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Effectiveness of Probiotics in Semi-Intensive Pond Cultivation: A Study on the Growth of White Shrimp (*Litopenaeus vannamei*) Using *Bacillus* spp. and *Lactobacillus* spp.

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ABSTRACT

Whiteleg shrimp (*Litopenaeus vannamei*) cultivation is one of the rapidly growing aquaculture sectors in Indonesia, especially in West Sumatra Province. However, the success of this cultivation is greatly influenced by feed efficiency, water quality, and shrimp health. The use of probiotics is one of the strategies that are widely developed to improve cultivation performance in a sustainable and environmentally friendly manner. This study aims to compare the effectiveness of two types of probiotics, namely *Bacillus* spp. and *Lactobacillus* spp., on the growth and survival of whiteleg shrimp in a semi-intensive pond system. The study was conducted experimentally in Padang Pariaman Regency using a Completely Randomized Design (CRD) consisting of three treatments and three replications: P1 (control without probiotics), P2 (*Bacillus* spp. probiotics), and P3 (*Lactobacillus* spp. probiotics). The parameters observed included daily growth rate, survival rate, feed conversion efficiency (FCR), and water quality (pH, DO, NH_3, and salinity). Data were analyzed using ANOVA test and continued with DMRT test at a significance level of 5%. The results showed that the P2 treatment gave the best results significantly on all main parameters. *Bacillus* spp. has been shown to increase growth rate, survival rate, feed efficiency, and stabilize pond water quality. The P3 treatment showed intermediate results, while P1 showed the lowest performance. Thus, *Bacillus* spp. is the most effective probiotic to support vaname shrimp cultivation in a semi-intensive system.

INTRODUCTION

Whiteleg shrimp (Litopenaeus vannamei) is one of the leading commodities in the aquaculture subsector that has high economic value and a large contribution to national fishery exports (Megawati et al., 2024; Paris et al., 2024). The Ministry of Marine Affairs and Fisheries (KKP) noted that national shrimp production in 2023 reached around 1.09 million tons (Ramadhani, 2023; Hapsari & Nurhayati, 2023).

In West Sumatra, Padang Pariaman Regency has the potential for extensive pond land and the availability of water resources that support the implementation of a semi-intensive pond cultivation system (Harisjon et al., 2021; Lisha et al., 2024). However, in recent years, the number of shrimp ponds in this area has decreased significantly. Data from the Padang Pariaman Regency Government shows that the number of shrimp ponds has decreased from around 70 units to only around 10 units in mid-2024 (DKP Padang Pariaman Regency, 2024).

This decline is caused by various factors, including decreasing pond productivity, high shrimp mortality rates, and fluctuations in water quality due to the accumulation of organic matter and metabolite waste. This problem has implications for increasing production costs and decreasing the efficiency of shrimp farming efforts in the area.

One of the technological approaches that is developing to overcome this problem is the use of probiotics. Probiotics are living microorganisms that, when applied in sufficient quantities, can have a positive effect on the health of the host and its environment. In the context of shrimp farming, probiotics can function to improve water quality, increase the shrimp's immune system, suppress pathogens, and improve digestive tract performance.

The two most commonly used probiotic groups in shrimp farming are Bacillus spp. and Lactobacillus spp.. Bacillus spp (Islami et al., 2024; Alisya, 2023). known to be effective in degrading organic waste and stabilizing water quality, while Lactobacillus spp (Susanti et al., 2025). plays a role in maintaining the balance of intestinal microflora and stimulating shrimp growth by increasing immunity (Ananta, 2024). Although both types of probiotics have been widely applied, until now there have been few scientific studies that directly compare their effectiveness in locally based semi-intensive pond systems, especially in Padang Pariaman Regency. The urgency of this study lies in the need to increase production efficiency and sustainability of shrimp cultivation as one of the economic supporting sectors for coastal communities in Padang Pariaman. The lack of locally based scientific information regarding the effectiveness of each type of probiotic means that many farmers still use a trial and error approach. Meanwhile, the novelty of this study lies in its approach which directly compares two groups of probiotics based on Bacillus spp. and Lactobacillus spp. in a semi-intensive pond cultivation system on a field scale, and integrates biological and environmental parameters simultaneously. It is hoped that the results of this study can provide practical recommendations for farmers and scientific contributions in the development of adaptive, efficient, and sustainable shrimp farming technology in the coastal areas of West Sumatra.

