



Characteristics of Vaname Shrimp Farm Residual Water Across Different Shrimp Ages

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Abstract: Vaname shrimp (*Litopenaeus vannamei*) aquaculture plays a crucial role in the fishery commodities to enhance the economy in Indonesia. The development of Vaname shrimp culture in Bengkunt Coastal Lampung has a strong potential due to its extensive coastline. To support the high demand of vaname shrimp, the intensive shrimp method can address this solution. However, intensive culture has a high distribution of shrimp requires large amounts of feed, that contributes to organic pollution in the water. Therefore, this study aims to determine the characteristics of shrimp farming residual water based on variations in shrimp ages to develop wastewater management strategies. This study was conducted from January 16 to March 12, 2024 at Lumintu shrimp pond in Bengkunt. This research is an exploratory descriptive study with a qualitative approach to assess the total of ammonia, nitrite, total organic matter (TOM), total bacterial abundance (TBC), and total vibrio bacteria (TVC). In conclusion, the study indicates that ammonia, nitrite, total bacterial count (TBC), and total Vibrio count (TVC) are within acceptable ranges. However, total organic matter (TOM) surpasses safe levels for shrimp ponds.

Keywords: Bengkunt; Intensive culture; *Litopenaeus vannamei*; Organic pollution

Introduction

Aquaculture is a strategic sector to support food security and the economy of coastal communities, driven by high domestic and international market demand. Vaname shrimp (*Litopenaeus vannamei*) aquaculture is one of the leading fishery commodities in Indonesia. According to the Ministry of Maritime Affairs and Fisheries (2022), the demand for shrimp exports in 2021 reached 250,715 tons and is predicted to increase yearly. Vaname shrimp development in West Coastal Lampung province continues to be carried out. The aquaculture sector has a strong potential in Bengkunt due to its extensive coastline. Vaname has a rapid growth and survival, despite some vulnerabilities, and well-suited to culture (Musa et al. 2020). In this study, cultivation was completed using an intensive system

with a distribution of 150 shrimp/m² using HDPE (high density polyethylene) plastic with a good pond water quality (Ariadi et al. 2021).

Intensive shrimp farming methods have a high density distribution, requiring large amounts of feed. Shrimp feed plays a crucial role in the growth and development of shrimp. However, shrimp feed is not fully eaten by shrimp. Feed residue contributes to organic pollution in the water (Djumanto et al. 2018). Increasing the amount of shrimp feed given along with the age of shrimp. Uneaten food contributes to increase of organic matter and toxic compounds such as nitrite (NO₂) and ammonia (NH₃) (Wulandari et al. 2015). In addition, secretion from the metabolic products of shrimp (urine and feces) potentially an organic load. The accumulated organic load releases nitrogen (NO₃) and phosphorus (PO₄). In sufficient amounts, nitrate and

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phosphorus are required as microalgae nutrients. However, excessive amounts lead to algae blooms and degrade water quality (Nugroho et al. 2014). On the other hand, particles of living organisms and residual feed will accumulate and become an organic matter (TOM) in the water. To address these problems, effluent water is drained during the culture period, replaced with fresh water, then completely drained at harvest time. Wastewater and sediment sludge discharged to the environment pose environmental risks. This will result in poor water quality, indicated by turbid water, reduced dissolved oxygen, and harmful gases. In the long-term, this activity will contribute to the environmental pollution (Ridwan et al. 2016). As demonstrated by Putra et al. (2014), increased organic matter leads to a reduction of dissolved oxygen due to microbial activity. Moreover, shrimp farming pollution leads to odors and health risks from mosquito breeding (Fitriana et al. 2022; Herdiyanti et al., 2023; Pujayani et al., 2022). Therefore, it is necessary to conduct further research to determine the characteristics of shrimp farming residual water based on variations in shrimp ages to develop wastewater management strategies.

Method

Study Design

This study was conducted from January 16 to March 12, 2024 at Lumintu shrimp pond in Bengkuntat, West Pesisir Regency, Lampung Province. This research is an exploratory descriptive study with a qualitative approach to assess the total of ammonia, nitrite, total organic matter (TOM), total bacterial counts (TBC), and total vibrio bacteria (TVC).

Sampling Method

Measurement of water quality parameters in 4 different culture ponds with 4000 m² each pond and distribution of 150 shrimps/m². Water sampling was conducted at different shrimp ages, from 0 to 60 days of cultivation. Wastewater samples were put into polyethylene bottles and brought to the laboratory for analysis (Putra et al. 2014).

Research Parameter

Table 1. Water Quality Paramters

Parameter	Unit	Method/Instruments
Ammonia (NH ₃)	Mg/l	Spectrophotometry (SNI06-6989.30-2005)
Nitrite (NO ₂ ⁻)	Mg/l	Spectrophotometry (No.IK/22-06/LDLH))
TOM	Mg/l	Titrimetri
TBC	CFU/ml	Prescott et al. (2002)
TVC	CFU/ml	Prescott et al. (2002)

The analyzed research parameters are presented in Table 1.

