sub> = Biomass weight of test fish at the beginning of cultivation (g)
- F = amount of feed consumed by test fish (g)

#### 2.4.6. Survival Rate

The survival rate (SR) is calculated using Effendie's (2003) formula, namely:  $SR = \frac{N_t}{N_o} \times 100\%$

Explanation:

- SR = Survival rate (%)
- N<sub>t</sub> = Number of test fish at the end of cultivation (tails)
- N<sub>o</sub> = Number of test fish at the beginning of cultivation (tails)

#### 2.4.7. Feed Digestibility

Feed digestibility can be calculated using the Watanabe (1988) formula as follows:  $KP (\%) = (1 - a/a_1) \times 100\%$

Explanation:

- KP = Feed digestibility (%)
- a = Cr<sub>2</sub>O<sub>2</sub> content in feed (%)
- a<sub>1</sub> = Cr<sub>2</sub>O<sub>2</sub> content in feces (%)

#### 2.4.8. Water Quality

Water quality measurements include Temperature, Dissolved Oxygen (DO), Acidity Level (pH), and Ammonia (NH<sub>3</sub>).

### 2.5. Data Analysis

The research data were presented in tables and graphs and analyzed using SPSS version 22.0. The analysis was performed using Analysis of Variance (ANOVA) based on a completely randomized design (CRD) to determine the effect of treatment on absolute weight growth, absolute length, specific growth rate, feed conversion ratio, feed efficiency, and survival rate of striped catfish (Steel et al., 1993). If there were significant differences at the 5% test level ( $P < 0.05$ ), the analysis continued with the Student-Newman-Keuls test to determine differences between treatments. Meanwhile, water quality data were presented in tables and analyzed descriptively.

## 3. Result and Discussion

### 3.1. Growth Rate

The results of absolute length and weight growth in striped catfish over the 50 days of the study, sampled every 10 days to observe growth in all treatments, are shown in Figures 2 and 3.

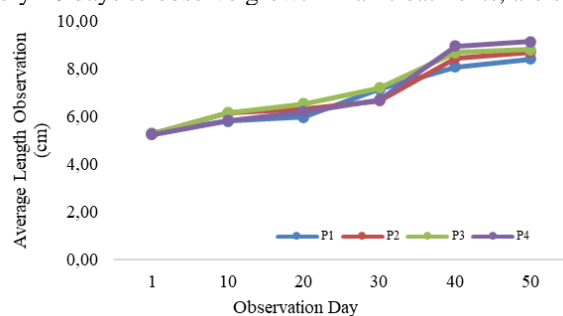


Figure 2. Average Growth in Length of Striped Catfish

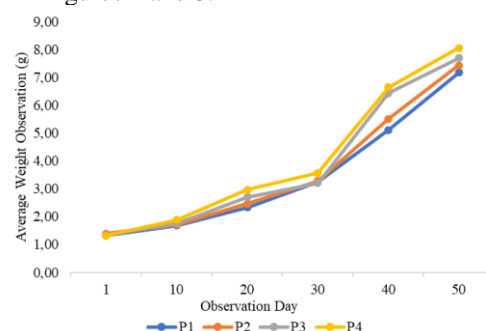


Figure 3. Average Weight Growth of Striped Catfish

The results showed that the average length increase in all treatments (P1, P2, P3, and P4) increased consistently over the 50-day maintenance period. The initial length of the fish was relatively uniform, ranging from 5.23 to 5.30 cm. At the end of the observation period, P4 showed the highest absolute length growth of 9.13 cm, followed by P3 (8.80 cm), P2 (8.70 cm), and P1 (8.41 cm). The most prominent rate of length growth occurred between days 30 and 40, indicating a rapid growth phase. These results show that P4 was more effective in increasing fish length growth than the other treatments. In general, the graph shows that the treatments administered increased

the absolute length of the fish during the observation period. The absolute length-growth data are shown in Table 1.