RESEARCH METHOD

1. Types and Approaches to Research

This study is a field experimental study using a quantitative approach. The main objective of this study was to test and compare the effectiveness of two types of probiotics, namely *Bacillus* spp. and *Lactobacillus* spp., on the parameters of growth, survival, and environmental quality of whiteleg shrimp (*Litopenaeus vannamei*) cultivation in a semi-intensive pond system.

The study was conducted using a Completely Randomized Design (CRD) consisting of three treatments, each with three replications, so that there were a total of 9 treatment units. This design was used to eliminate external variables that could affect the results of the study and to ensure that the observed differences were truly caused by the probiotic treatment.

2. Location and Time of Research

The study was conducted at a semi-intensive pond location located in Nagari Ulakan, Ulakan Tapakis District, Padang Pariaman Regency, West Sumatra Province. This location was chosen because it is a vaname shrimp cultivation area with a traditional to semi-intensive system that is still actively managed by local farmer groups. The research implementation period lasted for 60 days of maintenance, starting from January to March 2025. Pond preparation activities, spreading fry, providing probiotics, and measuring parameters were carried out systematically during this period. The research treatments and treatment codes used are as follows:

- P1 (Control): Without adding probiotics
- P2: Addition of *Bacillus* spp.-based probiotics (using commercial Vibrex products)
- P3: Addition of *Lactobacillus* spp.-based probiotics (using commercial Pro-EM1 products)

3. Research Parameters

a. Independent Variable: Type of probiotic given (*Bacillus* spp. and *Lactobacillus* spp.)

b. Dependent Variables:
   - Daily growth rate (g/day)
   - Shrimp survival rate (Survival rate, %)
   - Feed conversion efficiency (Feed Conversion Ratio / FCR)
   - Water quality (temperature, pH, DO, salinity, and ammonia)

4. Research Procedures

a. Preparation of shrimp ponds

The initial stage in implementing this research is to prepare the pond. The pond is first drained and thoroughly cleaned from mud and previous cultivation residues to prevent disease and maintain the quality of the pond bottom. After the pond is clean, a liming process is carried out using 300 kg of dolomite lime per hectare. This liming aims to stabilize the pH of the pond bottom to suit optimal conditions for the growth of vaname shrimp. Furthermore, the pond is filled with seawater to a height of about ±100 cm, then left for 7 days for the stabilization process before spreading the fry.

b. Spreading shrimp larvae

The fry used in this study were PL-10 stage fry obtained from certified hatcheries and had gone through a quality testing process to ensure their health and uniformity. Before being released into the pond, the fry were first acclimatized for 1 to 2 hours using a gradual method, in order to adjust the temperature and salinity of the water between the transport container and the pond environment. The distribution was carried out with a stocking density of 80 per square meter, in a pond measuring 5 x 5 meters, which had been standardized in each treatment unit.

c. Probiotic Administration

The administration of probiotics was carried out according to the predetermined treatment. In the P2 treatment, the commercial probiotic Vibrex containing *Bacillus* spp. bacteria was used, with a dose of 1 gram per cubic meter of pond water, which was applied twice a week. In addition, this probiotic was also given through feed by spraying it as much as 5 grams per kilogram of feed, to support the stability of the shrimp intestinal microbiota. Meanwhile, in the P3 treatment, the commercial probiotic Pro-EM1 was used which was based on *Lactobacillus* spp.. This probiotic was applied to the pond water as much as 10 mL per cubic meter, twice a week, and sprayed onto the feed at a dose of 10 mL per kilogram of feed using 3% molasses adhesive. Probiotics were given consistently during the maintenance period to support the growth, health of the shrimp, and the stability of the quality of the pond environment.

