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PROBIOTIC-BASED POND MANAGEMENT STRATEGY TO IMPROVE THE CULTURE PERFORMANCE OF PACIFIC WHITE SHRIMP *Litopenaeus vannamei*

Strategi Pengelolaan Tambak Berbasis Probiotik untuk Meningkatkan Kinerja Budidaya Udang Vaname *Litopenaues vannamei*

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ABSTRACT

Pacific white shrimp *Litopenaeus vannamei* aquaculture has become a primary alternative to increase national aquaculture production following the decline in tiger shrimp farming due to disease outbreaks. However, the grow-out phase still faces challenges such as limited availability of high-quality post-larvae and deteriorating environmental conditions. The application of probiotics is considered a promising approach, as it can improve water quality, suppress pathogens, and enhance shrimp growth and resilience. This study integrates probiotic application into the grow-out management system to improve production efficiency and sustainability. The research was conducted through direct observation and active participation in farming activities, combined with secondary data collection from verified sources. Observed parameters included mean body weight (MBW), average daily growth (ADG), and survival rate (SR). The grow-out activities involved pond preparation, stocking of post-larvae at a density of 120–180 individuals/m² following acclimatization, blind feeding during the first 10 days, and feed administration based on the feeding rate (FR) thereafter. Daily water quality management and disease control were also carried out. The cultivation period lasted for three months, followed by partial and total harvesting, yielding up to 3 tons of shrimp per pond. Post-harvest, the shrimp were sorted and distributed to consumers using refrigerated vehicles.

Keywords: Grow Out, Pacific White Shrimp, Probiotic, Sustainability, Water Quality

ABSTRAK

Budidaya udang vaname *Litopenaeus vannamei* menjadi alternatif utama untuk meningkatkan produksi perikanan nasional setelah menurunnya keberhasilan udang windu akibat penyakit. Namun, fase pembesaran masih menghadapi kendala berupa keterbatasan benur unggul dan penurunan kualitas lingkungan. Penggunaan probiotik menjadi salah satu pendekatan potensial karena dapat memperbaiki kualitas air, menekan patogen, serta meningkatkan pertumbuhan dan ketahanan udang. Studi ini mengintegrasikan aplikasi probiotik dalam sistem pembesaran untuk meningkatkan efisiensi dan performa produksi secara berkelanjutan. Penelitian dilakukan melalui observasi langsung dan partisipasi aktif dalam kegiatan budidaya, serta pengumpulan data sekunder dari sumber terverifikasi. Parameter yang diamati meliputi *mean body weight* (MBW), *average daily growth* (ADG), dan *survival rate* (SR). Kegiatan pembesaran meliputi persiapan wadah, penebaran benur dengan kepadatan 120–180 ekor/m² setelah aklimatisasi, pemberian pakan secara *blind feeding* (hari ke-1–10) dan berdasarkan *feeding rate* (FR) pada fase lanjut, pengelolaan kualitas air harian, serta pengendalian hama dan penyakit. Masa pemeliharaan berlangsung selama tiga bulan dengan panen parsial dan total, menghasilkan hingga 3 ton udang per petak. Pascapanen, udang disortir dan didistribusikan ke konsumen menggunakan kendaraan berpendingin.

Kata Kunci: Udang Vaname, Pembesaran, Probiotik, Kualitas Air, Berkelanjutan

INTRODUCTION

Shrimp cultivation is a subsector of aquaculture that plays a strategic role in supporting food security and increasing national foreign exchange (Hidayat & Yadi, 2016). Since its inception in Indonesia, the sector has shown a positive trend of increasing production, boosting foreign exchange. However, since 1996, there has been a significant decline due to high incidences of diseases such as white spot syndrome virus (WSSV) and vibriosis (Prihanto *et al.,* 2021; Ambat *et al.,* 2022). These two diseases are indicators of declining pond environmental quality, contributing to the high failure rate of tiger shrimp cultivation in Indonesia (BBAP Situbondo, 2006; Haryanti *et al.,* 2012; Putri, 2021).

