

The effectiveness of a combination of probiotics and natural wheat and sesame based prebiotics in enhancing the growth performance of giant freshwater prawns (*Macrobrachium rosenbergii*)

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Abstrak

Tantangan utama dalam budidaya udang galah adalah laju pertumbuhannya yang relatif lambat, yang secara langsung memengaruhi produktivitas dan profitabilitas. Penelitian ini bertujuan untuk mengevaluasi efektivitas kombinasi probiotik dan prebiotik berbasis gandum dan wijen (sinbiotik) terhadap performa pertumbuhan udang galah. Penelitian ini menggunakan metode eksperimen Rancangan Acak Lengkap (RAL) dengan empat perlakuan, yaitu: Kontrol (P1), Probiotik (P2), Sinbiotik berbasis gandum (P3), dan Sinbiotik berbasis wijen (P4), masing-masing diulang sebanyak tiga kali. Parameter yang diamati meliputi performa pertumbuhan, rasio konversi pakan (FCR), tingkat kelangsungan hidup, dan histologi usus. Perlakuan P3 memberikan hasil terbaik dengan rata-rata pertambahan bobot sebesar $4,03 \pm 1,85$ g, laju pertumbuhan spesifik (SGR) sebesar $0,61 \pm 0,23\%$ per hari, pertambahan panjang $1,82 \pm 0,45$ cm, dan laju pertumbuhan panjang spesifik (SLGR) sebesar $0,27 \pm 0,06\%$ per hari. Rasio Konversi Pakan (FCR) terendah ditemukan pada perlakuan P3, yaitu sebesar $2,66 \pm 0,53$ g, yang menunjukkan efisiensi pakan terbaik serta mikrovili usus yang lebih seragam dan memanjang. Tingkat kelangsungan hidup pada P3 mencapai $93,33 \pm 11,55\%$. Perlakuan P3 terbukti meningkatkan pertumbuhan, efisiensi pakan, dan kesehatan usus pada udang galah. Studi lanjutan disarankan untuk menelusuri mekanisme molekuler dari sinbiotik terhadap gen yang berhubungan dengan sistem pencernaan dan kekebalan tubuh.

Kata kunci: Sinbiotik, udang galah, histologi usus, bahan alami, pertumbuhan

Abstract

The main challenge in farming *M. rosenbergii* is its relatively slow growth rate, which directly affects productivity and profitability. This research evaluates the effectiveness of probiotic and prebiotic combinations based on wheat and sesame (synbiotics) on the growth performance of giant prawns. This research used a Completely Randomized Design (CRD) with four treatments: Control (P1), Probiotic (P2), Wheat-based Synbiotic (P3), and Sesame-based Synbiotic (P4), each replicated three times. Observed parameters included growth performance, feed conversion ratio (FCR), survival rate, and intestinal histology. Treatment P3 provided the best result with an average weight gain of 4.03 ± 1.85 g, a specific growth rate (SGR) of $0.61 \pm 0.23\%$ per day, a length gain of 1.82 ± 0.45 cm, and a specific growth rate of length (SLGR) of $0.27 \pm 0.06\%$ per day. The lowest Feed Conversion Ratio (FCR) was found in P3, at 2.66 ± 0.53 g, indicating the best feed efficiency and more uniform and longer intestinal microvilli. The survival rate in P3 reached $93.33 \pm 11.55\%$. Treatment P3 improved growth, feed efficiency, and intestinal health in giant prawns. Additional studies are suggested to investigate the molecular mechanisms by which synbiotics affect digestive and immune-related genes.

Keywords: Synbiotic, giant freshwater prawns, intestinal histology, natural materials, growth

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Highlight

- Synbiotic supplementation offers a promising and sustainable alternative to antibiotics in giant freshwater prawns.
- Synbiotics derived from environmentally friendly natural materials significantly improved the growth of giant freshwater prawns and increased survival rates.
- Natural prebiotics can enhance nutrient absorption in giant freshwater prawns.