d. Shrimp maintenance

During the maintenance period, vaname shrimp were fed commercial feed (CP brand or similar) 3 to 4 times per day. The amount and frequency of feeding were adjusted to the shrimp's body weight and consumption level, which was observed through eating habits and leftover feed at the bottom of the pond. Visual observations of shrimp behavior were carried out routinely, supported by body weight sampling every 10 days to monitor growth rates. In addition, daily mortality rates were recorded to determine the survival rate in each treatment. To maintain the quality of the cultivation environment, water changes of 10–20% were carried out per week and the bottom of the pond was siphoned every three days. This siphoning aims to reduce the accumulation of organic matter, such as leftover feed and feces, which can reduce water quality and trigger the growth of pathogenic microorganisms.

5. Data Collection Techniques

a. **Daily Growth:** The average weight of shrimp is calculated every 10 days by weighing a sample of 30 shrimp per pond.

b. ***Survival rate*** **(%):**

$$SR = \frac{total\ live\ shrimp}{total\ shrimp\ at\ the\ start\ of\ treatment} \times 100$$

c. ***Feed Conversion Ratio*** **(FCR):**

$$FCR = \frac{total\ feed\ given\ (gr)}{harvest\ biomass\ weight\ (gr)}$$

d. **Water Quality:**

Measured using digital tools:

- pH meter
- Dissolved Oxygen (DO) meter
- Refractometer (salinity)
- Ammonia test kit
- Digital thermometer (temperature): Measurements are taken weekly.

6. Data Analysis Techniques

Data obtained from observations will be analyzed using Analysis of Variance (ANOVA) at a significance level of 5% to determine the effect of treatment. If there is a significant difference, it is continued with Duncan's Multiple Range Test (DMRT) to determine the differences between treatments more specifically (Setyawati et al., 2024). All data processing is carried out using statistical software, namely SPSS and Microsoft Excel.

RESULT AND DISCUSSION

Result

This study was conducted to evaluate the effect of administering two types of probiotics, namely *Bacillus* spp. and *Lactobacillus* spp., on growth, survival, feed efficiency, and water quality in whiteleg shrimp (*Litopenaeus vannamei*) cultivation in a semi-intensive pond system. Data obtained from three treatments—control without probiotics (P1), administration of *Bacillus* spp. probiotics (P2), and administration of *Lactobacillus* spp. probiotics (P3) are presented briefly in Table 1.

Table 1. Average Results of Research Parameters Based on Treatment

Treatment	Growth Rate (g/day)	Survival (%)	FCR	pH	DO (mg/L)	NH_3 (mg/L)	Salinity (ppt)
P1 (Control)	0.211	76.5	1.70	7.8	4.5	0.45	28
P2 (*Bacillus spp.*)	0.272	89.3	1.30	8.0	5.8	0.25	30
P3 (*Lactobacillus spp.*)	0.253	85.0	1.40	7.9	5.5	0.30	29

Daily Growth Rate

The daily growth rate of whiteleg shrimp showed differences between treatments. Treatment P2 using *Bacillus* spp.-based probiotics recorded the highest daily growth rate of 0.272 g/day. Followed by treatment P3 (*Lactobacillus* spp.) with a value of 0.253 g/day, and the control (P1) showed the lowest growth of 0.211 g/day. This indicates that the use of probiotics has an effect on the growth rate of shrimp during the maintenance period.

Survival rate

The highest shrimp survival rate was obtained in treatment P2 with a percentage of 89.3%, followed by P3 at 85.0%, and the lowest was in the control at 76.5%. These data indicate that the administration of probiotics, especially *Bacillus* spp., Can increase the survival of whiteleg shrimp during the cultivation period.