In response to these challenges, commodity diversification was carried out by introducing the whiteleg shrimp *Litopenaeus vannamei* (Manan & Putra, 2014; Annisa, 2022), which is known for its fast growth rate, higher disease tolerance, and competitive economic value (Iskandar *et al.,* 2022a). Since its official release as a superior variety through Decree of the Minister of Maritime Affairs and Fisheries No. 41/2001, whiteleg shrimp has become the primary choice for intensive cultivation activities in various regions in Indonesia (Sukenda *et al.,* 2009; Hendriana *et al.,* 2024). However, in their report, Kurniawan et al. (2021) stated that the success of whiteleg shrimp cultivation still depends on the provision of superior seeds and good environmental management (Supriyono *et al.,* 2025). Challenges such as the availability of quality shrimp fry and water quality degradation are limiting factors in the grow-out phase (Kurniawan *et al.,* 2021; Iskandar *et al.,* 2022b).

According to data from the Fish Quarantine, Quality Control, and Safety of Fishery Products Agency (BKIPM), there is a significant gap between the supply and demand of whiteleg shrimp fry, demonstrating the importance of increasing efficiency and productivity in this sector (BKIPM, 2018). Moehammad et al. (2025) state that one emerging approach to supporting whiteleg shrimp cultivation performance is the use of probiotics. Probiotics are live microorganisms that, when administered in appropriate amounts, can provide physiological benefits to the host (Aviany *et al.,* 2020).

In the context of aquaculture, probiotics have been shown to improve environmental quality, suppress pathogen populations (Kusmiatun *et al.,* 2022), and enhance shrimp growth and survival (Wijayanto *et al.,* 2020; Fajri, 2022). Prihanto et al. (2021) stated that the main benefits of administering probiotics include: (1) balancing the pond microbiota, (2) increasing feed efficiency and growth rate, (3) reducing levels of toxic compounds such as ammonia and nitrite, and (4) strengthening the shrimp's immune system against disease infections.

With the increasing demand for shrimp production nationally, the implementation of technologies that support efficient and sustainable cultivation is essential. This study integrates probiotics into the management system of whiteleg shrimp farming, with the goal of providing not only an ecological solution but also an applicative dissemination as an innovative strategy that supports overall improved production performance.

METHODS

The fish study and cultivation were conducted at PT Menjangan Mas, Bali, from February to April 2024. The method used was a combination of direct on-site observation and active participation in all stages of the cultivation process. Iskandar et al. (2022b) stated in their report that this method aimed to obtain comprehensive data regarding the technical aspects of cultivation operations, as well as distribution and marketing processes.

Secondary data was obtained from various official documents and verified sources and then analyzed with the involvement of relevant stakeholders to support the study (Nugraha *et al.,* 2022). Observed parameters included mean body weight (MBW), average daily growth (ADG), and survival rate (SR) of the cultivated and observed commodities. MBW, ADG, and SR were calculated using the following formula:

1. Mean body weight (MBW) is a parameter that describes the average weight of individual shrimp sampled. The MBW value is calculated using the following formula (Witoko *et al.,* 2018):

$$\text{MBW (g)} = \frac{\text{Total sample weight (g)}}{\text{Number of samples (fish)}}$$

2. Average daily growth (ADG) is an indicator that shows the average daily increase in shrimp weight during a specific culture period. It can be used to assess shrimp growth rate. The ADG value is calculated using the following formula (Haliman & Adijaya, 2005):

$$\text{ADG (g)} = \frac{\text{MBW from previous sampling (g)} - \text{MBW from sampling (g)}}{\text{Sampling time interval (days)}}$$

3. Survival rate (SR) indicates the percentage of shrimp that survive the culture period compared to the initial number stocked. The SR value is calculated using the following formula (Haliman & Adiwijaya, 2005):

$$\text{SR (\%)} = \frac{\text{Number of live fish at the end of culture (fish)}}{\text{Number of live fish at the beginning of culture (fish)}} x\ 100\%$$

RESULTS

Commodities

Whiteleg shrimp belong to the Penaeidae family and are classified in the Arthropoda phylum. This species has a body composed of segments (jointed) and undergoes a periodic exoskeleton shedding process known as moulting (Mente, 2008) (Figure 1).

Figure 1. Whiteleg Shrimp, *Litopenaeus vannamei*

The head structure of whiteleg shrimp consists of antennules, antennae, mandibles, and two pairs of maxillae (Mogalekar *et al.,* 2025). In addition, the shrimp's head is equipped with three pairs of maxillopeda, which function in feeding, and five pairs of walking legs (periopods), also known as decapods. The endopodites of the walking legs are attached to the cephalothorax and connected by the coxa. The sequence of segments between the coxa and dactylus includes the base, ischium, merus, carpus, and propodus. Morphologically, this species has two teeth on the ventral side of the rostrum and 8–9 teeth on the dorsal side of the rostrum (Haliman & Adijaya, 2005).