Table 1. Growth Rate of Striped Catfish

Treatment	Absolute Length (cm)	Absolute Weight (g)	SGR (% g/day)
P <sub>1</sub>	3,11±0,06 <sup>a</sup>	5,83±0,06 <sup>a</sup>	1,96±0,01 <sup>a</sup>
P <sub>2</sub>	3,43±0,06 <sup>b</sup>	6,04±0,07 <sup>a</sup>	2,00±0,01 <sup>b</sup>
P <sub>3</sub>	3,53±0,11 <sup>b</sup>	6,35±0,19 <sup>b</sup>	2,04±0,02 <sup>c</sup>
P <sub>4</sub>	3,90±0,30 <sup>c</sup>	6,74±0,11 <sup>c</sup>	2,08±0,02 <sup>d</sup>

The results showed that administering rabal probiotics at different doses significantly affected the absolute length growth of striped catfish. The highest absolute length growth was observed in P<sub>4</sub> (40 mL/100 g feed), with an average of 3.90±0.06 cm, while the lowest was in P<sub>1</sub> (without probiotics), with an average of 3.11 cm. Analysis of variance (ANOVA) showed that the rabal probiotic treatment had a significant effect ( $P < 0.05$ ). The SNK follow-up test showed that P<sub>4</sub> differed significantly from the other treatments, whereas P<sub>1</sub> and P<sub>2</sub> did not. This indicates that increasing the probiotic dose can promote more optimal growth in fish length. The high absolute length growth in P<sub>4</sub> indicates that probiotics play a role in increasing feed utilization efficiency. Probiotics can balance the gastrointestinal microflora, increase digestive enzyme activity, and accelerate the degradation of organic matter, thereby improving the nutritional availability of nutrients in the feed. With energy and nutrient requirements met, fish can maximize their length growth. This is in line with the opinion of [Shinta et al. \(2021\)](#) that administering high doses of probiotics (50 mL/kg of feed) to fish can improve growth performance because probiotics function to improve the digestive environment and nutrient absorption efficiency.

In addition, this study's findings support those of [Herfiko et al. \(2024\)](#), who reported that treatment without probiotic supplementation resulted in the lowest growth rate, while high probiotic doses produced the best results. The consistency of these results shows that the use of probiotics at optimal doses is not only effective in catfish but also has the potential to be applied to other farmed fish species. Thus, the use of rabal probiotics at the right dose can be an important strategy to support the success of catfish farming by improving growth performance. Overall, this study shows that a rabal probiotic dose of 40 mL/100 g of feed is optimal for increasing absolute length growth in catfish. The application of probiotics in feed not only functions as a growth enhancer but also contributes to creating a more efficient and sustainable farming system. These results reinforce the understanding that combining feed with probiotic supplements is a reliable approach to supporting aquaculture productivity.

The graph of average weight growth of striped catfish during 50 days of cultivation shows a gradual increase in weight in all treatments. The initial weight of the fish was relatively uniform in the range of 1.32–1.40 g, then increased significantly from day 20 to the end of the study. On day 50, treatment P<sub>4</sub> gave the highest average weight of 8.06 g, followed by P<sub>3</sub> (7.70 g), P<sub>2</sub> (7.43 g), and P<sub>1</sub> (7.17 g). The consistency of growth in P<sub>4</sub> indicated that this treatment was the most effective in increasing catfish weight compared to other treatments. These results indicate that the treatment, especially with the addition of the optimal dose of rabal probiotics, increased the efficiency of nutrient utilization in feed, thereby supporting maximum growth in fish weight.

The results showed that administering rabal probiotics at different doses significantly affected the absolute weight gain of striped catfish. The highest absolute weight was obtained in treatment P<sub>4</sub> (40 mL/100 g feed) at 6.74±0.11 g, while the lowest absolute weight was found in P<sub>1</sub> (without probiotics) at 5.83±0.06 g. The ANOVA test showed that the treatment had a significant effect ( $P < 0.05$ ), and the SNK follow-up test showed that P<sub>4</sub> differed significantly from the other treatments, whereas P<sub>1</sub> and P<sub>2</sub> did not differ significantly. This confirms that administering high-dose rabal probiotics (40 mL/100 g feed) is the most effective treatment for increasing weight gain in catfish.

