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STANDAR OPERASIONAL MANAJEMEN KUALITAS AIR DAN PROSES PEMBENIHAN UDANG VANNAMEI DI PT. ESAPUTLII PRAKARSA UTAMA KABUPATEN BARRU

Operational Standards for Water Quality Management and Vannamei Shrimp Hatchery Process at PT. Esaputlii Main Initiative of Barru Regency

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ABSTRAK

Udang vannamei (Litopenaeus vannamei) merupakan komoditas akuakultur unggulan di Indonesia yang produksinya sangat bergantung pada ketersediaan benur berkualitas. Fase pembenihan (hatchery) merupakan tahap kritis yang menentukan kualitas dan kuantitas benur. Pada fase ini, kualitas air menjadi parameter penting yang secara langsung memengaruhi fisiologi, tingkat kelangsungan hidup (survival rate), dan kesehatan (health rate) larva. Oleh karena itu, penerapan manajemen kualitas air yang komprehensif dan berkelanjutan di unit hatchery menjadi prasyarat utama untuk menghasilkan benur yang unggul. Penelitian ini bertujuan untuk menganalisis teknik manajemen kualitas air dalam produksi larva udang vaname (Litopenaeus vannamei) di PT. Esaputlii Prakarsa Utama, Kabupaten Barru. Fokusnya pada praktik sanitasi wadah, pengelolaan sumber air, pemantauan parameter kunci, dan teknik operasional yang diterapkan. Penelitian ini menggunakan pendekatan kualitatif deskriptif dengan metode observasi partisipatif dan pengukuran langsung selama 4 bulan (Februari - Mei 2025). Data kualitas air dianalisis secara statistik deskriptif untuk mengevaluasi korelasi antara parameter kunci dengan kinerja biologis larva. Implementasi manajemen kualitas air yang mencakup sanitasi ketat (100 ppm kaporit), sumber air terkontrol (salinitas 30-33 ppt), dan pemantauan rutin berhasil mempertahankan parameter dalam kisaran optimal: suhu 31-34°C, salinitas 30-32 g/L, pH 8.1-8.5, dan alkalinitas 128-152 mg/L. Kinerja biologis larva yang dihasilkan menunjukkan nilai yang tinggi dan stabil, ditandai dengan tingkat penetasan telur (Hatching Rate) mencapai 85-90%, serta tingkat kelangsungan hidup (Survival Rate) yang terjaga pada setiap stadia, yaitu Nauplius (90%), Zoea (85%), Mysis (80%), dan Post-Larva (75%). Selain itu, tingkat kesehatan (Health Rate) larva juga konsisten di atas 87,5% pada semua stadia, dengan prevalensi abnormalitas dan infeksi Vibrio spp. yang rendah, mengindikasikan lingkungan budidaya yang stabil dan mendukung. Konsistensi parameter kualitas air dalam kisaran optimal, yang diwujudkan melalui manajemen yang komprehensif, berbanding lurus dengan peningkatan kinerja biologis larva, yang tercermin dari tingginya hatching rate, survival rate, health rate. Penerapan praktik serupa pada hatchery skala kecil diharapkan dapat meningkatkan kualitas dan kuantitas produksi benur.

ABSTRACT

Whiteleg shrimp (*Litopenaeus vannamei*) is a leading aquaculture commodity in Indonesia whose production is highly dependent on the availability of quality fry. The hatchery phase is a critical stage that determines the quality and quantity of fry. In this phase, water quality is an important parameter that directly affects the physiology, survival rate, and health of larvae. Therefore, the implementation of comprehensive and sustainable water quality management in the hatchery unit is a primary prerequisite for producing superior fry. This study aims to analyze water quality management techniques in the production of whiteleg shrimp (Litopenaeus vannamei) larvae at PT. Esaputlii Prakarsa Utama, Barru Regency. The focus is on container sanitation practices, water source management, monitoring of key parameters, and operational techniques applied. This study uses a descriptive qualitative approach with participatory observation methods and direct measurements for 4 months (February - May 2025). Water quality data are analyzed using descriptive statistics to evaluate the correlation between key parameters and the biological performance of larvae. The implementation of water quality management including strict sanitation (100 ppm chlorine), controlled water sources (salinity 30-33 ppt), and regular monitoring successfully maintained parameters within the optimal range: temperature 31-34°C, salinity 30-32 g/L, pH 8.1-8.5, and alkalinity 128-152 mg/L. The biological performance of the larvae produced showed high and stable values, marked by an egg hatching rate of 85-90%, as well as a maintained survival rate at each stage, namely Nauplius (90%), Zoea (85%), Mysis (80%), and Post-Larva (75%). In addition, the health rate of the larvae was also consistently above 87.5% at all stages, with a low prevalence of abnormalities and Vibrio spp. infections, indicating a stable and supportive cultivation environment. Consistent water quality parameters within the optimal range, achieved through comprehensive management, are directly proportional to improved larval biological performance, as reflected in high hatching rates, survival rates, and health rates. Implementing similar practices in small-scale hatcheries is expected to improve the quality and quantity of larval fry production.