One of the distinctive characteristics of whiteleg shrimp is the presence of carotenoid pigments in its skin. As the species grows, the levels of these pigments tend to decrease, caused by the moulting process, in which some of the pigment is shed along with the exoskeleton (Ashraf *et al.,* 2025). These carotenoid pigments give the shrimp their reddish-white color (Gökoğlu, 2024). In his publication, Sucipto (2024) stated that whiteleg shrimp also have several advantages compared to other shrimp species, including relatively high resistance to disease and the ability to adapt to suboptimal environmental conditions. This species can grow in a salinity range of 5–35 g/L, a temperature of 24–32°C, a dissolved oxygen level of ≥4 mg/L, and a water pH of 7.0–8.5 (Ponce *et al.,* 2019). Furthermore, Iskandar et al. (2022a) stated that whiteleg shrimp exhibit tolerance to high densities, even exceeding 70 individuals/m², and are capable of optimal growth even when fed with relatively low protein feed (Li *et al.,* 2017).

Pond Drying and Cleaning Process

The pond drying and cleaning process at the study site took 7–14 days. The initial stage involved cleaning the ponds by brushing the walls and bottom, followed by spraying with clean seawater to push and drain any remaining debris through the outlet channel. During the drying period, inspections and repairs were also carried out on damaged high-density polyethylene (HDPE) plastic linings. If holes or tears were found in the plastic, the locations were marked with approximately 30 cm long bamboo poles. Next, patching is performed to repair the damage. This process takes 2–4 days, depending on the severity of the damage found in the plot.

The following day, a hydrogen peroxide (H_2O_2) solution is applied at a concentration of 5 ppm. The hydrogen peroxide solution is evenly sprinkled over the entire surface of the pond embankment wall (Figure 2).

Figure 2. Spreading the Hydrogen Peroxide (H_2O_2) Solution

Pond Water Filling and Sterilization

The pond water was filled 7-14 days before the fry were released, using clean seawater (pre-treatment). Each pond was filled with water to a height of 90 cm. Initially, after water filling, cupric sulfate ($CuSO_4$) was spread at a dose of 1.5 ppm, which acts as an algaecide. At the study site, the dose of cupric sulfate used was adjusted to the water's alkalinity level. On the second day, a crustacean containing dichlorvos was spread to control the presence of crustaceans in the water. The crustacean was applied directly to the pond in the morning at a concentration of 1-2 ppm. On the third day, chlorine ($Ca(ClO)_2$) was added at a dose of 30 ppm as a water sanitation measure (Figure 3). Four water wheels were operated to ensure the active ingredient was evenly distributed, allowing it to react optimally throughout the water column of the rearing pond.

Figure 3. Distribution of Chlorine ($Ca(ClO)_2$)

Preparation of Pond Water Before Stocking Shrimp Fry

Pond water preparation was carried out after the entire water sterilization process was completed, with the aim of supporting the growth of plankton as natural food for the shrimp. One treatment applied to improve water quality in the initial stages of cultivation is liming (Figure 4a).

On the first day, fermentation paste was made to stimulate plankton growth. The paste was made in a 50-liter bucket or drum, adding 5 kg of bran, 2 liters of molasses as a carbon source, and 50 grams of yeast. The mixture was stirred thoroughly and then allowed to stand for 24 hours before use (Figure 4).

Figure 4. Fermentation Paste

The fermentation paste was spread over seven days. The first day of the rearing period. In the following days, a nitrogen source was added in the form of super NB (nutrient broth) (Marindo Lab, Surabaya) at a dose of 0.5 ppm dissolved in 3 liters of fresh water, then evenly distributed throughout the culture medium.

Fry Stocking

The fry used in the study were sourced from PT. Central Pertiwi Bahari (CPB) Rembang, Central Java. Fry quality plays a crucial role in determining the success of the cultivation. Selected fry met predetermined quality standards, including relatively uniform color and size, complete body parts, freedom from pathogen contamination, and a full stomach, indicated by a clearly visible and unbroken brown color.