Introductions

One of the economically valuable aquaculture commodities is the giant freshwater prawn (*Macrobrachium rosenbergii*), with global production reaching 294,000 tons in 2020, representing 2.6% of total crustacean production (FAO, 2022). However, one of the main challenges in farming *M. rosenbergii* is its relatively slow growth rate, which directly impacts productivity and profitability (New, 2005). A major factor contributing to this issue is suboptimal feed quality, which fails to meet the prawn's nutritional requirements effectively (Fahrudin *et al.*, 2023). Feed quality plays a crucial role in the growth and health of giant freshwater prawns (Mao & Lu, 2023). It serves as the primary source of essential nutrients, including proteins, lipids, carbohydrates, vitamins, and minerals, which regulate growth, physiological processes, reproduction, and disease resistance (Prabu *et al.*, 2017).

Poor feed quality, both in terms of nutritional composition and digestibility, can result in slow growth (Gatlin *et al.*, 2007). Therefore, innovations in feed formulation are needed to enhance nutritional quality and improve feed utilization efficiency, thereby optimizing the growth performance of giant freshwater prawns. As a sustainable solution, feed technology has advanced significantly in recent decades, particularly with the incorporation of probiotics and prebiotics (synbiotics), which are considered environmentally friendly alternatives (Butt *et al.*, 2021). The application of synbiotics, a combination of probiotics and prebiotics, has emerged as a promising strategy for improving feed quality (Merrifield *et al.*, 2010).

Several studies have demonstrated that supplementing feed with probiotics, natural prebiotics, and synbiotics can provide various health benefits to cultured organisms (Zhang *et al.*, 2011). Probiotics are live microorganisms that, when ingested through food or water, enhance health by balancing the gut microbiota (El-Saadony *et al.*, 2021). Probiotics generally refer to microbial feed additives administered to the host organism to modulate gut microbiota (Hoseinifar *et al.*, 2018). In contrast, prebiotics are non-digestible food components that are not directly assimilated by the host but serve as substrates for beneficial microbes (Gibson & Roberfroid, 1995). Prebiotics influence the presence of beneficial microbiota, modulate metabolic pathways, regulate digestive enzyme activity, and enhance the immune system of aquatic organisms (Cisneros *et al.*, 2023). Prebiotics are derived from various plants, including wheat and sesame (Kaur *et al.*, 2021). Wheat contains key prebiotic components such as fructans, arabinoxylan-oligosaccharides (AXOS), and dietary fibers that support digestive health (Moshfegh *et al.*, 1999). Meanwhile, sesame contains fiber types like lignans, arabinoxylan, and oligosaccharides, which possess prebiotic properties that promote the growth of beneficial gut bacteria (Miran *et al.*, 2024).

The combination of probiotics and prebiotics is expected to create a healthier gut microbiota environment, thereby improving digestion and nutrient absorption efficiency (Ringø *et al.*, 2010). Studies indicate that specific probiotics, such as *Bacillus* sp. and *Lactobacillus* sp., can enhance gut health and feed efficiency in various fish and shrimp species (Mohapatra *et al.*, 2012). Additionally, prebiotics such as mannan-oligosaccharides and fructo-oligosaccharides have been found to support the growth of beneficial gut bacteria (Torrecillas *et al.*, 2014). However, research on the most effective probiotic-prebiotic combinations for optimizing the growth of *M. rosenbergii* remains limited. Synbiotics, the combination of probiotics and prebiotics, have been shown to produce more significant synergistic effects compared to their individual use. Studies suggest that incorporating synbiotics into feed can enhance growth performance, improve feed conversion efficiency (FCR) (Ariğ *et al.*, 2013), and strengthen the immune response of prawns (Wongsasak *et al.*, 2015). This research investigates the effectiveness of a unique combination of probiotics with wheat- and sesame-derived prebiotics in enhancing the growth performance of giant freshwater prawns. The study

evaluates key parameters, including survival rate, growth efficiency, and feed conversion ratio, to determine the potential of this approach as an alternative growth-promoting strategy.

Materials and methods

Research design

This experiment was conducted in the aquatic laboratory of Djuanda University using a Completely Randomized Design (CRD) experimental method. The study consisted of four treatments: commercial feed as a control (P1), feed supplemented with probiotics (P2), wheat-based synbiotic feed (P3), and sesame-based synbiotic feed (P4). Each treatment was repeated three times to enhance reliability and ensure accuracy. The Shrimp were cultured for 70 days, with weight sampling conducted every 10 days using a Digipounds version 3-9000 digital scale.