The increase in weight in treatment P<sub>4</sub> is closely related to the role of probiotic microorganisms, such as *Lactobacillus* sp. and *Saccharomyces* sp., which can improve digestion and nutrient absorption efficiency in the digestive tract. Probiotic microbes play a role in breaking down complex compounds into simple nutrients that are easier to absorb, so that energy from feed can be optimally utilized for body growth. According to [Sainah et al. \(2016\)](#), microorganisms such as *Lactobacillus casei* and *Saccharomyces cerevisiae* can increase digestive enzyme activity and nutrient absorption, while [Agung & Rohmawati \(2021\)](#) add that probiotics maintain intestinal microbial balance in the intestine through nutrient competition and adhesion receptors, thereby increasing feed efficiency.

In addition to lactic acid bacteria, yeast in probiotics also plays an important role in producing energy substrates in intestinal cells that can improve fish digestion ([Jullianty et al., 2020](#)). [Violentina et al. \(2022\)](#) reported that administering rabal probiotics can increase fish weight and length by improving intestinal microflora and increasing feed digestion rate. In line with this, [Linayati et al. \(2021\)](#) stated that the presence of *Lactobacillus* in probiotics supports feed fermentation, thereby increasing the availability of nutrients that fish can absorb. This explains why treatment with a higher probiotic dose (P<sub>4</sub>) resulted in better growth than other treatments.

This study is also consistent with the results reported in other fish species. [Apriliani et al. \(2024\)](#) found that administering 0.3 mL/L of Rabal probiotics in the maintenance medium increased the absolute weight gain of baung fish by up to 9.88 g, while [Norry et al. \(2025\)](#) reported an increase in absolute weight of 1.63 g in tilapia

fry given 100 mL/kg of Rabal probiotics in their feed. [Hadijah & Gatta \(2022\)](#) explained that without probiotics, protein hydrolysis does not proceed optimally, resulting in reduced nutrient absorption and stunted growth. Thus, the use of optimal probiotic doses has been proven effective not only in striped catfish but also has great potential for application in other farmed fish commodities.

Table 3 shows that the highest specific growth rate (SGR) of striped catfish was observed in P4 with an average of 2.08%/day, followed by P3 (2.03%), P2 (2.00%), and the lowest in P1 (1.96%/day). Statistical analysis showed significant differences between treatments ( $P < 0.05$ ), and the SNK follow-up test confirmed that each treatment had a significantly different effect on SGR. This indicates that administering higher doses of rabal probiotics can promote more optimal fish growth rates.

The increase in LPS levels in the high-dose probiotic treatment was closely associated with the presence of beneficial bacteria, such as *Lactobacillus* sp. and *Saccharomyces cerevisiae*. These microbes play a role in increasing digestive efficiency and improving water quality. *Lactobacillus casei* is known to aid nutrient absorption and inhibit the growth of pathogenic bacteria. At the same time, *Saccharomyces cerevisiae* can produce peptidases, proteases, and amylase enzymes that break down proteins and carbohydrates into simpler forms, making nutrients easier for fish to absorb. This mechanism has implications for accelerated growth, as emphasized by [Hidayatullah et al. \(2020\)](#), who state that the appropriate use of probiotics can increase feed efficiency and growth performance in catfish.

The results of this study are also in line with those of [Apriliani et al. \(2024\)](#), who found that administering tape yeast probiotics to catfish (*Clarias* sp.) significantly increased LPS by up to 2.91%/day, higher than in the treatment without probiotics. Despite differences in species and probiotic types, both this study and previous studies demonstrate that adding probiotics consistently increases specific growth rates in farmed fish. Therefore, the use of rabal probiotics can be recommended as an effective strategy to improve catfish growth performance.

### 3.2. Feed Conversion Ratio (FCR) and Feed Efficiency

Based on observations conducted during 50 days of research, the feed conversion ratio and feed efficiency of catfish raised using a recirculation system were obtained. This is shown in Table 2.