At the study site, fry were stocked at 6:00 a.m. WITA (Central Indonesian Time), with a post-larva (PL) size of 10 and an average stocking density of 139 fry/m². Information regarding fry stocking is presented in Table 1.

Table 1. Data on the Number of Fry Stocked in the Observed Ponds During Study

Pond Plot	Area (m^2)	Pond Water Level (cm)	Number of Fry (shrimp)	Stocking Density (shrimp/m^2)	Origin of Fry
G1	2,782	100	381,940	137	CPB
G2	2,715	90	381,940	140	CPB
G3	2,698	100	381,940	141	CPB
G4	2,010	90	279,110	138	CPB
G5	2,745	100	381,940	139	CPB
Average	2,590	96	361,374	139	

The shipping documents, the number of Styrofoam boxes containing fry, the number of fry bags in each Styrofoam box, the total number of fry, and the water quality inside the plastic bags containing the fry were checked and verified upon arrival at the stocking location. The number of fry was counted using an expert count tool. Water quality parameters measured upon arrival at the location included temperature, dissolved oxygen, salinity, and pH.

Before being released into the rearing ponds, the fry underwent a 30-minute acclimatization process. This process involved placing the fry bags in pond plots that had previously been fitted with bamboo supports at the ends (Figure 5a). Once the water temperature in the bags approached that of the pond water, the bags were slowly opened and pond water was gradually added. The fry were then carefully released into the plots, ensuring that no individuals were left behind (Figure 5b).

Figure 5. Handling of Ready-To-Stock Fry: Acclimatization (a) Spreading of Fry (b)

Feeding

Feed is an essential component that plays a crucial role in supporting the growth and survival of whiteleg shrimp. The types of feed used in this study were artificial feed in powder, crumble, and pellet forms, adjusted to the shrimp's age (days of culture; DOC). In the initial cultivation phase (DOC 1–10), feed was provided using a blind feeding method, while from DOC 30 until harvest, feed was provided based on the calculated feeding rate (FR).

The selection of feed form and size was adjusted to the shrimp biomass to ensure efficient feed consumption and determine feeding frequency. The specifications of the feed types used during the cultivation process at the study site are presented in Table 2.

Table 2. Data on Specifications, Percentage of Feed Amount Given During the Study

Feed Code	Feed Specifications and Sizes (mm)	Shrimp Weight (gr)	Feeding (% Body Weight)	Frequency (Times/Day)
681 V	Crumble 0.425 – 0.71	0.8 – 1.0	10.0 - 8.0	4
682 V	Crumble 0.71 – 1.0	1.0 – 2.5	8.0 - 7.5	5

Feed Code	Feed Specifications and Sizes (mm)	Shrimp Weight (gr)	Feeding (% Body Weight)	Frequency (Times/Day)
683 V	Pelet 1.2 x 1-2	2.5 – 8	7.5 - 3.9	6
683 SP	pelet 1.6 x 1-3	8 – 18	3.9 - 2.6	6
684 SV	pelet 1.8 x 1-3	18 – 25	2.6 - 2.2	6
684 SV	pelet 2 x 3-5	> 25	< 2.2	6

Blind Feeding Method

Blind feeding is a method of providing feed based on estimated doses without calculating exact requirements. This method is applied during the initial phase of shrimp cultivation, from 1 to 30 days of age. During this period, shrimp are trained to climb onto the floating cage, and evaluation of remaining feed begins when the shrimp are 21 days old. During this period, feed provided through the floating cage is 0.5% of the total daily feed. Feeding frequency during the blind feeding period is four times daily: at 7:00 AM, 11:00 AM, 3:00 PM, and 7:00 PM WITA (Central Indonesian Time).

Post-Blind Feeding

Feeding after the blind feeding phase begins when the shrimp reach 30 days of age and continues until harvest. The amount of feed provided is determined based on the shrimp's FR (Frequency of Feeding) and biomass, requiring sampling to measure the average shrimp body weight to calculate total biomass.

The feeding method is carried out by monitoring the floating cages placed in each pond. Four floating cages are installed at the front of each pond. Feeding is done through the fish tank every time the feed is released, and feed consumption is evaluated two hours afterward. If the feed in the fish tank is depleted or only a very small amount remains, the feed dosage can be increased.