Data Analysis

Qualitative analysis and descriptive presentation were performed using averaged data from each pond to provide information on the total of ammonia, nitrite, total organic matter (TOM), total bacterial abundance (TBC), and total vibrio bacteria (TVC) at Lumintu wastewater shrimp pond in Bengkuntat, West Pesisir Regency, Lampung Province.

Result and Discussion

The data of parameters total ammonia, nitrite, total organic matter (TOM), total bacterial count (TBC), and total vibrio bacteria (TVC) is presented in Table 2.

Table 2. Water Quality Analysis

DOC	Parameters				
	NH ₃ (mg/l)	NO ₂ ⁻ (mg/l)	TOM (mg/l)	TBC (CFU/ml)	TVC (CFU/ml)
4	0.00	0.00	249	3.7 x 10 ⁴	1.1 x 10 ³
18	0.00	0.00	298	3.8 x 10 ⁴	3 x 10 ³
25	0.00	0.00	340	4.8 x 10 ⁴	1.3 x 10 ³
40	0.00	0.3	362	4.5 x 10 ⁴	3.8 x 10 ³
46	0.05	0.10	389	6 x 10 ⁴	2.6 x 10 ³
53	0.4	2.0	400	6.4 x 10 ⁴	2.8 x 10 ³
60	1.5	2.5	461	7.1 x 10 ⁴	3.0 x 10 ³

The data shows the total of parameters NH₃, NO₂⁻, TOM, TBC, and TVC in different days of culture (DOC). Overall, the increase of NH₃ is related to the increasing ages of shrimp. Essentially, ammonia production is driven by the protein in the feed. Decomposing dead shrimp or phytoplankton produces NH₃. However, none was detected from DOC 4 to DOC 40, indicates there was no accumulation of feed waste or shrimp fecal during the period (Dewi & Frinaldi, 2023).

Ammonia levels went up from DOC 46 to DOC 60, peaking at 1.5 mg/l in DOC 60. This rise is attributed to the escalating organic load (TOM) in the water, wherein an organic load of 461 mg/l resulted in an ammonia peak. Consistent with Prasetyono et al. (2022), a strong correlation between TOM and ammonia, demonstrates a significant impact of organic matters on ammonia levels. Although ammonia levels in this study is within 4-5 mg/l, further monitoring is required to stabilize ammonia parameters (Romadhona et al. 2016).

Meanwhile, the data demonstrates a positive correlation between DOC and nitrite levels. Nitrite was not detected between DOC 4 and DOC 25, while a peak of 2.5 mg/l at DOC 60 is relatively suitable for the shrimp culture. Nitrite levels below 4.5 mg/l remain acceptable. However, nitrite accumulation can

negatively affect the environment (Yunarty et al. 2022). High organic matter, leading to turbid water, can affect nitrite concentration (Halim et al. 2022). Nitrite is a nitrogen compound that results from the oxidation of NH₃ to nitrate and is toxic to shrimp from shrimp feed. The presence of nitrite in the waters indicates that the ecosystem is disturbed. High levels of nitrite will interfere with shrimp growth rates and mortality for intolerant shrimp (Ariadi et al. 2020).

However, despite other parameters, total organic matter (TOM) was notably high. The data shows a progressive increase to the maximum levels of 461 mg/l at DOC 60, from an initial level of 249 mg/l at DOC 4. According to Hermawan et al. (2020), TOM levels should remain <80 mg/l for intensive shrimp culture. High levels of TOM will enhance *Vibrio sp* populations which are toxic to shrimp (Wafi et al. 2020).

In this study, there was a difference between the bacteria colonies (TBC) and the vibrio populations (TVC). Notably, TBC shows an increase with rising DOC levels, reaching a peak of 7.1×10^4 CFU/ml at DOC 60, and the minimum at DOC 4 was 3.7×10^4 CFU/ml. In contrast, vibrio populations showed a lower than the TBC. At DOC 60, TVC only reached $3,0 \times 10^3$ CFU/ml. consistent with Sukenda et al. (2006), a rise in bacterial populations can lead to a higher mortality rate of TVC. According to Halim et al. (2022), the optimum TBC levels are $\geq 10^4$ CFU/ml, while the optimum TVC levels are $\leq 3 \times 10^3$ CFU/ml.

Conclusion

The study indicates that ammonia, nitrite, total bacterial count (TBC), and total *Vibrio* count (TVC) are within acceptable ranges. However, total organic matter (TOM) surpasses safe levels for shrimp ponds.

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Conflicts of Interest

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