Feed Conversion Efficiency (FCR)

The FCR value describes the efficiency of feed use. The results showed that the best FCR was achieved by treatment P2 with a value of 1.30, followed by P3 with an FCR of 1.40. The control treatment showed the highest (worst) value of 1.70. The low FCR value in P2 indicates that the use of *Bacillus* spp. probiotics can increase the efficiency of feed use in semi-intensive pond systems.

Water Quality

Water quality during the study was relatively stable in the three treatments, but there were quite striking differences in values in several parameters. The average water pH ranged from 7.8 to 8.0; the highest value was found in P2. The highest DO (dissolved oxygen) value was also recorded in P2 at 5.8 mg/L, indicating better dissolved oxygen quality. Conversely, the lowest NH_3 (ammonia) value was also found in P2 at 0.25 mg/L, indicating a more effective organic matter decomposition process. Salinity was relatively stable between 28 and 30 ppt, with little variation between treatments.

ANOVA Test Result

This study used ANOVA (Analysis of Variance) test to determine whether there was a significant effect of probiotic treatment on vaname shrimp cultivation parameters. For parameters that showed significant differences, further testing was carried out using Duncan's Multiple Range Test (DMRT) with the Tukey HSD approach to determine which treatment groups were significantly different.

Table 2. ANOVA Test Results on Vaname Shrimp Cultivation Parameters

Parameters	F Count	p-value	Significance Level (α)	Description
Growth Rate (g/day)	153.34	0.000007	0.000	There are differences between treatments
Survival (%)	96.06	0.000028	0.005	There are differences between treatments

Parameters	F Count	p-value	Significance Level (α)	Description
FCR	48.96	0.000192	0.005	There are differences between treatments
pH	3.77	0.085	0.255	There are no significant differences
DO (mg/L)	15.23	0.004	0.000	There are differences between treatments
NH_3 (mg/L)	37.54	0.000391	0.000	There are differences between treatments
Salinity (ppt)	12.67	0.006	0.005	There are differences between treatments

Interpretation:

The results of the ANOVA test show that six of the seven parameters have a p value <0.05, meaning that there is a significant effect of treatment on these parameters. Only the pH parameter did not show a significant difference between treatments.

DMRT Advanced Test Results (Tukey HSD)

Further tests were carried out on significant parameters to see real differences between treatments. The following is an example of the DMRT results on the daily growth rate parameter:

Table 3. Tukey HSD Test Results on Daily Growth Rate

Treatment Comparison	Average Difference	p-value
P1 and P2	+0.0607	0.0000
P1 and P3	+0.0420	0.0001
P2 and P3	−0.0187	0.0046

The results of the DMRT further test on the daily growth rate parameter showed that the P2 treatment using *Bacillus* spp.-based probiotics was statistically significantly different compared to the P1 (control) and P3 (*Lactobacillus* spp. probiotics) treatments. In addition, the P3 treatment also showed a significant difference compared to the control (P1), but not as good as P2. Based on this, it can be concluded that the P2 treatment is the best treatment statistically in increasing the growth rate of whiteleg shrimp in a semi-intensive pond system. Similar polarization of results was also found in other parameters, namely survival rate, feed conversion efficiency (FCR), and ammonia concentration (NH_3). In all these parameters, the pattern formed consistently shows the order P2> P3> P1, which means that *Bacillus* spp. probiotics have the strongest effect in improving cultivation performance, followed by *Lactobacillus* spp., and finally the treatment without probiotics. These results strengthen the finding that the use of probiotics, especially those based on *Bacillus* spp., provides significant benefits to the productivity and efficiency of the whiteleg shrimp cultivation system. Based on the results of statistical tests that have been conducted, it can be concluded that the treatment of probiotic types has a significant effect on the performance of whiteleg shrimp cultivation in a semi-intensive pond system. Of the three treatments tested, treatment P2 using *Bacillus* spp.-based probiotics showed the best results statistically in almost all parameters observed, including growth rate, survival rate, feed conversion efficiency (FCR), and water quality (DO and NH_3).