Feed is increased if observations indicate the fish tank is consistently empty for two to three consecutive days. Feed additions are made in the range of 1–1.5 kg per 100,000 shrimp. Technically, the calculation of daily feed requirements based on sampling results in pond G1 at DOC 61 is presented as follows:

Number of stockings = 381,940 shrimp
MBW sampling = 7.9 grams
FR = 3.3%
SR = 80%

Where:
MBW = Mean Body Weight
SR = Survival Rate

Calculation method:
Amount of feed per day = MBW x Number of fry x SR
= 7.9 g x 381,940 shrimp x 80%
= 7.9 g x 305,552 = 2,413 kg
Therefore, the total amount of feed per day for 1 pond is:
2,413 kg x 3.3% = 79.62 kg of feed

Water Management

Water quality is an important factor that needs to be considered in shrimp cultivation activities, as it directly affects shrimp survival. Water quality parameters monitored daily included temperature, salinity, pH, dissolved oxygen content, ammonia, and water clarity.

Based on measurements during the study, the average water temperature was recorded at

30°C, with an average salinity of 33 g L^{-1}. pH measurements were conducted by taking water samples using plastic cups, then inserting a pH meter into the sample to obtain the pH value, which was then recorded. The measurements showed that the average pH value during maintenance was 8.1. Lime ($CaCO_3$) was also added to the study site to stabilize the pH, and the valves were cleaned to maintain the quality of the pond environment.

Water clarity was measured using a Secchi disk. The disk, connected to a sampling bottle, was immersed in the water until the disk was no longer visible from the surface. The depth at which the disk disappeared was recorded using a scale on the Secchi disk stem, and water samples were taken simultaneously from each pond plot. Observations showed that at the beginning of stocking, water clarity was around 60–70 cm, while during the maintenance phase, above DOC 30, clarity decreased to around 30–40 cm.

Water quality measurements were conducted directly at the observation site by taking 250 mL water samples. The water samples were collected using plastic bottles tied to a Secchi disk and then placed in sample containers for laboratory testing. Water quality tests were conducted every morning at 8:00 a.m. WITA (Central Indonesian Time), while water clarity tests were conducted twice daily, at 7:00 a.m. and 4:00 p.m. WITA (Central Indonesian Time). The results of the water quality parameter measurements are presented in Table 3.

Table 3. Results of Water Quality Parameter Measurements at the Study Site

Parameter	Optimal Range	Measurement Results
1. Temperature	28-32 ºC	29-32 ºC
2. Clarity	25-40 cm	25-70 cm
3. Dissolved Oxygen	3-7.5 mg L^{-1}	4.60 – 5.50
4. Salinity	15-25 g L^{-1}	30-35 g L^{-1}
5. Water Color	Brownish green	Green-brown
6. pH	7.5-8	7.5-9.0
7. Ammonia	< 1 mg L^{-1}	0.05 mg L^{-1}

Pond Siphoning

Siphoning is the process of removing waste from the culture medium to maintain and improve water quality. At the study site, siphoning begins when the shrimp reach 40 days of age and then continues routinely once a week. The siphoning process is carried out twice daily, in the morning and evening, using a 3-inch diameter spiral hose. Siphoning is focused around the main drain. The spiral hose is connected directly to the central drain pipe to facilitate the removal of leftover feed, feces, and accumulated silt at the bottom of the pond. Pond bottom siphoning and sludge removal results in a pond bottom free of silt and uneaten feed residue.

Application of Probiotics in Ponds

Probiotics are microorganisms intentionally cultivated in a medium to support stable water quality during cultivation. Probiotics are administered in two ways: by direct application to the water and through feed mixtures. The type of probiotic used in this study was Aerob-BAC (Sintesa Karya, PT.), which contains aerobic bacteria such as *Bacillus* sp., *Pseudomonas* sp., *Nitrobacter* sp., and *Aerobacter* sp.

The probiotic production process at the study site began with the fermentation of a mixture of bacteria and bran. The ingredients used in the fermentation included 150 g of yeast, 75 mL of aerotolerant bacteria (AT-BAK), and 3 kg of bran. The mixture was fermented in a closed container for 24 hours. Bacterial cultures were then carried out in a 1,100 L container, with the addition of 7.5 L of Aerob-BAC, 200 g of sodium, 250 g of Biomax, 125 g of vitamin C, and 250 g of vitamin B complex. Cultures were carried out daily, with preparation beginning one day before application to the culture medium. The probiotics were administered every morning at 7:00 a.m. WITA.