Preparation of research object and rearing containers

The giant freshwater prawns used as test subjects had an average size of 7-10 cm and a weight of 8 – 10 g, obtained from the Center for Freshwater Aquaculture in Sukabumi, West Java. A total of 60 prawns were randomly distributed into 30 cm × 30 cm × 30 cm aquariums equipped with an aeration system. The stocking density in each aquarium was five prawns.

Feed preparation

This study used commercial feed with a protein content of 28% (Sukenda *et al.*, 2015). The feed was supplemented with the commercial probiotic Probio-7, produced by PT. Tamasindo Veterinary. This probiotic contains several microorganisms, including *Bacillus subtilis*, *Lactobacillus acidophilus*, *Rhodopseudomonas*, *Saccharomyces cerevisiae*, and *Aspergillus oryzae*, each with a density of 1×10^{11} CFU L⁻¹. Probio-7 was incorporated into the feed using a coating method at a dose of 5 mL kg⁻¹ of feed (Sukenda *et al.*, 2015).

According to the treatment groups, prebiotics in wheat and sesame flour were added at 5 grams per kilogram of feed, serving as a nutrient source for probiotics in the synbiotic feed formulation. The feed coating process involved adding 100 mL of water per kilogram of feed, with egg white used as a binder, as Purnamasari *et al.* (2022) suggested. Additionally, 5 grams of sugar were included as an activator to maintain probiotic viability and microbial activity during storage (Suharman *et al.*, 2021). The feed was dried at room temperature for five hours without direct sunlight exposure to ensure probiotic survival.

Feeding procedure

The feed was administered at 3% of the prawn's biomass per day, and the schedule of feeding was divided into three sessions: morning (07:00 AM), afternoon (01:00 PM), and evening (07:00 PM). To maintain water quality, uneaten feed that settled at the bottom of the aquarium was routinely siphoned. Maintaining optimal water quality throughout the study was crucial, as probiotics in the feed could influence the balance of the microbial ecosystem within the aquarium.

Survival rate, growth performance, and feed conversion ratio

The study evaluated key metrics, including survival rate (SR), weight gain (WG), specific growth rate (SGR), length gain (LG), and specific length growth rate (SLGR), using formulas from Zarantoniello *et al.* (2023). At the end of the experiment, the feed conversion ratio (FCR) was calculated according to Al-Hafedh (2008), ensuring an accurate assessment of the growth performance of the formula according to Al-Hafedh (2008).

$$\text{SR (\%)} = \frac{\text{Final Shrimp Count}}{\text{Initial Shrimp Count}} \times 100\%$$

WG (g) = Final Body Weight (FBW) - Initial Body Weight (IBW)

SGR (% hari¹) = $\frac{\ln \text{FBW} - \ln \text{IBW}}{\text{Experimental Days}} \times 100$

LG (cm) = Final Length (Lt) - Initial Length (Lo)

SLGR (% hari¹) = $\frac{\ln \text{Lt} - \ln \text{Lo}}{\text{Experimental Days}} \times 100$

FCR (g) = $\frac{\text{Total Feed Intake (g)}}{\text{Total Weight Gain (g)}}$

Intestinal histology preparation

Intestinal samples were collected on day 70 of the observation period, with three samples obtained from each treatment group. The preparation method followed the protocol described by (Nuryati *et al.*, 2023). The histological preparations were made through multiple steps, including fixation, embedding, sectioning, and staining. The fixation process involved immersing the intestinal samples in a 10% BNF solution for 24–48 hours, followed by a gradual dehydration process using ethanol. In the next step, tissue paraffinization was performed by immersing the samples in xylene and paraffin. Finally, the tissues were sectioned using a microtome of 0.5 micrometers. The sections were then stained using *hematoxylin* and *eosin*. Histological observations were conducted using an Olympus CX31 microscope at a magnification of 40 × 10, and the images were captured using an Optilab camera.

Data analysis

The observed data on growth performance, feed conversion ratio (FCR), and survival rate were analyzed using a one-way Analysis of Variance (ANOVA) to evaluate the impact of different treatments with the assistance of Microsoft Excel 365. When significant differences were detected ($P < 0.05$), Duncan's post-hoc test was applied using IBM SPSS Statistics 20 to identify variations between treatments. Additionally, histological analysis was conducted using a descriptive approach.

