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Monitoring Of Water Quality in Vanamei Shrimp (*Litopenaeus vannamei*) Farming in Cv. Cemarasewu Sumber Rejeki, Cilacap

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Abstract

Pacific White Shrimp (*Litopenaeus vannamei*) is a frequently cultivated shrimp species. This is because it offers promising prospects and profits. Superior vannamei can be produced by considering several aspects of the cultivation process. Internal factors include the origin and quality of the seeds, as well as external factors, including cultivation water quality, feeding, technology, and pest and disease control. This research was conducted from September 15 to October 15, 2022, at CV. Cemarasewu Sumber Rejeki, Jetis Village, Cilacap, Central Java. The purpose of this study was to determine the water quality conditions in Pacific White Shrimp rearing ponds at CV. Cemarasewu Sumber Rejeki, Cilacap. Three ponds were used for data collection: plots B13, B14, and B15, with shrimp rearing ages of 100-129 days. Research results indicated that plots B13, B14, and B15 at CV. Cemarasewu Sumber Rejeki provides good water quality for Pacific White Shrimp cultivation. The results of water quality parameters measured in this study include: brightness up to 35 cm, temperature ranging from 27-29 ºC, pH ranging from 7.6-8.3, salinity ranging from 14-22 ppt, alkalinity ranging from 125-169.6 ppm, TOM ranging from 70.4-79.2 ppm, DO ranging from 4.32-4.98 ppm, phosphate ranging from 0.25-0.5 ppm, nitrite ranging from 0.013-0.085 ppm, nitrate 0 ppm, ammonia ranging from 0.00-0.085 ppm, ammonium ranging from 0.00-0.50 ppm and plankton ranging from 2,500-282,500. It can be concluded that the water quality in pond plots B13, B14, and B15 at CV. Cemarasewu Sumber Rejeki meets the appropriate standards to support Pacific white shrimp cultivation.

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Introduction

Aquaculture is an alternative activity to increase fisheries production (Hikmayani *et al*., 2012; Karuppasamy *et al*., 2013). Successful aquaculture requires an organism, a living medium, and a container or cultivation site. Pacific White Shrimp is one type of shrimp that is frequently cultivated due to its promising prospects and profitability (Babu *et al*., 2014).

Superior vannamei commodities can be produced by paying attention to several aspects of the cultivation process. Internal aspects, including the origin and quality of the seeds, must be considered, as well as external factors, including the quality of the cultivation water, feeding, the technology used, and pest and disease control (Haliman & Adijaya, 2005). The main problem often found in the failure of Pacific White Shrimp production is poor water quality during the cultivation period, especially in intensive ponds. Therefore, water quality management during the cultivation process is absolutely necessary. Several water quality parameters that are often measured and affect shrimp growth are dissolved oxygen (DO), temperature, pH, salinity, ammonia, and alkalinity (Wiranto & Hermida, 2010).

There is a difference between good and bad water conditions based on the amount of chemical substances in cultivated biota that are not properly broken down. Good and bad cultivation water conditions will affect the shrimp growth process, shrimp activity, appetite, moulting process, and disease resistance, which ultimately impact the cultivation results, namely the achievement of profits or losses. Water quality refers to the nature of water and the presence of living organisms, energy substances, or other components in the water. Water quality is expressed by several parameters, namely dissolved oxygen (DO), temperature, pH, salinity, ammonia, and alkalinity (Wiranto & Hermida, 2010).

Materials and methods

Time and Place of Research

The research was conducted from September 2022 to October 2022. The research location was at the CV. Cemarasewu Sewu Sumber Rejeki pond, Jetis Village, Nusawungu District, Cilacap Regency.

Research Design and Methods

Three ponds were used for data collection in the study: B13, B14, and B15, with shrimp rearing ages ranging from 100 to 129 days. Water quality parameters measured directly in the field included temperature, clarity, and dissolved oxygen. Laboratory analysis included salinity, pH, alkalinity, Total Organic Matter (TOM), phosphate, nitrite, nitrate, ammonium, and plankton.

The method used was a survey. Primary data was collected from measurements of environmental factors, both in the field and through laboratory analysis. Secondary data was obtained from relevant agencies near the research location, and literature was obtained from libraries, the internet, and other sources related to the activity.

Research Work Procedures

The work procedure conducted in this study involved taking water samples in each pond plot, using a 600 mL bottle attached to a secchi disk to take water samples prec isely at the Anco bridge, followed by laboratory analyses of chemical and biological properties, and direct observation of physics in each plot.

Results and Discussion

Water Sampling

Determination of Water Sampling Points

The sampling location was in Block B of ponds B13, B14, and B15 of CV. Cemarasewu Sumber Rejeki. Water sampling points were taken directly from the shrimp ponds. There were three sampling points in each pond, located near the corners of the pond. Each water sampling point was connected to an anco net, ensuring the water flow in the block was maintained using bamboo. For each water sampling point, only one sample was taken, close to the pond outlet.

Water Sampling Procedure

Water sampling was conducted twice a week, for Block B every Monday and Thursday. Each sample point was sampled using a 600 mL bottle at a single point, typically in the surface zone (0 meters), and then retrieved horizontally after being submerged to a depth of 80 cm. Water samples were then placed into 30 mL sample bottles that had been labeled based on each pond plot. Then, chemical, biological, plankton, and bacterial observations were carried out in the laboratory. Water physics observations were conducted directly in the pond, such as temperature, clarity, and dissolved oxygen.