Kata Kunci	*Kabupaten Barru, Kualitas Air, PT. Esaputlii Prakarsa Utama, Pembudidaya Skala Kecil, Udang Vannamei*
Keywords	*Barru Regency, Water Quality, PT. Esaputlii Prakarsa Utama, Small-Scale Cultivators, Vannamei Shrimp*
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INTRODUCTION

The whiteleg shrimp (Litopenaeus vannamei) is a native species of Central American waters and several Central and South American countries, such as Ecuador, Venezuela, Panama, and Brazil (Fajar Ramadani et al., 2023; Nugraha et al., 2022). In Indonesia, East Java Province became the initial center for whiteleg shrimp development. Zamroni et al. (2021) revealed that it was an alternative substitute for Penaeus monodon shrimp, which at that time experienced declining and failed production due to technical and non-technical factors. The contribution of whiteleg shrimp exports from East Java has an impact on the national economy, such as increasing foreign exchange, creating jobs, and growing supporting sectors. However, Indonesia must also adapt to global market dynamics and maintain competitiveness to maintain its position as a major player in the whiteleg shrimp trade (Endah Dwi Putri Hapsari & Nurhayati, 2023). Vannamei shrimp is recognized as a superior variety (Farabi & Latuconsina, 2023; Sa'adah, 2025) due to its numerous advantages, including disease resistance, high environmental adaptability, rapid growth (Nanga Se et al., 2023), and responsiveness to feed (Jelinda et al., 2024). Therefore, the availability of high-quality seed, both genetically and morphologically, is a determining factor in successful cultivation. These superior morphological characteristics include good larval development and superior morphological traits (Rasuliyanasari & Diniariwisan, 2024a).

The shrimp farming industry is a leading sector in aquaculture in Indonesia, playing a vital role in supporting food security, job creation, and increasing fishery exports (Mazidatul Qonita et al., 2024; Shafa Khairunisaa et al., 2024). A critical factor in the sustainability of this industry is the availability of high-quality shrimp larvae (post-larvae) from hatcheries. The production of healthy, uniform fry with a high survival rate is significantly influenced by water quality management implemented in hatcheries (Lestari et al., 2022; Weda Yanti et al., 2023).

Water quality is an environmental parameter that directly affects the physiology, survival rate, and health of whiteleg shrimp larvae in hatcheries (Adriant et al., 2025). Parameters such as temperature, salinity, pH, dissolved oxygen (DO), ammonia, and nitrite must be maintained within optimal ranges to support the metamorphosis process from the nauplius to the post-larva (PL) stages (Kurniaji et al., 2023). For example, temperature and pH fluctuations outside the optimal range can disrupt the molting process and digestive enzyme activity in larvae, leading to decreased SR and HR (Maknun & Sumsanto, 2023b). These inappropriate conditions can lead to chronic stress, decreased appetite, metabolic disorders, and even mass mortality of larvae. Unfortunately, many hatcheries in Indonesia still lack an integrated and sustainable water quality monitoring system.