Treatment P3 using *Lactobacillus* spp. probiotics showed better performance than the control treatment, but was still below P2 in terms of effectiveness. This indicates that although *Lactobacillus* spp. contributes to improving cultivation performance, its effectiveness is not as optimal as *Bacillus* spp.

In contrast, treatment P1 (control) which did not use probiotics consistently showed the lowest results in all important parameters, including slow growth, low survival rate, and high FCR. This condition indicates that the absence of probiotics has a negative impact on the performance of whiteleg shrimp cultivation, both from a biological and environmental aspect.

DISCUSSION

A. Effect of Probiotics on the Growth Rate of Whiteleg Shrimp

The results showed that the administration of probiotics had a significant effect on the growth rate of whiteleg shrimp (*Litopenaeus vannamei*). The P2 treatment using *Bacillus* spp.-based probiotics produced the highest daily growth rate compared to the P3 (*Lactobacillus* spp.) and control (P1) treatments. This growth pattern shows that probiotic microorganisms play an important role in the physiological processes of shrimp, especially in increasing nutrient absorption and metabolic efficiency.

Probiotics, especially from the genus *Bacillus* , are known to have the ability to produce various digestive enzymes such as proteases, amylases, and lipases which play a role in breaking down complex nutrients in feed into simpler and more easily absorbed forms (Imanan et al., 2025; Yarashima & Mayasari, 2024). The increase in the availability of these nutrients has a direct impact on the growth of shrimp biomass. In addition, *Bacillus* spp. able to adapt to the shrimp digestive tract environment, improve intestinal microflora, and strengthen intestinal epithelial function to increase absorption capacity (Kasmi et al., 2024; Yarashima & Mayasari, 2024).

In line with these results, research by Syah & Junianto (2024) showed that the application of *Bacillus* subtilis to vaname shrimp cultivation in a semi-intensive system increased daily growth by 12–18% compared to controls without probiotics. Another study by Widodo et al. (2019) also reported that *Bacillus* spp. not only accelerates growth, but also improves the balance of the microbial ecosystem in the intestine and prevents pathogen colonization.

Meanwhile, the P3 treatment using *Lactobacillus* spp. also showed increased growth compared to the control, although the value was lower than P2. *Lactobacillus* spp. has the ability to produce organic acids, bacteriolysins, and other antimicrobial compounds that can inhibit pathogenic bacteria in the digestive tract (Aini et al., 2021). However, the enzymatic activity and colonization of *Lactobacillus* spp. in the shrimp digestive tract may not be as optimal as *Bacillus* spp., especially since this genus is more common in the vertebrate and freshwater digestive tract environment (Jannah et al., 2018)

The control (P1), which did not receive probiotic treatment, produced the lowest growth rate. This indicates that without biological supplements, the ability of shrimp to utilize nutrients from commercial feed is not optimal. The absence of probiotics also increases the possibility of digestive disorders, environmental stress, and intestinal microbiota imbalances that can suppress growth.

From a practical perspective, the use of *Bacillus* spp. as probiotics in semi-intensive cultivation is an effective approach to improve growth performance without significantly increasing feed costs. This has a positive impact on farmers in increasing productivity, shortening harvest times, and supporting the principles of environmentally friendly sustainable cultivation.

B. Effect of Probiotics on Survival Rate

The results of this study indicate that the administration of probiotics has a significant effect on the survival rate of whiteleg shrimp (*Litopenaeus vannamei*), where treatment P2 (probiotic *Bacillus* spp.) showed the highest survival rate, followed by P3 (*Lactobacillus* spp.) and P1 (control). This pattern indicates that probiotics play a role in increasing the shrimp's resistance to environmental conditions and disease attacks.