The distribution of probiotics throughout the pond waters is supported by the rotating water current driven by a water wheel. The water wheel also functions to maintain dissolved oxygen levels in the water so that they do not drop below 3.5 ppm. This condition is crucial to ensure the aerobic decomposition of organic matter, thus preventing the production of compounds harmful to the cultivated organisms.

Pest and Disease Management

During the study, cases of Infectious Myonecrosis Virus (IMNV), commonly known as "mio," were discovered. IMNV is a viral agent that has a significant impact on the shrimp farming industry, both in Indonesia and globally. Currently, there is no effective therapy for this viral infection, so the primary approach is prevention.

Pests frequently found at the study site include crabs and birds. Pest prevention measures include installing crab protection devices (CPDs) on pond embankments at a height of 30-40 cm and bird scaring devices (BSDs) at a height of 180 cm.

Shrimp Growth and Population Monitoring

At the study site, shrimp growth monitoring was conducted through sampling activities aimed at evaluating the rate of weight growth and survival rate of shrimp over a specific period. Observed parameters included mean body weight (MBW), which was calculated by dividing the total weight of weighed shrimp by the number of individuals sampled. Meanwhile, average daily growth (ADG) was calculated based on the difference between the final and initial MBW, then divided by the time interval between samplings. The first sampling procedure was conducted when the shrimp were 30 days old.

Sampling was conducted once a week at 7:00 a.m. WITA (Central Indonesian Time). The sampling method involved casting a net from the surface to the bottom of the pond at a single sampling point. The captured shrimp were then placed in a drum before being transferred to a condom net for weighing to obtain average shrimp weight data. Furthermore, the number of shrimp caught was counted and then extrapolated based on the pond area to estimate the total shrimp population within the pond. The sampling data are presented in Table 4.

Table 4. Sampling Data

Date	DOC	MBW (g)	Size (shrimp/kg)	ADG (g)	SR (%)
25 March	47	5.51	173.6	0.123	71
25 March	47	5.72	183.9	0.116	63
25 March	47	5.77	180.4	0.118	63
25 March	47	5.53	195.2	0.109	68
25 March	47	5.64	183.1	0.116	72

Harvesting and Post-Harvest Handling

Shrimp harvesting at the study site was carried out using three methods: partial harvest, total harvest, and emergency harvest. Partial harvest involves removing a portion of the shrimp population from the pond to reduce density and support optimal growth of the remaining shrimp. Total harvest is the method of harvesting the entire shrimp population in the pond, while emergency harvest is carried out in response to disease outbreaks that threaten the continuity of cultivation.

In the partial harvest method, feed is spread at one point in the pond to attract shrimp, then the shrimp are caught using a net cast at that point. The caught shrimp are then placed in drums and transported by vehicle to the sorting room.

The total harvest method begins by turning off all water wheels in the pond to be harvested, followed by pumping out the water to reduce the water level. Harvesters then catch all the shrimp using nets. The netted shrimp are then collected in condom nets, transferred to drums, and then transported to the sorting room.

Post-harvest handling is the final stage in shrimp farming before the product is distributed and marketed. After harvesting, the shrimp are sorted and sized by the collector. This process aims to separate shrimp that meet sales quality standards (fresh size) from those that do not meet the criteria, such as those that are too small (undersized) or have suboptimal physical condition, such as a soft body. The shrimp that meet the criteria are placed in baskets and then weighed.

The weighed shrimp are then transported using trucks equipped with storage boxes filled with ice cubes to maintain product freshness during shipping. The shrimp are arranged evenly in the boxes using a layered method, alternating layers of shrimp and ice cubes in a 1:1 ratio. This strategy aims to maintain a uniformly low temperature so that the shrimp maintain their quality and freshness until they reach their destination.

DISCUSSION

Pond drying aims to accelerate the oxidation of hazardous substances, decompose organic matter in the soil, and decompose dead plankton, making nutrients available for the growth of natural food. It also allows for air exchange within the pond, allowing the mineralization of organic matter to occur. It also eradicates pests and diseases, as well as predatory and competitive wild fish fry (Nur *et al.,* 2021; Iskandar *et al.,* 2022b; Maulinawati *et al.,* 2022).