PT. Esaputlii Prakarsa Utama is a vannamei shrimp (Litopenaeus vannamei) hatchery located in Barru Regency, South Sulawesi. As a private hatchery operating for over five years, the company has a large enough fry production capacity to meet the demand of both local and international farmers. Therefore, the implementation of a comprehensive, accurate, and sustainable water quality management system at PT. Esaputlii Prakarsa Utama is essential. This system includes routine and periodic monitoring of water parameters using calibrated equipment, proper water exchange protocols, filtration system management, feeding control to minimize the accumulation of metabolite residues, and responsible management of aquaculture waste. Good management not only increases the productivity and efficiency of fry production in the hatchery itself but also has a positive ripple effect for downstream shrimp farmers who are its customers. Healthy, high-quality fry are fundamental to successful grow-out cultivation. Based on this, the purpose of this study was to determine the techniques used in handling vannamei shrimp fry at PT. Esaputlii Prakarsa Utama, especially water quality management.

METHODS

Time and Location

The research activities were conducted over a four-month period, from February to May 2025, at PT. Esaputlii Prakarsa Utama, Barru Regency, South Sulawesi Province.

Data Collection Method

This research adopted a qualitative research method with a descriptive approach. This approach involved the following data collection techniques:

a. Direct participation in the activities regarding the stages of the water quality process implemented in the whiteleg shrimp (Litopenaeus vannamei) larval rearing unit at PT. Esaputlii Prakarsa Utama.
b. Observations and sampling at the PT. Esaputlii Prakarsa Utama site. Observations were conducted in the production unit, which consists of three broodstock rearing tanks (each unit containing four concrete tanks), eight egg hatching tanks, and several concrete larval rearing tanks measuring 4 m x 4 m x 1.5 m. Water quality parameters were measured routinely with daily replications throughout the rearing period. In the larval tank, measurements were taken daily for each developmental stage (Nauplius, Zoea, Mysis, and Post-Larva). Water quality sampling was carried out at two fixed times, namely 06.00 WITA (morning) and 14.00 WITA (afternoon). Temperature measurements were carried out at both times, while salinity, pH, and alkalinity parameters were measured once a day in the morning (06.00 WITA). Dissolved oxygen (DO) monitoring was also carried out once a day in the morning using a DO meter. This sampling time was intended to capture fluctuations in key parameters such as temperature and pH due to the influence of sunlight and daily operational activities. Water quality measurements used a set of calibrated instruments, namely: a pH meter (model Hanna HI98107), a DO meter (model Lutron DO-5510), and a refractometer (model Atago Master-S/Millα). The pH and DO meters were calibrated before daily use with standard buffer solutions (pH 4, 7, and 10) and sodium sulfite solution (for zero DO), according to the instruction manual. Alkalinity measurements were performed using a titration method with methyl orange indicator (APHA 2320 B method). All instruments underwent periodic calibration verification every three months by the laboratory to ensure the accuracy of the measurement results.

Data Analysis

Water quality data were analyzed using descriptive statistics to calculate the mean, standard deviation, and range (minimum-maximum) for each parameter per larval stage. Additionally, a simple Pearson correlation analysis was performed to evaluate the relationship between key parameters (such as afternoon temperature) and the larval Survival Rate (SR) or Health Rate (HR). A difference-of-means test (such as an independent t-test) can also be used to compare water quality performance between tanks or between treatment groups, if necessary.

This research was conducted after obtaining approval from the management of PT. Esaputlii Prakarsa Utama. All field activities implemented strict biosecurity protocols, including footwear disinfection, hand washing, and restricted access to production areas. Personnel safety was ensured by the use of personal protective equipment (PPE), such as gloves and boots, when in contact with water or chemicals. All observations, measurements, and interviews were documented in writing and visually.

Research Flowchart

Figure 1. Research Flowchart

RESULT AND DISCUSSION

The stages of water quality management research for vannamei shrimp production at PT. Esaputlii Prakarsa Utama, Barru Regency, are divided into two stages: 1) container preparation; 2) media preparation; 3) broodstock maintenance; 4) egg hatching; 5) broodstock water quality management; 6) larval rearing water quality monitoring; 7) larval media water changes.

1. Container Preparation

PT. Esaputlii Prakarsa Utama uses a container for producing vannamei shrimp larvae consisting of a broodstock rearing tank, including a broodstock rearing and maturation tank, an egg-laying and hatching tank, a larval rearing tank, and an algae culture tank (Cahyanurani and Anin Ariska Dowansiba et al., 2022).

a. Rearing and Maturation Tanks

PT. Esaputlii Prakarsa Utama has three broodstock rooms. Each broodstock unit has three broodstock rearing and maturation rooms, each with four circular concrete tanks used for broodstock rearing. The broodstock rearing tanks used at PT. The Esaputlii is a concrete tank with a diameter of 5 meters and a water level of 0.8 meters, coated with black paint. It is equipped with three inlets: an aeration channel installed around the perimeter of the tank, a seawater channel, a freshwater channel, and an outlet channel located in the center of the tank.