Treatment	Feed Conversion Ratio	Feed Efficiency (%)
P <sub>1</sub>	1,56±0,01 <sup>a</sup>	64,20±0,43 <sup>a</sup>
P <sub>2</sub>	1,49±0,00 <sup>b</sup>	67,10±0,11 <sup>b</sup>
P <sub>3</sub>	1,46±0,01 <sup>c</sup>	68,48±0,27 <sup>c</sup>
P <sub>4</sub>	1,43±0,01 <sup>d</sup>	69,93±0,33 <sup>d</sup>

The results in Table 4 show that treatment with rabal probiotics had a significant effect on feed conversion ratio (FCR) and feed efficiency (FE). Treatment P4 produced the lowest FCR of 1.43 and the highest PE of 69.93%, while treatment P1 (without probiotics) showed the highest FCR of 1.56 and the lowest PE of 64.20%. The results of the ANOVA and SNK tests confirm that each treatment produced significant differences, with higher probiotic doses resulting in better feed utilisation by the fish. The decrease in FCR indicates that fish require less feed to gain body weight, while the increase in EP reflects higher nutrient utilisation efficiency. This is closely related to the role of microorganisms in probiotic rabal, such as *Lactobacillus* sp., which can enhance digestive enzyme activity and improve nutrient digestibility. Thus, feed is more effectively converted into fish meat.

According to [Maspeke et al. \(2024\)](#), probiotics can improve tilapia growth by improving nutrient breakdown and feed digestibility. These findings are reinforced by [Lestari et al. \(2024\)](#), who explain that probiotics play a role in feed fermentation, thereby increasing digestibility and utilisation efficiency. The results of this study show a similar pattern, with the optimal probiotic dose positively affecting the FCR and EP of catfish. In line with these results, [Norry et al. \(2025\)](#) reported that Yamogi probiotic administration to tilapia significantly reduced FCR and increased EP. The best treatment resulted in an FCR of 1.09 with an EP of 91.72%, far superior to the control group without probiotics, which recorded an FCR of 4.52 and an EP of only 22.11%. This further supports the evidence that the use of probiotics at the appropriate dosage can improve growth performance and feed efficiency in various types of farmed fish.

### 3.3. Survival Rate

Survival rate is the survival rate of fish in the cultivation process from the initial stocking to harvest. Several factors affect the survival rate of striped catfish, including water quality, the feed provided, and stocking density. The results of striped catfish survival observations are shown in Table 3.

In The analysis of variance (ANOVA) showed that administering Rabal probiotics at different doses significantly affected striped catfish survival rate ( $p < 0.05$ ). Based on the SNK follow-up test, treatment P4 ( $85 \pm 3.06\%$ ) had the highest survival rate and was significantly different from all other treatments. P3 ( $77 \pm 3.06\%$ ) was significantly different from P1, but not from P2. Meanwhile, P2 ( $71 \pm 2.30\%$ ) was not significantly different from P1 or P3, and P1 ( $69 \pm 4.16\%$ ) had the lowest survival rate. This increase in survival rate indicates that

probiotics play an important role in maintaining the health and immunity of fish. The *Lactobacillus* content in Rabal probiotics can improve gut microbiota, boost immunity, and suppress the growth of pathogens (Afrianto & Liviaty, 2019). Stable environmental conditions, a recirculation system, and probiotic-fermented feed also contribute to high survival rates, especially in P4 (Mopangga et al., 2023).

Table 3. Results of Striped Catfish Survival Observations

Repeat	Treatment			
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>
1	70	70	78	88
2	72	74	74	86
3	64	70	80	82
Total	206	214	232	256
Average	69±4,16 <sup>a</sup>	71±2,30 <sup>ab</sup>	77±3,06 <sup>b</sup>	85±3,06 <sup>c</sup>

### 3.4. Feed Digestibility

Feed digestibility is an important parameter for determining how much feed can be utilized by fish for growth. Feed digestibility in this study was calculated using the external indicator method, with chromium oxide (Cr<sub>2</sub>O<sub>3</sub>) added at 0.5% to the feed. The results of feed digestibility calculations for striped catfish during the study are presented in Table 4.