Result

Weight gain

This study revealed that using the synbiotic-enriched feed, a combination of probiotics and prebiotics effectively enhanced the weight gain of *Macrobrachium rosenbergii*. Treatment P3 showed a significantly higher average weight gain than the other treatments (Figure 1). The results of the study indicate that synbiotic-supplemented feed positively influenced growth performance. The best treatment was observed in the P3, which resulted in an average weight gain of 4.03 ± 1.85 g. With an average initial weight of 7.39 ± 2.94 (Figure 2A) and an average final weight of 11.42 ± 1.76 (Figure 2B). In comparison, the group P1 recorded an average weight gain of 2.09 ± 0.40 g, followed by the P4 group with an increase of 1.85 ± 0.43 g. The treatment P2 exhibited the lowest weight gain, increasing to only 1.64 ± 0.48 g.

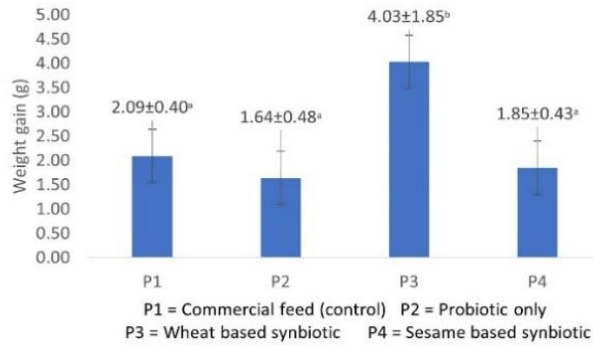


Figure 1. Weight gain of giant freshwater prawns
*^aP1, P2 and P4 showed no significant differences, ^bP3 was significantly

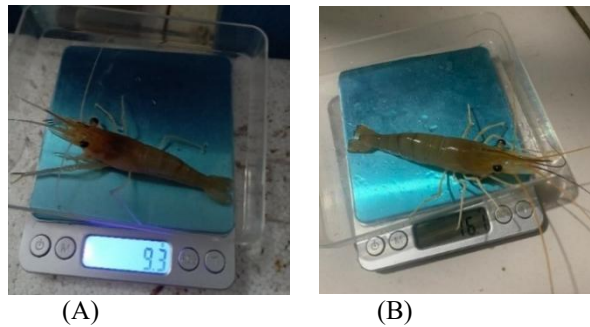


Figure 2. Body weight of giant prawn
initial body weight (P3) giant freshwater prawn before treatment; (B) final body weight (P3) giant freshwater prawn after treatment

Specific Growth Rate (SGR)

The Specific Growth Rate (SGR) measures the percentage increase in body weight per day (Figure 3). This study demonstrated that the administration of symbiotic-enriched feed could improve the SGR of *M. rosenbergii*. The best result was in treatment P3, which achieved an SGR of $0.61 \pm 0.23\% \text{ day}^{-1}$. Meanwhile, treatment P2 showed an SGR of $0.38 \pm 0.06\% \text{ day}^{-1}$, followed by treatment P1 with an SGR of $0.36 \pm 0.08\% \text{ day}^{-1}$. The lowest SGR was recorded in Treatment P4 (sesame-based synbiotic) at $0.30 \pm 0.04\% \text{ day}^{-1}$.

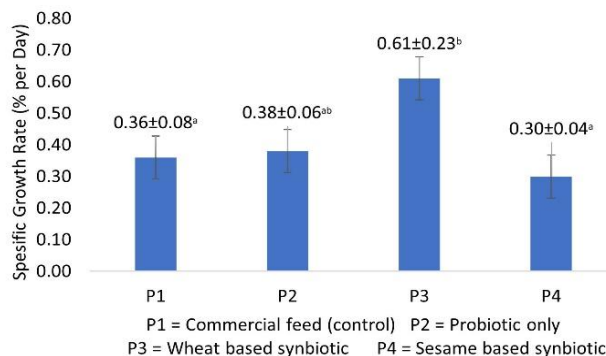


Figure 3. Specific Growth Rate (SGR) of giant freshwater prawns
*^aP1, P2 and P4 no significant difference, ^{ab}P2 and P3 show differences between treatments ^bP3 is significantly different from the other treatments

Increase in body length

The increase in body length reflects its physiological performance, which is highly influenced by nutritional balance and aquaculture environmental conditions. The use of synbiotic feed ($P < 0.05$) showed a significant effect on body length growth (Figure 4). The

best treatment was observed in P3, with an average length increase of 1.82 ± 0.45 cm. With an average initial length of 8.66 ± 0.39 (Figure 5A) and an average final length of $10,50 \pm 0.46$ (Figure 5B). Meanwhile, P4 recorded an average length increase of 0.64 ± 0.09 cm, followed by P1 with 0.51 ± 0.34 cm. The lowest length increase was found in P2, at 0.41 ± 0.24 cm.