Applying a hydrogen peroxide (H_2O_2) solution at a concentration of 5 ppm by evenly spraying the solution over the entire surface of the pond embankment walls aims to control the spread of ectoparasites and endoparasites in fish farming activities. Arini et al. (2018) stated that ectoparasite and endoparasite control strategies in fish farming can be implemented through several methods, including the use of methylene blue, sodium chloride (NaCl), formalin, potassium permanganate, malachite green oxalate, furacin, and hydrogen peroxide. Hydrogen peroxide used in aquaculture has the ability to release oxygen when reacting with water, and at concentrations up to 35%, this compound does not negatively impact water quality (Arvin and Pedersen, 2015; Wiyoto *et al.,* 2023). Furthermore, Buchmann (2022) in his publication stated that hydrogen peroxide has the potential as an alternative to formalin in aquaculture practices for pathogen control (Zou *et al.,* 2020). Another advantage of hydrogen peroxide is its more environmentally friendly nature because its degradation products are only water and oxygen (El-hack *et al.,* 2022; Wiyoto *et al.,* 2023).

At the study site, the dose of cupric sulfate used was adjusted to the alkalinity level of the water; the higher the alkalinity, the higher the dose required (Sirois, 1991). In their report, Pradeep et al. (2015) stated that the use of cupric sulfate in shrimp culture water aims to minimize algae growth by inhibiting the photosynthesis process and oxidative phosphorylation in the electron transport chain. The distribution of crustacean active ingredients containing dichlorvos on the second day after the pond was filled with water was to control the presence of crustaceans in the water. According to Erdogan et al. (2007), dichlorvos (2,2-dichlorovinyl dimethyl phosphate; DDVP) is able to kill crustaceans through the mechanism of inhibiting the enzyme acetylcholinesterase (AChE). On the third day, chlorine was sprinkled into the pond water to kill bacteria and other microorganisms that could potentially contaminate the culture medium. Azzahrah & Andi (2014) stated that chlorine also plays a role in oxidizing iron which, if present in high concentrations, can endanger the survival of vaname shrimp.

Biological control of bacterial diseases in shrimp is an alternative technique that is increasingly being implemented in aquaculture (Kurniawan *et al.,* 2021). One approach, according to Usman et al. (2023), is the application of commercial probiotic bacteria, such as Super NB, which has been widely used in grow-out ponds. This type of probiotic not only suppresses the growth of pathogenic bacteria but also plays a role in reducing the risk of disease.

Fry quality standards are a key factor in successful aquaculture. Sanz (2018) reports that good and healthy fry must meet certain requirements, including specific pathogen-free (SPF) and specific pathogen-resistant (SPR) certification issued by a diagnostic laboratory through polymerase chain reaction (PCR) testing. Selection of fry at the study site also followed the standards outlined by Liao & Chien (2011), which required uniform color and size, a complete body without defects, free of pathogens, and a full stomach, as evidenced by a clear, unbroken brown color.

The acclimatization process, as a stage in the distribution of whiteleg shrimp (Vanamelidae) aims to reduce the mortality rate of shrimp fry during and after distribution (Surianti et al. 2024). Shrimp fry distribution is carried out when the environmental temperature is low because shrimp are classified as polykylothermic organisms, meaning their body temperature is affected by environmental temperature (Topuz & Kır, 2023). Based on the results of water quality parameter measurements presented in Table 3, the average water temperature was recorded in the range of 29-32ºC. This value is still within the tolerance limits of whiteleg shrimp life, as reported by Rahmadina et al. (2022), who stated that whiteleg shrimp have an optimal temperature tolerance in the range of 15-33°C. Water temperatures exceeding the optimal limit can increase the toxicity of dissolved substances, which in turn causes increased oxygen demand and metabolic rate. Furthermore, Millard et al. (2021) stated that extreme temperature changes can cause stress in shrimp, which has an impact on increasing susceptibility to disease attacks. Water temperature fluctuations are generally influenced by the intensity of sunlight (Shields, 2019).

At the beginning of stocking, water clarity is around 60–70 cm, while during the maintenance phase, above DOC 30, clarity decreases to around 30–40 cm. Water clarity reflects the level of light penetration and the density of phytoplankton, which play a crucial role in photosynthesis in the culture environment. The appropriate clarity level for supra-intensive whiteleg shrimp cultivation is between 20–39 cm (Iskandar *et al.,* 2022b).