Table 4. Feed Digestibility of Striped Catfish

Treatment	Faecal Water Content (%)	Cr <sub>2</sub> O <sub>3</sub> Feces (%)	Feed Digestibility (%)
P <sub>1</sub>	10,89	1,26	60,32
P <sub>2</sub>	11,00	1,32	62,12
P <sub>3</sub>	11,54	1,75	71,43
P <sub>4</sub>	9,00	1,85	72,97

Based on Table 4, the digestibility value of striped catfish feed ranges from 60.32% to 72.97%. Treatment P4 produced the highest digestibility (72.97%), while P1 showed the lowest (60.32%). This indicates that adding Rabal probiotics can increase feed utilization efficiency in fish, thereby optimizing nutrient absorption for growth rather than wasting nutrients in faeces. The increase in feed digestibility in the probiotic treatment is related to the beneficial microorganisms' role in improving the balance of intestinal microflora and producing digestive enzymes, such as protease, amylase, and lipase. These enzymes play a role in breaking down complex carbohydrates, fats, and proteins into simpler molecules, thereby facilitating digestion and optimizing nutrient absorption. Treatments P3 and P4 were proven to have a significant effect compared to P1 and P2, so that probiotic doses above 30 mL/100 g of feed began to have an optimal effect on digestibility.

The optimal dose was demonstrated in treatment P4 (40 mL/100 g feed), consistent with the opinion of Sitanggang et al. (2021) that probiotics not only serve as supplements but also improve overall feed quality. Conversely, treatment P1 without probiotics had the lowest digestibility value, indicating low nutrient utilization efficiency. This condition impedes fish growth and may reduce water quality by accumulating undigested feed residues.

### 3.5. Water Quality

Water quality is a supporting factor in the growth and survival of striped catfish and in their cultivation. The following is data on water quality measurements for each treatment during the 50-day study, presented in Table 5.

Table 5. Water Quality Measurement Results During the Study

Parameters	Treatment			
	P <sub>1</sub>	P <sub>2</sub>	P <sub>3</sub>	P <sub>4</sub>
Temperature(°C)	27,6-29,2	27,9-29	28-29,1	28-28,9
pH	6-6,3	6-6,8	6-6,9	6-7,3
DO (mg/l)	4,2-5,5	4,3-5,5	4,2-5,5	4,1-5,5
Ammonia (mg/l)	0,0122	0,0143	0,0178	0,0221

Based on water quality measurements (Table 5), the temperature during the study ranged from 27.6 in 29.2°C across all treatments. The addition of rabal probiotics had no significant effect on temperature, as the activity of microorganisms did not cause significant thermal changes. This temperature range remains within the optimal 27–30°C range for striped catfish growth (Kordi, 2010), thereby supporting the fish's metabolic activity and physiological balance.

The pH values showed variations between treatments, with P1 recording the lowest range (6.0–6.3) and increasing in the probiotic treatments, reaching 6–7.3 in P4. This increase indicates the role of probiotic microorganisms in stabilizing pH by degrading organic matter. According to Effendi (2003), the optimal pH range for freshwater fish farming is 6.5–8.5, so the pH values in P2-P4 are close to or within this range. This has a

positive impact on nutrient absorption efficiency and prevents physiological stress in fish. Dissolved oxygen (DO) levels during the study ranged from 4.1 to 5.5 mg/l, with the highest value at P2 and the lowest at P4. Probiotics are thought to help maintain DO stability by decomposing organic matter without causing excessive ammonia accumulation. This is important to ensure that the respiration processes of fish and microorganisms proceed optimally.

Meanwhile, the highest ammonia level was found at P4 (0.0221 mg/l) and the lowest at P1 (0.0122 mg/l). The increase in ammonia levels at high probiotic doses was likely due to increased metabolism by fish and microorganisms, as well as the accumulation of feed residues. However, these values were still within tolerance limits, mainly because the temperature and pH were kept stable. Yan et al. (2019) explained that an increase in pH and temperature will increase the proportion of  $\text{NH}_3$ , thereby increasing its toxicity. This was evident from the absence of stress symptoms or fish mortality during the study.

## 4. Conclusions

Based on the study's results, it can be concluded that administering rabal probiotics at different doses significantly affects the growth and survival of striped catfish, including average weight gain, average length, specific growth rate, feed efficiency, feed conversion ratio, and survival rate. The best treatment was obtained at a dose of 40 ml/100 g of feed (P4), which resulted in an absolute length of 3.72 cm, absolute weight of 6.74 g, specific growth rate of 2.08% per day, FCR value of 1.43, feed efficiency of 69.93%, and a survival rate of 85%, which was statistically significantly different ( $P < 0.05$ ) compared to the other treatments.

## 5. References

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