Preparation of the maintenance tank includes washing the tank with detergent and freshwater, scrubbing with a moistened scouring pad to remove any remaining dirt stuck to the tank walls and bottom. Then, it is rinsed with freshwater. Next, chlorine is added at a dose of 100 ppm and rinsed with freshwater until clean to remove any dirt and allow the rinsing water to dry. The maintenance tank is then filled with seawater from a reservoir to a height of 50 cm.

Figure 1. Maintenance Tank

b. Egg Spawning and Hatching Tanks

Egg hatching is carried out using rectangular concrete tanks measuring 5 m x 2 m x 1.5 m, with a total of 8 tanks per unit. Spawning tanks are cleaned by scrubbing the walls and bottom with a scouring pad moistened with detergent, then rinsing with fresh water until clean. Next, chlorine is added at a dose of 100 ppm and rinsed with fresh water until clean to remove any dirt.

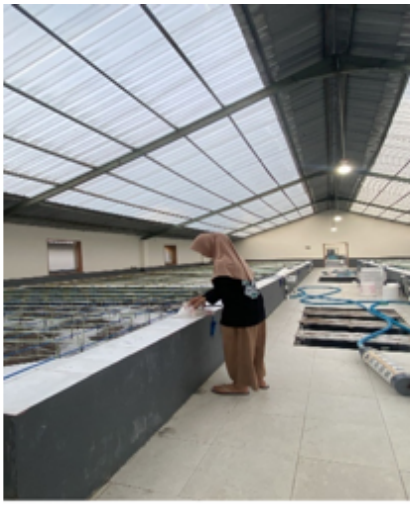

Figure 2. Egg laying and hatching tank

c. Larval Rearing Tank

The larval rearing process uses a rectangular concrete tank measuring 4 m x 4 m x 1.5 m with a capacity of 15 m^3 and constructed of concrete. The tank is designed to be blunt to avoid dead spots. The walls of the tank are painted white to reflect light, adapting to the positive phototaxis characteristics of white shrimp larvae. Container preparation includes sanitizing the tank, covering it with plastic, and sanitizing the airstone. Tank sanitization is carried out by spraying chlorine into the tank and aeration hose, then dissolving detergent and washing the tank walls, bottom, and aeration hose using a scouring pad. The washed tank is then rinsed with fresh water until clean. Tank sanitization is carried out by rinsing the tank and aeration hose with 500 L of fresh water mixed with 100 ppm chlorine. Airstone sanitization is carried out by removing all airstones from the aeration hose, soaking them in HCl solution for 24 hours, rinsing them with fresh water, and drying them. The plastic tub cover is cleaned with fresh water by scrubbing it thoroughly, then drying it. Next, reinstall the stones and lead weights. Rinse the tub with fresh water and fill it with 10 m^3 of seawater for maintenance.

Figure 3. Larva maintenance tank

d. Natural Feed Culture Tank

Thalassiosira sp.'s natural feed culture tanks range from small, fiber-constructed tanks with a capacity of 1-2 m^3 for intermediate cultures to rectangular, concrete-constructed tanks with an optimal capacity of 10 m^3. The corners of the tanks are rounded to avoid dead spots. Cleaning the natural feed tanks involves cleaning the walls and bottom by brushing with a scouring pad moistened with detergent, then rinsing with fresh water until clean.

Figure 4. Natural Feed Culture Tank

2. Media Preparation

PT. Esaputlii Prakarsa Utama uses both seawater and freshwater. Seawater is used for broodstock rearing, larval rearing, and natural feed culture, while freshwater is used for sterilizing equipment, sterilizing containers, and reducing salinity (Ghufron et al., 2017; Scabra et al., 2021). The seawater and freshwater supply systems at PT. The Esaputlii Prakarsa Utama project is as follows:

a. Seawater

The seawater used comes from the Makassar Strait. Seawater is drawn using two centrifugal pumps connected by 4-inch diameter PVC (Poly Vinyl Chloride) pipes, 100 meters long. The ends of the pipes are wrapped with activated carbon, a 25 cm thick shell charcoal, and a depth of 10 meters. The seawater used has a temperature of 27°-30°C, a salinity of 30-33 ppt, a pH of 7-8.3, and an alkalinity of 120-150.

b. Freshwater

The freshwater used comes from a drilled well in the Jalange area, 1 km from PT. Esaputlii Prakarsa Utama Barru. The water is pumped using a submersible pump to a depth of 70 m.

