

Ammonia and Nitrite Control Techniques in Vannamei Shrimp Cultivation Media at PT. Panen Berkah Sejahtera Bersama (PBSB) Sambelia, East Lombok

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ABSTRACT

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Intensive cultivation of vannamei shrimp (*Litopenaeus vannamei*) requires good water quality management to support the growth, health, and survival of the shrimp. This research was conducted at PT. Panen Berkah Sejahtera Bersama (PBSB), East Lombok, for 25 days (April 9–May 3, 2025) with the aim of determining the control techniques for ammonia (NH₃) and nitrite (NO₂) in the cultivation media. The method used was descriptive with primary data collection through observation, active participation, interviews, and field documentation, as well as secondary data from company archives and related literature. The water quality management techniques applied included siphoning the pond bottom, waste disposal through a central drain system, and the use of Aquastar Pond probiotics. The water quality parameters observed included ammonia, nitrite, dissolved oxygen (DO), salinity, and pH. The results showed that ammonia levels were stable at 0.0000 mg/L and nitrite was in the range of 0.007–0.059 mg/L, remaining within safe limits for whiteleg shrimp. DO, salinity, and pH parameters were also within optimal ranges, supporting metabolism, osmoregulatory balance, and nitrifying microbial activity. The application of siphoning techniques, waste disposal, and probiotics has proven effective in maintaining stable water quality and creating optimal cultivation conditions for the growth and health of vannamei shrimp.

INTRODUCTION

As a maritime nation, Indonesia has enormous potential for marine, freshwater, and brackish water resources. Fisheries cultivation is a strategic sector for meeting the need for animal protein while simultaneously boosting the local economy. Increasing domestic and export market demand makes the aquaculture sector a promising prospect. One of the leading commodities widely cultivated is the whiteleg shrimp (*Litopenaeus vannamei*). This commodity boasts several advantages, including rapid growth, a high survival rate, a relatively short rearing period (90–100 days per cycle), and tolerance to various environmental conditions (Purnamasari *et al.*, 2017). National shrimp production in 2019–2020 was recorded

at 856,753 tons and is targeted to increase to 2 million tons per year by 2024 (KKP, 2021). This situation encourages farmers to increase production through intensive systems (Yunarty *et al.*, 2022).

The demand for high-quality shrimp fry is increasing, while hatchery production still faces the challenge of high mortality due to declining water quality (Dowansiba, 2022). During the grow-out phase, water quality is a crucial factor in determining the success of shrimp farming. Stable water conditions support shrimp growth and health, while declining quality can trigger stress, reduce growth, and even lead to death (Fahrudin *et al.*, 2023). The main problem in intensive farming systems is the accumulation of feed and fecal waste, which triggers an increase in ammonia ($\text{NH}_3/\text{NH}_4^+$) and nitrite (NO_2^-) in the pond. Both of these compounds are toxic, can disrupt metabolism, reduce immunity, and inhibit shrimp growth (Jumraeni *et al.*, 2020; Cahyono *et al.*, 2023). An imbalance in the nitrification process can also lead to dangerous levels of nitrite accumulation (Balubi *et al.*, 2020).

Various previous studies have demonstrated the effectiveness of water quality management techniques. Research by Gompi *et al.* (2023) reported that siphoning is a crucial factor in the success of vannamei shrimp cultivation. This activity aims to remove sediment from the bottom of the pond using a flexible suction hose. Kusmiatun *et al.* (2022) added that probiotics are microbes that can be introduced into the cultivation environment to improve environmental quality by decomposing organic matter and increasing feed digestibility in the digestive tract. Lusiana *et al.* (2021) noted that the use of a water wheel can collect waste and leftover feed in the center, allowing it to be disposed of or removed through a central drain system, simplifying the siphoning process. Akbarurrasyid *et al.* (2024) added that cultivation water treatments such as siphoning, water changes, and the use of probiotics are efforts to create optimal water quality conditions to support the growth of *Litopenaeus vannamei*.