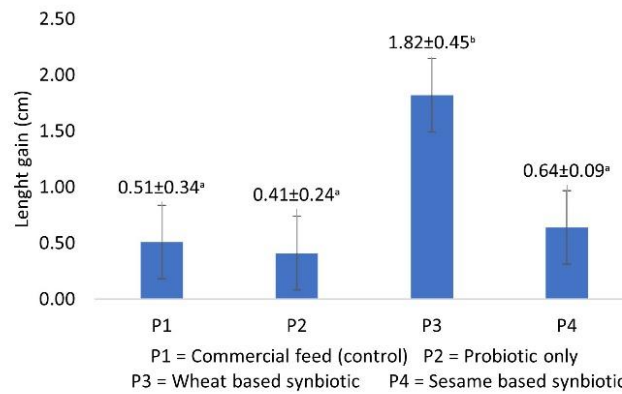


Figure 4. Graph of giant freshwater prawns body length increase. ^aP1, P2 and P4 show no significant differences, ^bP3 is significantly different from the other treatments.

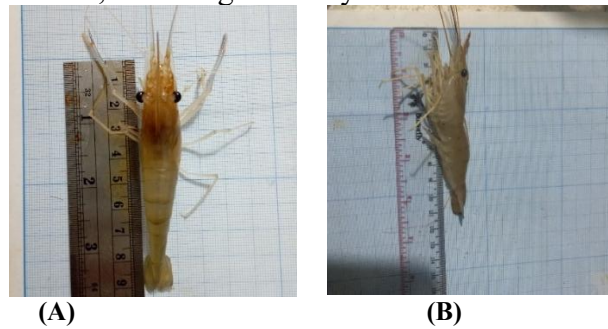


Figure 5. Length gain of giant freshwater prawns. (A) initial body length (P3) giant freshwater prawn before treatment; (B) final body length (P3) giant freshwater prawn after treatment

Specific length growth rate

The Specific Length Growth Rate (SLGR) measures the percentage increase in body length per day. The best observation results during the rearing period were recorded in treatment P3 (Figure 6), which achieved a specific length growth rate of $0.27 \pm 0.06\%$ day⁻¹. This was followed by treatment P4 with an SLGR of $0.10 \pm 0.01\%$ day⁻¹, treatment P1 with $0.08 \pm 0.05\%$ day⁻¹, and the lowest result was observed in treatment P2, with a specific length growth rate of $0.07 \pm 0.04\%$ day⁻¹.

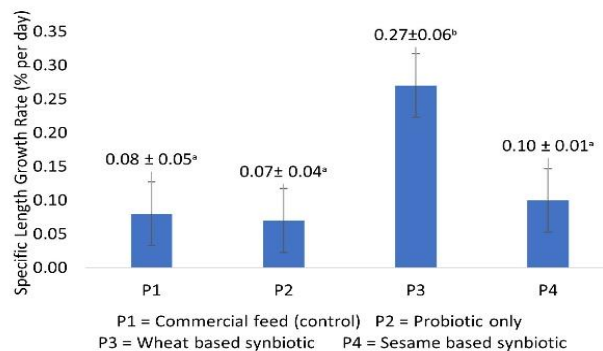


Figure 6. Graph of Specific Length Growth Rate, ^aP1, P2 and P4 show no significant differences, ^bP3 is significantly different from the other treatments.

Feed Conversion Ratio (FCR)

This study's treatment P3 (Figure 7) recorded the lowest feed conversion ratio (FCR), with a value of 2.66 ± 0.53 g, indicating the highest feed efficiency. Meanwhile, treatment P4 recorded the highest FCR, at 4.68 ± 1.65 g, demonstrating lower feed efficiency than the other treatments. This FCR value indicates that treatment P3 provided the best results in feed utilization efficiency for the growth of giant freshwater prawns. The decrease in FCR in P3 suggests the potential benefits of combining probiotics and wheat-based prebiotics in enhancing nutrient absorption and feed conversion. Conversely, although P2 utilized probiotics, its higher FCR value may indicate that adding wheat prebiotics significantly improved efficiency.