3. Broodstock Maintenance

Water quality management in the broodstock tank is carried out using a flow-through system, where water flows simultaneously (intake and discharge). To maintain water quality, water circulation is carried out once a day, in the morning at 6:30 a.m. WITA (Central Indonesian Time). The tank is also cleaned by scrubbing the walls and bottom of the tank with a scouring pad. In addition to water quality management, water quality is also monitored to ensure compliance with company standards.

Figure 5. Broodstock Maintenance Tank Cleaning Process

4. Broodstock Spawning

The spawning process for whiteleg shrimp broodstock at PT. Esaputlii Prakarsa Utama is carried out after sampling at 6:30 a.m. WITA. Selection of mature or gonad-matured broodstock is carried out after circulation or until the broodstock tank volume remains at 20%. This is done by removing mature broodstock using a scoop and flashlight to determine gonad maturity (each scoop contains one broodstock). A mature female broodstock is characterized by a golden yellow color from the back of the shrimp to the base of the tail. The mature female broodstock were transferred into the male broodstock tank, and each transferred female was counted to facilitate the inspection of fertilized females. The spawning process was carried out by the male swimming behind the female, following the female. Then, he aligned his body opposite the female's body to release sperm attached to the female's thellicum. The mating process took place for approximately 7 hours in calm conditions. Next, a check (sampling of mated broodstock) was carried out. The selection check for mated broodstock was carried out at 1:30 PM WITA. Mature female broodstock were identified by the presence of spermatophores on the thellicum. The mature broodstock were removed and placed in buckets containing 5-7 liters of water with a maximum of 2 broodstock per bucket. They were then transferred to a 1.5 m x 1.5 m x 1 m net installed at the edge of the egg hatching tank. Meanwhile, unfertilized female broodstock were returned to the female broodstock maintenance tank.

Figure 6. Broodstock Spawning Process

5. Egg Hatching

The optimal temperature for the egg hatching process is 29-32°C. Egg hatching was performed by checking the eggs at 8:00 PM WITA (Central Indonesian Time) and transferring the female back to the rearing tank. A broodstock that had released its eggs was identified by the absence of golden-yellow eggs on its dorsal abdomen. During the hatching process, the eggs were stirred using strong aeration and manually using a modified long pipe with a perforated board. The purpose of stirring was to keep the eggs floating and prevent them from accumulating at the bottom of the tank, thus promoting hatching.

Egg sampling was carried out at 6:00 AM WITA (Central Indonesian Time) before the eggs hatched using a sampling method. Six 250 ml samples were taken from six beakers. A manual count was then performed by gradually pouring the sample water into a Petri dish. To facilitate counting, the dish was covered with black plastic to ensure the eggs were clearly visible, and then counted. The results from the six samples were averaged, and the total number of eggs (fecundity) was calculated. Egg sampling is also useful for estimating the population and determining the quality or degree of fertilization (Fertility Rate). Fertilized egg development is observed after counting eggs using a 4x10 magnification microscope.

Figure 7. Egg sampling observation process

6. Broodstock Water Quality Management

During broodstock maintenance, water quality measurements are carried out, including temperature ranging from 28-29°C, pH 7-8, salinity 31-32 mg/l, and DO 6-7 mg/l. Standard temperature parameters for broodstock maintenance are 28-33°C, pH 7.0-8.5, salinity 30-34 mg/l, and DO (Dissolved Oxygen) >4 mg/l. During maintenance, daily siphoning is performed to remove leftover feed, feces, and moulting shrimp shells, as leftover feed can contaminate the rearing medium (Iskandar et al., 2022). Water quality management also involves a flow-through process, or continuous water circulation, at 200–300% per day.