Dissolved oxygen is a crucial parameter in shrimp cultivation because it plays a role in respiration, the process of converting nutrients into energy needed for growth (Jasmin *et al.,* 2022). The average dissolved oxygen content in this study indicates an optimal range of 4.60–5.50. Lack of oxygen can cause stress, increase the risk of disease infection, and even death of cultivated organisms (Millard *et al.,* 2021).

The water salinity at the study site ranged from 30–35 g L^{-1}. Humairah et al. (2024) stated that salinity is the level of salt content in water, which plays a crucial role in the osmoregulation process of aquatic organisms. Adequate salinity is necessary to maintain water balance within the shrimp's body cells, thus supporting smooth metabolic processes (Taqwa *et al.,* 2021). Whiteleg shrimp are euryhaline organisms capable of adapting to a wide range of salinities, with optimal growth rates typically in the range of 15–30 g L^{-1} (Haliman & Adijaya, 2005; Jaffer *et al.,* 2020).

The pH range during cultivation was recorded at 7.5–9.0. This indicates that the water pH is within the optimal tolerance range for whiteleg shrimp cultivation. In reality, water pH also influences appetite and various chemical reactions that occur in the water (Ariadi *et al.,* 2021). A pH concentration in waters that is too low can inhibit the moulting process by causing the exoskeleton tissue to soften, thus reducing shrimp survival (Lemos & Weissman, 2021). According to Fajeri et al. (2020), most aquatic organisms are sensitive to pH changes and generally grow optimally in the pH range of 7.0–8.5. Matching the pH value between the aquatic environment and the physiological needs of the organisms is crucial for optimal shrimp growth (Mansyur *et al.,* 2021).

Ammonia levels are measured periodically to ensure that dissolved ammonia concentrations remain within safe limits and are not toxic to shrimp. In this study, measurements were conducted once a week, with an average ammonia concentration in the pond of 0.05 mg L^{-1}. Supono (2015) stated that ammonia exists in two forms in water: free ammonia (NH_3), which is toxic, and ammonium (NH_4^+), which is generally non-toxic to cultivated organisms. The proportions of these two forms are strongly influenced by water pH and temperature. The tolerance limits for ammonia for whiteleg shrimp are free ammonia <1 mgL^{-1} and ammonium <2 mgL^{-1}.

The study identified an infection with Infectious Myonecrosis Virus (IMNV), commonly known as "mio." This virus is highly pathogenic, with reported mortality rates reaching 40–70% (Kusumaningrum *et al.,* 2012). Haliman & Dian (2006) stated that, to date, there is no effective therapy available to treat this viral infection, so the primary approach is prevention. According to Umiliana (2016), IMNV can infect shrimp from the post-larval stage to the juvenile and adult stages. Shrimp resistance to IMNV infection varies depending on their developmental stage (Manoppo *et al.,* 2011), with juvenile and sub-adult stages reported to be the most susceptible (Munaeni *et al.,* 2023). Infection at these stages can cause a high mortality rate, ranging from 40% to 70% (Kusumaningrum *et al.,* 2012). Meylinda (2021) stated that shrimp aged more than 30 days generally begin to experience a decline in the quality of the pond bottom environment, which contributes to water quality degradation and increases the risk of infection. Clinically, IMNV in whiteleg shrimp is characterized by extensive muscle necrosis, which appears as a white discoloration of the muscle tissue, especially in the dorsal region. This discoloration resembles the appearance of cooked shrimp (Febriani *et al.,* 2013; Umiliana, 2016).

CONCLUSION

In this study, pond preparation included drying, cleaning, and sterilization to remove pathogens and repair the HDPE lining. Fertilization with fermented bran and probiotics supported plankton growth. SPF- and SPR-certified PL-10 shrimp were stocked after acclimatization at a density of 139 individuals/m². Feed was administered in stages, from blind feeding to a rate-feeding system. Water quality was observed to be stable, with clarity decreasing from 60–70 cm to 30–40 cm. This technical management created an optimal environment for the growth and survival of whiteleg shrimp.

Based on the study results, it is recommended to optimize natural fertilization to maintain plankton productivity, monitor water clarity as an indicator of biological activity, and increase the intensity of water quality monitoring to prevent shrimp stress. Evaluation of the feeding system and the use of technologies such as autofeeders should also be considered for efficiency. Furthermore, this management implementation can be replicated in other locations with adjustments to local conditions.

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