Therefore, water quality management through a combination of siphoning, central draining, and probiotic application is crucial for successful vannamei shrimp cultivation. Based on this, this field research was conducted at PT. Panen Berkah Sejahtera Bersama in East Lombok to directly study ammonia and nitrite control techniques in vannamei shrimp cultivation media.

METHODS

This research was conducted for 25 days, from April 9 to May 3, 2025, at PT. Panen Berkah Sejahtera Bersama (PBSB) in Dadap Village, Sambelia District, East Lombok Regency. This location was chosen because it has an intensive vannamei shrimp cultivation system that implements modern and integrated water quality control techniques. The method used was descriptive. According to Martias (2021), descriptive methods are a statistical method related to data collection and presentation, thereby providing useful information. The data collected consisted of primary and secondary data (Sari & Zafri, 2019). Primary data were obtained through direct observation of cultivation activities, interviews with technicians and field staff, active participation in daily activities, and documentation of field activities. Secondary data were obtained from company archives, previous cultivation reports, SNI standards, and other literature relevant to vannamei shrimp cultivation. The tools used in this activity include stationery, large and small flasks, 1 liter sample bottles, mobile phones, waterwheels, condoms (shrimp filtering tools during siphoning), central and outlet pipes (6–8 inches), plastic, rafts, spiral hoses, and materials used include sea water as a living medium for shrimp and probiotics as organic waste decomposers in the pond, as well as water quality measuring tools, namely:

- DO meter to measure dissolved oxygen levels,
- pH meter to measure the acidity level of water,
- Refractometer for measuring salinity,
- Spectrophotometer for ammonia and nitrite analysis.

Data analysis was carried out descriptively by describing water quality management activities such as siphoning techniques, waste disposal, use of probiotics, and monitoring of water quality parameters.

- The siphoning technique is to remove leftover feed, feces, and organic waste that settles at the bottom of the pond so that it does not decompose into ammonia and nitrite.
- Waste Disposal Technique (Central Drain System) is to remove dirty water containing organic and inorganic waste so that the water quality remains stable.

The use of probiotics is to utilize good microorganisms to accelerate the decomposition of organic materials, suppress the growth of pathogenic bacteria and balance the water ecosystem.

RESULTS

Table 1. Water Quality Results (Ammonia, Nitrite, Salinity, DO, pH)

Date/Month /Year	Pool	Ammonia	Nitrite	Salinity	DO		pH	
					M	E	M	A
09/04/2025	C18B	0.0000 mg/L	0.012 mg/L	34 ppt	4.95 mg/L	5.22 mg/L	8.1	8.3
12/04/2025	C18B	0.0000 mg/L	0.007 mg/L	35 ppt	4.89 mg/L	4.70 mg/L	8.2	8.4
04/16/2025	C18B	0.0000 mg/L	0.024 mg/L	35 ppt	4.78 mg/L	4.94 mg/L	8.1	8.3
04/19/2025	C18B	0.0000 mg/L	0.059 mg/L	36 ppt	5.00 mg/L	4.94 mg/L	8.1	8.3
04/23/2025	C18B	0.0000 mg/L	0.021 mg/L	35 ppt	5.22 mg/L	5.07 mg/L	8.0	8.2
04/26/2025	C18B	0.0000 mg/L	0.021 mg/L	34 ppt	5.00 mg/L	4.82 mg/L	7.9	8.2
04/30/2025	C18B	0.0000 mg/L	0.019 mg/L	35 ppt	5.34 mg/L	5.11 mg/L	7.9	8.2
03/05/2025	C18B	0.0000 mg/L	0.022 mg/L	36 ppt	5.09 mg/L	4.89 mg/L	7.8	8.1

Information:

M: Morning

E: Evening

A: Afternoon

DISCUSSION

Based on the results in Table 1. regarding water quality observation data during the vannamei shrimp cultivation period, it can be seen that the condition of the pond waters is still within the optimal range, especially for the parameters of ammonia (NH₃) and nitrite (NO₂),

which are crucial factors in the success of intensive cultivation. In shrimp cultivation activities, water quality is one of the main aspects that must be maintained because it directly affects the survival rate (survival rate), growth, and health of shrimp. Ammonia and nitrite parameters require special attention because these two compounds are the main products of shrimp metabolism, uneaten feed, and the decomposition of organic matter at the bottom of the pond. If not properly controlled, the accumulation of ammonia and nitrite will reduce water quality, cause stress to shrimp, inhibit growth, and potentially cause mass mortality. Observations show that ammonia levels during the cultivation period were at zero, indicating the effectiveness of water quality management techniques implemented through siphoning and waste disposal that are able to reduce the accumulation of organic matter that causes ammonia formation. Meanwhile, nitrite levels that were previously detected in the low range can also be controlled through the implementation of integrated water quality management, such as the use of probiotics that play a role in accelerating the nitrification process, installing water wheels to increase dissolved oxygen (DO) to support the activity of nitrifying bacteria, and regular water changes to reduce the concentration of toxic compounds in the pond.

Ammonia is a nitrogen compound produced from shrimp metabolic waste and the decomposition of feed and organic matter. Ammonia can irritate shrimp gills, making it difficult for them to absorb oxygen. The ammonia levels observed were stable at 0.0000 mg/L. The ammonia range should not exceed 2.0 mg/L. High ammonia concentrations can inhibit shrimp growth and increase toxic nitrite levels in the water. This is in accordance with the opinion of Yuniarty *et al.* (2022) that ammonia levels for aquatic biota are in the range of 0.5-2.0 mg/L.

Nitrite (NO_2) is an intermediate compound in the nitrogen cycle, both in the nitrification process between ammonia and nitrate compounds, as well as in the nitrification process between nitrate and ammonia compounds (Amalia *et al.*, 2021). Nitrite obtained during the research was in the range of 0.007–0.059 mg/L. The measured nitrite levels showed slight fluctuations, from 0.007 mg/L to 0.059 mg/L, but remained within the safe limit for vannamei shrimp, which is generally less than 0.1 mg/L. This fluctuation likely occurred due to the nitrification process not running smoothly, so that the conversion of nitrite to nitrate did not run properly. However, siphoning techniques, probiotic administration and routine waste disposal were able to keep nitrite from reaching toxic levels for shrimp. This is in accordance with the statement by Putra *et al.* (2023), the optimum nitrite range is 0.05 mg/L. Excessive nitrite levels can disrupt the process of oxygen binding by blood hemoglobin. Toifur *et al.* (2022) added that the siphon method is used to clean dirt deposits at the bottom of the pond, thereby helping to reduce nitrite and ammonia levels.

Siphoning is a method of removing waste, leftover feed, and organic sediment from the bottom of a pond using a hose or pipe based on the principle of water pressure differences. Waste disposal plays a crucial role in maintaining water quality by removing leftover feed, feces, and organic sediment from the pond. In a central drain system, waste is collected in the center of the pond with the help of a waterwheel, then discharged four times daily through outlet pipes (6 & 8 inches) until the water appears clear. The waste is then channeled to a Final Waste Treatment Plant (IPAL) for re-sedimentation before being discharged into the sea. According to Lusiana *et al.* (2021), the use of a waterwheel facilitates the clumping of waste in the central section, thus streamlining the disposal and siphoning processes. Waste removed from the pond is then channeled to a Final Waste Treatment Plant (IPAL), which aims to re-sediment the pond waste before being discharged into the sea. This is in accordance with the statement by Lusiana *et al.* (2021) that the use of a waterwheel is able to collect dirt and

leftover feed in the middle, so that it can be disposed of or removed through the central drain system and makes the siphoning process easier.