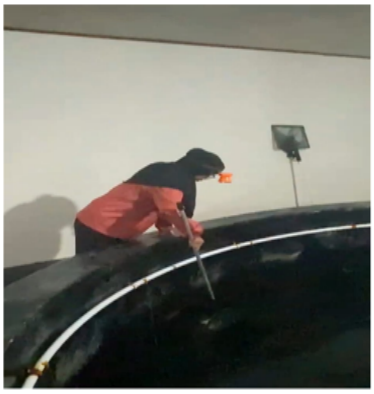

Figure 8. Siphoning process

7. Water Quality Monitoring for Larval Maintenance

Water quality monitoring during larval rearing involves monitoring water quality parameters. These parameters include temperature, salinity, pH, and alkalinity (Maknun & Sumsanto, 2023a).

a. Temperature

Temperature measurements were taken twice daily, at 6:00 AM and 2:00 PM WITA. The instrument used for this measurement was a thermometer. The temperature measurements during the experiment ranged from 31–32.5°C at 7:00 AM WITA, and between 33–34°C at 2:00 PM WITA. These temperature spikes are strongly suspected to be influenced by direct solar radiation and heat accumulation from operational activities in the rearing room. Temperatures exceeding the optimal range (31–32°C) have the potential to cause physiological stress in larvae, increase metabolic rate, and reduce appetite and feed efficiency. To anticipate these negative impacts, PT. Esaputlii Prakarsa Utama implemented several corrective measures based on real-time conditions. One of these measures was increasing aeration intensity to improve dissolved oxygen levels and facilitate cooling through surface water evaporation. Furthermore, shading nets were installed over the tanks to reduce exposure to direct solar radiation. Under certain conditions, particularly when temperatures tended to be consistently high, the flowthrough water volume was increased to accelerate water changes and stabilize the temperature of the rearing medium. These measures proved effective in preventing extreme temperature fluctuations and maintaining optimal environmental conditions for larval development, particularly in the Zoea and Mysis stages, which are vulnerable to temperature changes.

b. Salinity

Salinity measurements were conducted once daily at 6:00 a.m. WITA (Central Indonesian Time). The instrument used for this parameter was a hand refractometer. The results of salinity measurements during the experiment ranged from 30–32 g/L.

c. pH

pH measurements were conducted once daily at 6:00 a.m. WITA (Central Indonesian Time). The instrument used for this measurement was a pH scanner. The pH measurement results during the experiment ranged from 8.1 to 8.5.

d. Alkalinity

Alkalinity measurements were conducted once daily, at 7:00 a.m. WITA (Central Indonesian Time) at the Nauplii to Zoea 3 stages. The lowest alkalinity value was 128 mg/L, while the highest was 152 mg/L. This increase in alkalinity acts as a pH buffer, preventing fluctuations. During larval rearing, alkalinity values tended to increase, from 128 mg/L to 152 mg/L. This increase in alkalinity plays a crucial role as a buffer, stabilizing pH fluctuations in the rearing medium. In the context of larviculture, pH stability is a determining factor for two fundamental physiological processes in shrimp larvae: molting and digestive enzyme activity. A stable pH ensures optimal decomposition and exoskeleton formation during the molting cycle. Sharp pH fluctuations can disrupt osmotic balance and inhibit the activity of the chitinase enzyme, which is essential for shedding old skin, potentially leading to incomplete molting and death (Inayah et al., 2023). Furthermore, larval digestive enzymes, such as protease and amylase, operate within specific pH ranges. pH stability maintained by adequate alkalinity allows these enzymes to function efficiently in digesting natural feeds (such as microalgae) and artificial feeds, ultimately supporting growth and survival rates. Thus, a controlled upward trend in alkalinity is not only an indicator of good water quality but also actively contributes to successful larval development by creating a stable physiological environment for their critical growth processes (Rasuliyanasari & Diniariwisan, 2024b). Complete water quality data can be seen in Table 1.