The increase in survival in probiotic treatments, especially *Bacillus* spp., can be explained through the mechanism of increasing non-specific shrimp immunity. Several studies, conducted by Permanti et al. (2018), showed that *Bacillus* probiotics were able to increase phagocytic activity, lysozyme production, and other immunity enzymes in shrimp. In addition, *Bacillus* spp. also produces antimicrobial metabolites that can suppress the population of pathogenic microorganisms such as Vibrio spp., which are known to be one of the main causes of shrimp death in cultivation.

Similar findings were reported by Moehammad et al. (2025), who found that the use of *Bacillus* subtilis in a marine aquaculture system can reduce shrimp mortality due to Vibrio harveyi and V. alginolyticus infections. Probiotics also support competition for space and nutrients in the digestive tract, so that pathogens do not have the opportunity to develop dominantly.

The P3 (*Lactobacillus* spp.) treatment also showed a significant increase in survival rate compared to the control. *Lactobacillus* spp. is known to be able to produce lactic acid, bacteriocins, and other bioactive compounds that can inhibit the growth of pathogenic bacteria. Research by Kusmiatun et al. (2022) stated that the use of *Lactobacillus* plantarum can increase shrimp survival by increasing immune resistance and modulating gut microbiota. However, the effectiveness of *Lactobacillus* spp. in brackish or marine pond environments is sometimes limited because this genus is more commonly found in freshwater environments or mammalian digestive systems (Dini et al., 2019).

The control group (P1), which did not receive probiotic treatment, showed the lowest survival rate. This suggests that in semi-intensive conditions that are susceptible to water quality fluctuations and diseases, probiotics play a crucial role as a balancing agent for gut microbiota and immune system booster. The absence of these biological agents makes shrimp more susceptible to environmental stress and infection.

C. Effect of Probiotics on Feed Conversion Efficiency (FCR)

Feed utilization efficiency is a key factor in the success of shrimp farming, because feed contributes up to 60–70% of the total production cost (Juarno et al., 2011). The Feed Conversion Ratio (FCR) parameter is an important indicator to assess how efficiently shrimp convert feed into biomass. In this study, the results showed that probiotic treatment, especially P2 (*Bacillus* spp.), significantly produced the lowest FCR value compared to P3 (*Lactobacillus* spp.) and control (P1). This means that shrimp given *Bacillus* spp. probiotics are able to utilize feed more efficiently.

The low FCR value in P2 is due to the role of probiotics in increasing the availability and utilization of nutrients, as well as suppressing the energy used to fight stress and pathogens. *Bacillus* spp. known to be able to produce digestive enzymes such as protease, amylase, and lipase which help in breaking down proteins, carbohydrates, and fats into easily absorbed forms (Jatnika et al., 2013; Prihatiningsih & Djatmiko, 2016; Abidin et al., 2015). These enzymes not only support the digestion process, but also reduce the waste of feed, thereby reducing the FCR ratio.

In addition, *Bacillus* spp. can also improve the condition of the shrimp intestinal microbiota, thereby improving the structure and function of the digestive tract. Research by Moehammad et al. (2025) showed that the use of *Bacillus* licheniformis probiotics in vaname shrimp cultivation can reduce FCR by up to 20% compared to the control group, while increasing harvest productivity.

Treatment P3 (*Lactobacillus* spp.) also gave better results than the control, although not as efficient as P2. This can be explained by the ability of *Lactobacillus* spp. in producing antimicrobial compounds and organic acids that support healthy intestinal conditions, but its external enzymatic activity and stability in the marine environment are considered less than *Bacillus* spp.. As a common probiotic in the mammalian digestive tract and freshwater environment, *Lactobacillus* colonization in a semi-intensive pond system with high salinity may not be optimal (Yustin et al., 2025; Rahayu, 2013).

In the control group (P1), the highest FCR value indicated that shrimp needed more feed to produce equivalent body weight. This is likely due to suboptimal nutrient absorption, less stable intestinal conditions, and high levels of stress due to imbalances in environmental microorganisms.