Figure 1. Waste Disposal Poces (Personal Documentation, 2025)

In addition to waste disposal, water quality improvement is also supported by the use of Aquastar Pond probiotics containing *Bacillus subtilis*. *Bacillus subtilis* works by breaking down leftover food, feces, and organic sediment at the bottom of the pond into simpler compounds so that waste does not accumulate. This bacterium supports the nitrification process by helping convert ammonia to nitrite and then nitrate, reducing the toxicity of nitrogen compounds. This probiotic functions to decompose organic matter, reduce ammonia and nitrite, suppress the growth of pathogenic bacteria, increase dissolved oxygen, and maintain pH stability.



Figure 2. Distribution of Probiotics (Personal Documentation, 2025)

The application of Aquastar Pond involves first culturing it by mixing it into a water-filled basin, then culturing it and leaving it for several days so that the bacteria in it can grow and become active. After the culturing process is complete, it is then spread around the pond using a raft so that it is evenly distributed and the bacteria can work optimally to improve water quality. This is in accordance with the statement of Kusmiatun *et al.* (2022) that probiotics are microbes that can be given to the cultivation environment to improve environmental quality by decomposing organic matter and increasing feed digestibility in the digestive tract. Panjaitan *et al.* (2023) added that bacillus plays a role in the field of pathogen control, as a decomposer of aquatic waste by reducing the level of organic pollution and increasing oxygen availability for fish and improving fish digestive ability by producing digestive enzymes that are very helpful for fish in digesting the feed consumed so that feed efficiency can increase and fish growth is more optimal.

Water quality parameters, such as salinity, were recorded as stable at 34–36 ppt, although slightly above the optimal range of 20–35 ppt. This is still considered safe and in accordance with the physiological tolerance of vannamei shrimp. Salinity stability is important for maintaining the balance of shrimp osmoregulation so that metabolic processes and growth run optimally. This is in accordance with the statement by Abdul *et al.* (2016), who stated that the optimal salinity range for shrimp is between 15–30 ppt. According to Nurhasana *et al.* (2021), salinity plays a role in shrimp osmoregulation and also the moulting process. At too high salinity, shrimp growth is disrupted because the osmoregulation process is disrupted. Morning and evening DO values ranging from 4.70 to 5.34 mg/L meet the minimum oxygen requirement for vannamei shrimp, which is estimated to be no less than 4 mg/L to support their physiological activities. Hendrayana *et al.* (2022) added that the decrease in oxygen concentration in waters is caused by high ammonia concentrations, which causes disruption of physiological and metabolic functions in organisms, such as respiratory disorders. DO values tend to be lower in the morning compared to the afternoon and evening. This is because during the day there is photosynthetic activity of phytoplankton that produces oxygen. In contrast, at night, phytoplankton do not photosynthesize and compete with shrimp for oxygen consumption. This is consistent with the statement of 4–6 ppm by Abdul *et al.*, (2016). Oxygen is needed to burn food substances consumed by shrimp and absorbed by the body or broken down into energy. The pH parameter ranging from 7.8 to 8.4 is also included in the optimal range, which supports the activity of waste-decomposing microorganisms and reduces ammonia toxicity in the water. This is in accordance with the opinion of Makmur *et al.* (2018), who stated that the suitable water pH range for intensive vannamei shrimp cultivation is 7.4–8.9 with an optimum range of 8.0.

CONCLUSION

The ammonia and nitrite control techniques used at PT. PBSB include siphoning, waste disposal through a central drain system, and the use of Aquastar Pond probiotics. Observations show that ammonia levels remain at 0.0000 mg/L and nitrite is within the safe range (0.007–0.059 mg/L). The ammonia and nitrite control techniques applied at PT. PBSB produce stable and safe cultivation media conditions, thereby increasing the success of intensive vannamei shrimp cultivation.

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