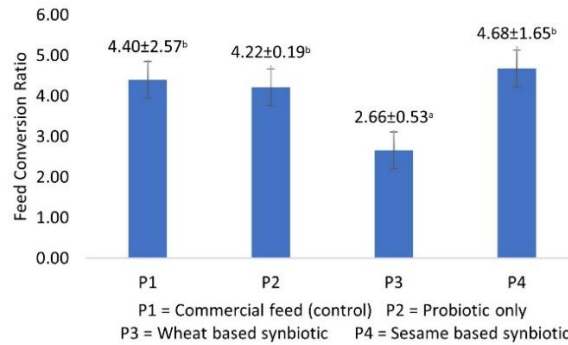


Figure 7. Graph of feed conversion ratio, (^aP1, P2 and P4 show no significant differences, ^bP3 is significantly different from the other treatments)

Survival Rate (SR)

There were no significant differences ($P > 0.05$) (Figure 8) in the survival rate across the treatments. The highest survival rates were recorded in the synbiotic treatments, with treatments P3 and P4 showing survival rates of $93.33 \pm 11.55\%$. Meanwhile, the lowest survival rates were observed in P1 and P2 treatments, at 80.00% (P1: $80.00 \pm 20.00\%$; P2: $80.00 \pm 0.00\%$).

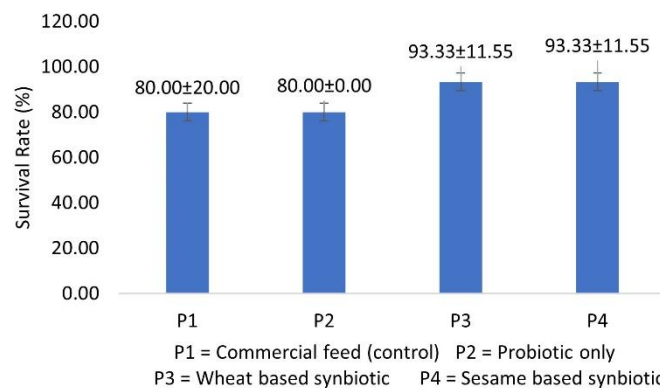


Figure 8. Survival Rate of Giant Freshwater Prawn During 70 Days of Rearing

Histology

The histological structure (Figure 9) of the intestine of giant freshwater prawn exhibits characteristic morphological adaptations typical of the Crustacea group. The intestinal mucosal layer is lined with simple columnar epithelium, with microvilli extending towards the intestinal lumen. In the observed histology, the microvilli appear non-uniform, with some being longer and pointed while others are shorter and blunt. Among the treatments, the best results were observed in P3, where the microvilli were uniform in size, denser, and extended towards the lumen.