Thus, the use of probiotics, especially from the genus *Bacillus* , has been shown to increase feed efficiency, reduce production costs, and improve the sustainability of the cultivation system. Low FCR means faster growth, shorter harvest age, and reduced organic waste to the environment in line with the principles of environmentally friendly and efficient aquaculture.

D. Effect of Probiotics on Pond Water Quality

Water quality is one of the critical factors in shrimp cultivation that affects the growth, health, and survival of shrimp. In this study, water quality was measured through pH, dissolved oxygen (DO), ammonia concentration (NH_3), and salinity parameters. The results showed that the administration of probiotics, especially *Bacillus* spp. in the P2 treatment, contributed positively to the stability and improvement of water quality during the cultivation period.

The highest DO value was achieved in the P2 treatment, indicating that the application of probiotics plays a role in creating a healthier and more oxygen-rich aquatic environment. According to Purwanta & Firdayati, (2002), optimal Dissolved oxygen (DO) is very important to support shrimp metabolism and growth, as well as prevent hypoxic conditions that can trigger stress and even cause death. One way to maintain DO stability in ponds is through the use of probiotics. Probiotics play a role in reducing the load of organic matter at the bottom of the pond which has the potential to reduce DO levels during the decomposition process. In addition, probiotics also help promote the stability of planktonic communities, as well as suppress the dominance of opportunistic microorganisms that can disrupt the balance of the pond ecosystem.

The use of *Bacillus* spp. in ponds increases the activity of positive microbes that do not consume excessive oxygen, and supports more balanced conditions in the water column (Putra et al., 2014; Setyati et al., 2016).

The P2 treatment also produced the lowest ammonia concentration compared to other treatments. Ammonia is one of the main wastes in intensive and semi-intensive cultivation systems that comes from shrimp metabolism and unutilized feed waste. In high concentrations, ammonia is toxic and can cause gill damage and inhibit growth (Scabra et al., 2014; Handayan, 2020).

Probiotics such as *Bacillus* spp. have an important role in maintaining the quality of the cultivation environment through various biological mechanisms. One of its abilities is to decompose organic matter such as feed waste and feces which are the main sources of ammonia formation in the cultivation system (Suhendar et al., 2022). In addition, several species such as *Bacillus* subtilis and *Bacillus* licheniformis have been shown to support the aerobic nitrification process, a biological process that oxidizes ammonia into a less toxic form of nitrogen (Nur'aeni et al., 2019). This activity is very helpful in controlling the accumulation of ammonia which is harmful to cultivated organisms. This finding is supported by research by Suwoyo et al. (2010), which states that the application of probiotics in shrimp ponds can reduce ammonia concentrations by 40-50% compared to systems without probiotics.

The pH value during the study was within the optimal range (7.8-8.0) for all three treatments, with no statistically significant differences. This shows that although probiotics do not directly affect pH, their use still helps maintain the stability of water chemistry by improving the waste decomposition system.

Salinity during the maintenance period was also within the optimal range (28-30 ppt) and did not show extreme fluctuations. These values are maintained through water management and are not directly controlled by the probiotic treatment, but it is important to note that the stability of water quality (pH, salinity, temperature) supports the action of the applied probiotics.

CONCLUSION

Based on the results of the research and discussion that has been carried out, it can be concluded that the provision of probiotics has a significant effect on growth, survival, feed conversion efficiency, and water quality in whiteleg shrimp (*Litopenaeus vannamei*) cultivation in a semi-intensive pond system.

1. The use of probiotics *Bacillus* spp. (treatment P2) has been proven to provide the best results statistically in almost all parameters observed, namely the highest daily growth rate, highest survival, lowest FCR, and more stable water quality (high DO and low ammonia).
2. Probiotics *Lactobacillus* spp. (treatment P3) also have a positive impact on cultivation performance, but their effectiveness is still below *Bacillus* spp.
3. The control treatment (P1) without probiotics consistently showed the lowest performance, indicating the importance of using probiotics in supporting the success of sustainable whiteleg shrimp cultivation.

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