Table 1. Water Quality for Vannamei Shrimp Larvae

Parameters	Nauplius Stage	Zoea Stage	Mysis Stage	Post Larva Stage
Suhu Pagi (°C)	31.2 ± 0.3	31.8 ± 0.3	32.0 ± 0.3	32.2 ± 0.3
Suhu Sore (°C)	33.2 ± 0.4	33.5 ± 0.4	33.8 ± 0.4	34.0 ± 0.4
Salinitas (g/l)	30.8 ± 0.5	31.0 ± 0.5	31.5 ± 0.5	32.0 ± 0.5
pH	8.2 ± 0.1	8.3 ± 0.1	8.4 ± 0.1	8.5 ± 0.1
Alkalinitas (mg/l)	128 ± 04	136 ± 6	144 ± 5	152 ± 4

Source: Processed Primary Data (2025)

Based on Table 1, it can be seen that water quality at each stage of white shrimp larval development at PT. Esaputlii Prakarsa Utama is maintained within the optimal range. Temperature, salinity, pH, alkalinity, and dissolved oxygen values show good consistency throughout larval development from the Nauplius to the Post-Larva stage. The gradual increase in alkalinity from the Nauplius to the Post-Larva stage (from 128 mg/L to 152 mg/L) plays a crucial role in stabilizing pH fluctuations, especially during the day. Furthermore, water exchange techniques tailored to the larval stage (10–30%)

contribute to maintaining the quality of the rearing medium from excess metabolite accumulation. Daily trends in temperature, salinity, pH, and alkalinity can be seen in Figure 10.

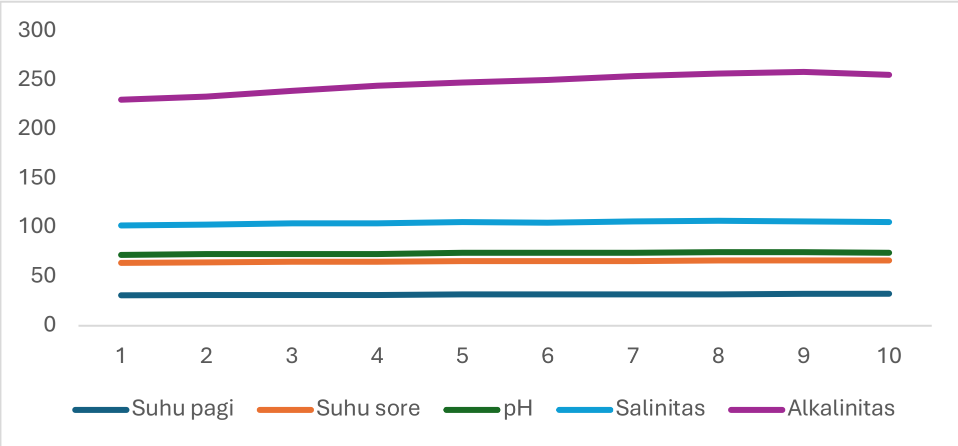

Figure 10. Daily Trends in Temperature, Salinity, pH, and Alkalinity

Based on the diagram above, it can be seen that water quality management at PT. The Esaputlii Main Initiative has successfully maintained key parameters within optimal and stable ranges, which are crucial for high larval survival and health rates. Stability of these parameters, particularly pH supported by adequate alkalinity, is crucial for reducing metabolic stress in larvae. Larval survival and health rates are shown in Table 2.

Table 2. Lava Survival and Health Rates

Larvae Stage	Average HR (%)	Average SR (%)	n
Nauplius	95.0 ± 1.0	90.0 ± 2.0	6
Zoea	92.5 ± 1.5	85.0 ± 2.5	6
Mysis	90.0 ± 2.0	80.0 ± 3.0	6
Post Larvae	87.5 ± 2.5	75.0 ± 3.5	6

Source: Processed Primary Data (2025)

Description:
HR : Health Rate
SR : Survival Rate
N : Number of tank samples observed for each stage

Based on Table 2, the HR and SR values are relatively stable and remain within a good range for each stage. This is indicated by the relatively small standard deviations and is supported by strict and consistent water quality management practices at PT. Esaputlii Prakarsa Utama. Regular monitoring and gradual water changes (10-30%) have successfully minimized fluctuations in environmental conditions that can cause significant stress to the larvae. Alkalinity, which tends to increase during rearing (128-152 mg/L), also plays a crucial role as a buffer, stabilizing the pH, thus supporting the physiological processes of the larvae.