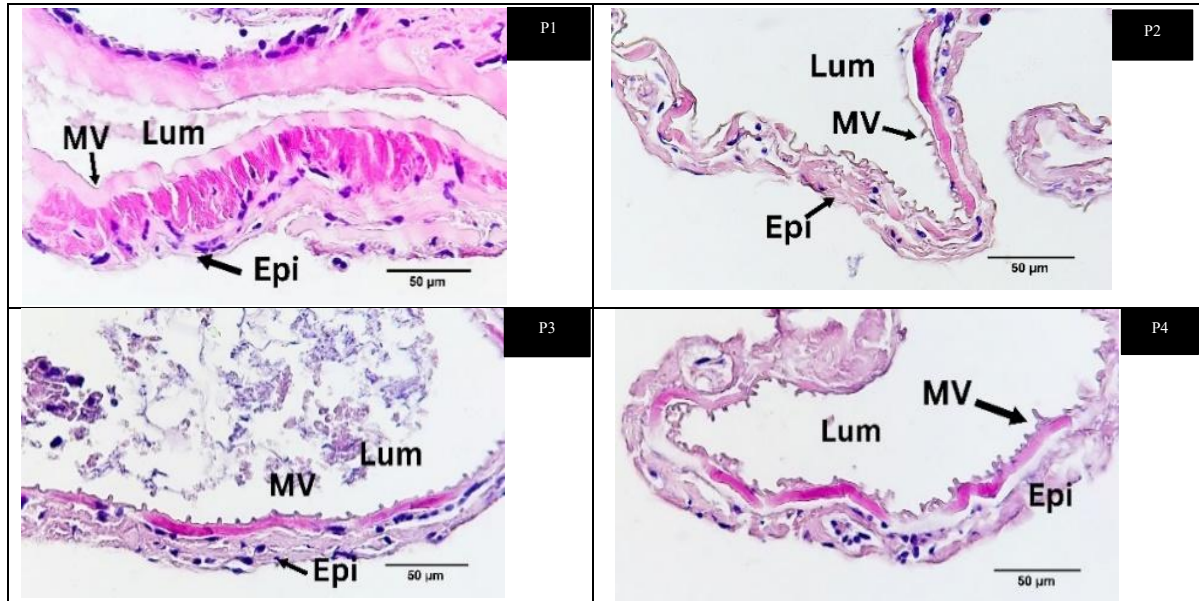


Figure 9. Histology of the intestine of giant freshwater prawn after 70 days maintenance; *(P1) Control, (P2) Probiotic, (P3) Wheat-Based Synbiotic, (P4) Sesame-Based Synbiotic (H&E, 4×10). Epi = Intestinal Epithelium, Lum = Intestinal Lumen, MV = Microvilli.

Discussion

Using a combination of probiotics and natural wheat prebiotics to cultivate giant freshwater prawns has been proven to sustainably improve growth performance and health. This study demonstrates that the P3 treatment resulted in superior growth performance compared to the other treatments, particularly when compared to the P4 treatment, as observed in weight gain, length gain, specific growth rate, specific length growth rate, and feed efficiency. The differences in outcomes between the two formulations highlight the distinct effects of a combination of probiotic and prebiotic sources on nutrient absorption and metabolic efficiency. This difference suggests that wheat-based prebiotics provide better nutritional support, potentially due to their composition, which may include fermentable fibers that promote beneficial gut microbiota proliferation. Wheat contains several prebiotic compounds, such as dietary fiber (Dhingra *et al.*, 2012), include oligosaccharides (Prosky *et al.*, 1988), inulin (Carlson *et al.*, 2018), β -glucan, arabinoxylan-oligosaccharide (AXOS) (Pritchard *et al.*, 2011), and fructans (Veenstra *et al.*, 2017).

In contrast, the lower weight gain in P4 implies that sesame-based prebiotics may not be as effective in enhancing nutrient absorption. Several studies have shown that the antinutritional compounds in sesame, such as phytic acid and tannins, can inhibit the absorption of essential minerals like calcium, iron, and zinc, which play a crucial role in optimal growth (Wei *et al.*, 2022). Nevertheless, while sesame has prebiotic benefits, its antinutritional content and associated effects should be carefully considered when used as a feed additive.

The prebiotic used in this research contains several microorganisms, including *Bacillus subtilis*, *Lactobacillus acidophilus*, *Rhodopseudomonas*, *Saccharomyces cerevisiae*, and *Aspergillus oryzae*. Probiotic microorganisms *Bacillus* spp. and *Lactobacillus* spp. have been extensively utilized in the aquaculture industry due to their ability to inhibit the growth of pathogenic bacteria and strengthen the prawn's immune system (Azhdari *et al.*, 2003). Including probiotics in feed has been proven to improve gut microbiota balance in prawns, enhancing digestion and nutrient absorption (Khanjani *et al.*, 2024).

Previous studies have indicated that wheat-based fibers offer a more readily fermentable substrate for beneficial bacteria, leading to enhanced digestion and improved weight gain. Prebiotics help increase the production of organic acids such as lactic acid and acetic acid, which lower intestinal pH and create an unfavorable environment for pathogenic bacteria (Gibson & Wang, 1994). The digestive system becomes healthier and more efficient in nutrient absorption by suppressing pathogenic bacteria. Prebiotics are non-digestible compounds that support the growth and activity of beneficial bacteria within the digestive system (Davani-Davari *et al.*, 2019). Several prebiotics have been extensively studied in aquaculture, including short-chain fructooligosaccharides, fructooligosaccharides (FOS), inulin, galactooligosaccharides, mannan-oligosaccharides, arabinoxylan-oligosaccharides, xylooligosaccharides, β -glucans, and isomaltooligosaccharides (Akter *et al.*, 2021; Sutriana *et al.*, 2025).