8. Water Changes in Larval Rearing Media

These water changes are carried out to improve water quality due to the loss of feces and potentially toxic feed residues (Yunarty et al., 2022). In addition to routinely measured parameters such as temperature, salinity, pH, and alkalinity, there are three other critical parameters in water quality management: Total Ammonia Nitrogen (TAN), nitrite (NO_2^-), and Dissolved Oxygen (DO). TAN, which consists of ionized ammonia (NH_4^+) and non-ionized ammonia (NH_3), is toxic to shrimp larvae, especially in the form of NH_3. The safe threshold for TAN for white shrimp is below 0.1 mg/L, while nitrite (NO_2^-) must be maintained below 0.5 mg/L (Suryanti et al., 2019). Nitrite can interfere with the blood's ability to bind oxygen, causing methemoglobinemia, which is fatal for larvae (Hastuti et al., 2024). The accumulation of TAN and NO_2^- can occur due to the decomposition of leftover feed, feces, and biomass, which increases as larvae develop (Supono, 2017). Therefore, regular water changes are a key strategy to prevent the accumulation of these toxic nitrogen compounds. Dissolved oxygen (DO) is a vital parameter affecting larval metabolism, growth, and survival. The optimal DO level for rearing whiteleg shrimp larvae is ≥5 mg/L. Low DO can cause stress, decreased appetite, and increased susceptibility to disease (Cahyanurani and Anin Ariska Dowansiba et al., 2022). In intensive culture systems, DO can decrease due to oxygen consumption by larvae, microorganisms, and the decomposition of organic matter. Daily DO measurements in the morning at PT. Esaputlii Prakarsa Utama indicate values within the safe range, but DO fluctuations can occur during the day or night due to biological activity and phytoplankton photosynthesis. Therefore, intensive aeration and partial water changes are essential to maintain stable DO levels. Water changes are performed every morning before feeding, with the percentage of water changes when the larvae enter the PL2-PL4 stages of water changes being 10-20%. After the larvae enter the PL 5 stage, water changes are carried out up to 30% according to water conditions. The increase in the percentage of water changes to 30% at the Post-Larva (PL) 5 stage and beyond is based on considerations of metabolic load, feeding rate, and biomass accumulation. At stages PL≥5, shrimp have entered an active growth phase with a high metabolic rate, resulting in more nitrogenous waste (ammonia and nitrite) and leftover feed. The increased feeding rate with increasing body size also contributes to the decline in water quality. Water changes of 20-30% can dilute the concentration of toxic compounds, reduce suspended organic matter, and provide a stable environment to support the growth and survival of the fry. In addition, gradual water changes also minimize osmotic stress on larvae, which are still vulnerable to drastic environmental changes. Click or tap here to enter text.

CONCLUSION AND SUGESSTIONS

Conclusion

The implementation of comprehensive and sustainable water quality management is a key factor in the success of whiteleg shrimp (Litopenaeus vannamei) fry production at PT. Esaputlii Prakarsa Utama, Barru Regency. This strictly and consistently implemented management system encompasses several key pillars. First, rigorous sanitation protocols and container preparation, such as the use of 100 ppm chlorine for all tank types, successfully create a sterile initial environment free of pathogens. Second, controlled management of water sources, both seawater (salinity 30-33 ppt) and freshwater, ensures the availability of high-quality and consistent culture media. Third, routine and systematic monitoring of water quality parameters—

including temperature (31-34°C), salinity (30-32 g/L), pH (8.1-8.5), and alkalinity (128-152 mg/L)—has been proven to maintain the stability of the culture environment. This success is reflected in the excellent biological performance of the larvae, characterized by an Egg Hatch Rate (HR) of 85-90%, as well as high and stable Survival Rates (SR) and Health Levels (HR) at each developmental stage (Nauplius to Post-Larva). Gradual increases in alkalinity play a crucial role as a buffer that stabilizes pH, thus supporting critical larval physiological processes such as molting and digestive enzyme activity. Furthermore, specific operational techniques such as a flow-through system in the brood tank and gradual water changes (10-30%) in the larval tank are effective in controlling the accumulation of toxic metabolites such as ammonia and nitrite.

Recommendations

Regular monitoring of parameters such as Total Ammonia Nitrogen (TAN) and Nitrite (NO_2^-) is recommended as part of the standard protocol. Although water changes are effective, quantitative data on TAN and nitrite will provide important information on toxin accumulation and allow for more precise corrective actions, thereby further improving the Survival Rate, particularly in the final stages.

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