Feed efficiency is one of the key parameters in the cultivation of giant prawns, which can be measured using the Feed Conversion Ratio (FCR). A lower FCR value indicates that the feed consumed by prawns is more effectively converted into biomass growth. In this study, the wheat-based synbiotic treatment exhibited the lowest FCR, indicating better feed efficiency than single probiotic or sesame-based synbiotic treatments. In aquaculture, probiotics are crucial in enhancing shrimp immunity against diseases, improving feed efficiency, and maintaining water quality in rearing systems (Butucel *et al.*, 2023). Probiotics are live microorganisms that provide health benefits to the host when taken in adequate amounts (Escobedo-Fregoso *et al.*, 2021). Including probiotics in feed has been proven to improve gut microbiota balance in Shrimp, thereby enhancing digestion and nutrient absorption (Khanjani *et al.*, 2024). This improvement in feed efficiency can be attributed to the role of prebiotics in enhancing nutrient absorption and improving the digestive function of Shrimp (Müller *et al.*, 2020).

The lower FCR in P3 implies that wheat-based prebiotics enhance nutrient absorption and minimize feed wastage, improving overall efficiency. Several studies have shown that improved gut health, facilitated by synbiotic supplementation, contributes to enhanced feed conversion by optimizing enzyme activity and nutrient assimilation. The higher FCR in P4 suggests that sesame-based prebiotics may not be as effective in facilitating digestion and absorption, leading to increased feed requirements to achieve similar growth rates.

The results of this study indicate that giant freshwater prawns fed with wheat-and sesame-based synbiotic diets exhibited a higher survival rate than the control group, while survival rate improvements were not statistically significant, the results suggest that synbiotic diets may contribute to increased resilience against environmental disease and stressors challenges. In addition to growth and feed efficiency, survival rate is another crucial parameter for evaluating the effectiveness of synbiotic feed (Mohan *et al.*, 2019). The role of probiotics in enhancing immune responses is well-established, with studies indicating that synbiotic supplementation can enhance mucosal immunity and protect against opportunistic pathogens. The similar survival rates between P3 and P4 indicate that both wheat- and sesame-based prebiotics may offer comparable benefits in terms of immune modulation, even though they differ in growth performance outcomes. It suggests combining probiotics and prebiotics can enhance shrimp resilience against suboptimal environmental conditions and potential pathogen attacks (Chen *et al.*, 2020).

Giant freshwater prawns fed with wheat-based synbiotic diets displayed more microvilli, uniform size, denser, and extended towards the lumen than other treatments. In contrast, the microvilli structure in P4 was less developed, implying that sesame-based prebiotics may not provide the same gut health benefits. Intestinal morphology is a critical determinant of digestive efficiency, and the observed differences suggest that wheat-based prebiotics are more effective in promoting gut structural adaptations that facilitate nutrient uptake. According to

Klahan *et al.* (2023), more microvilli enhance digestion and improve nutrient utilization efficiency. These microvilli function to increase the absorptive surface for nutrient uptake. This variation reflects physiological differences influenced by dietary status and environmental conditions (Felgenhauer, 1992). Wheat is rich in soluble and insoluble fiber, particularly beta-glucan, which, as reported by Pritchard *et al.* (2011), functions as an immunostimulant and supports gut microbiota balance. In this study, wheat was shown to improve nutrient efficiency in the diet, leading to enhanced growth performance in giant freshwater prawns.

This mechanism can be explained by the role of probiotics in strengthening the prawn's immune system, while prebiotics serve as an energy source for beneficial gut microbes. Khanjani *et al.*, (2024) also support this mechanism. In addition to health and growth benefits for prawns, the use of wheat-based synbiotics also offers advantages in terms of environmental sustainability. Compared to antibiotics or synthetic chemicals, synbiotics provide a more ecofriendly solution by reducing the risk of antibiotic resistance and minimizing negative impacts on aquatic ecosystems.

Conclusion

Based on the research results, synbiotics, which combine probiotics and prebiotics with wheat-based ingredients, proved effective in improving the growth performance, intestinal health, feed efficiency, and survival of giant freshwater prawns. This finding reinforces that prebiotics are essential in enhancing the absorption of giant shrimp nutrients, especially those derived from natural ingredients.

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