Water Quality Monitoring

Brightness

Water brightness is a condition that indicates the ability of light to penetrate water layers at a certain depth. Water brightness is greatly influenced by dissolved substances in the water. The greater the brightness, the greater the light penetration, thus increasing the depth of the water layer for photosynthesis.

Table 1. Brightness Values of Plots B13, B14 & B15

Plot	3/10		10/10		17 /10		24 /10		31 /10	
	M	A	M	A	M	A	M	A	M	A
B13	35	35	35	35	35	35	35	35	35	35
B14	35	35	35	35	35	35	35	35	35	35
B15	35	35	35	35	35	35	35	35	35	35

Where: (M) Morning; (A) Afternoon

Brightness was measured using a Secchi disk attached to a pipe and then submerged vertically. Measurements were taken once a week in the morning and evening. The results are shown in Table 1.

Based on the brightness measurements above, the brightness value is 35 cm. This brightness measurement result is considered good for shrimp growth. This is in line with the opinion of Syukur (2002) who stated that the brightness value that supports the life of aquatic organisms is around 20-40 cm from the surface. This is also reinforced by the opinion (Amri, 2003), that the brightness range for shrimp cultivation is 25-45 cm.

Temperature

Water temperature plays a crucial role in determining the growth and survival of farmed shrimp. A higher temperature will cause the shrimp's metabolism to accelerate. Pond water temperature depends on the weather and directly affects appetite. At temperatures above 26ºC, appetite decreases by up to 50%. Water temperature, especially at the bottom, is also affected by particle density, which can be measured by its clarity. Temperature measurements are made using a thermometer immersed in the pond. The results are shown in Table 2.

Based on the temperature measurements above, the morning temperature range is 27-28ºC, and the afternoon temperature range is 29ºC. These temperature measurements indicate that the temperature is optimal for shrimp. This is consistent with Kordi (2007), who stated that vannamei shrimp can grow well at a temperature range of 24-34°C and ideally at 28-31°C. A low temperature of 21-23ºC will result in low feed consumption, while a temperature that is too high will cause feed consumption to stop. Therefore, maintaining stable pond water temperatures is one of the factors for successful pacific white shrimp cultivation.

Table 2. Temperature Values of Plots B13, B14 & B15

Plot	**3/10**		**10/10**		**17 /10**		**24 /10**		**31 /10**	
	M	A	M	A	M	A	M	A	M	A
B13	27	29	27	29	27	29	27	29	27	29
B14	27	29	28	30	27	29	27	29	27	29
B15	27	29	27	29	27	29	27	29	27	29

Where: (M) Morning; (A) Afternoon

pH

The acidity (pH) of water influences the increase in ammonia and H_2S content in the water. The higher the pH level, the more toxic ammonia compounds are found. This is because ammonia is more easily absorbed into the shrimp's body. Increasing the pH level in water can lead to an increase in toxic ammonia content (Effendi, 2003). The pH measurements obtained in the morning were 7.6-7.9, and in the afternoon were 8.0-8.3. The pH measurements were carried out using a pH meter, which was inserted into the water sample taken from the pond and then placed in a 220 mL glass of mineral water. The results of the pH measurements can be seen in Table 3.

The pH measurement results above indicate the value ranging from 7.6 to 7.9 in the morning and 8.0 to 8.3 in the afternoon. The high pH value obtained from the measurement results indicates that the pH value is optimal for the growth of Pacific White Shrimp. According to Suprapto (2005), the optimal pH range for Pacific White Shrimp cultivation is between 7.0 and 8.5, with a tolerance of 6.5-9. The pH concentration of the water will affect the shrimp's appetite. In addition, a pH below the tolerance range will cause difficulty in molting, causing the skin to become soft and leading to low survival.

Salinity

Salinity is a measure of the amount of salt dissolved in a volume of water. High salinity disrupts osmoregulation, slowing shrimp growth because more energy is used for osmoregulation than for growth. Furthermore, shrimp will have difficulty molting due to their tough skin. Salinity measurement results are shown in Table 4.

Table 3. pH Value of Plots B13, B14 & B15

Plot	3/10		10/10		17 /10		24 /10		31 /10	
	M	A	M	A	M	A	M	A	M	A
B13	7.6	8.1	7.6	8.0	7.7	8.1	7.8	8.2	7.8	8.2
B14	7.6	8.1	7.6	8.1	7.7	8.1	7.8	8.2	7.8	8.1
B15	7.9	8.2	7.8	8.2	7.9	8.2	7.9	8.3	7.9	8.3

Where: (M) Morning; (A) Afternoon

Table 4. Salinity Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	19	18	20	19	20
B14	22	20	21	21	22
B15	15	15	14	14	16

Based on the salinity measurements above, the morning and afternoon temperature range is 17-21 ppt. The results of the salinity measurements above indicate that the salinity values are good for shrimp growth. Shrimp growth is relatively good at salinities between 5 and 30 ppt (Suharyadi, 2011). Pacific white shrimp are euryhaline, meaning they can survive in a wide range of salinities, so they can be cultivated in coastal areas with salinities of 15-40 ppt (Bray *et al*., 1994). Pacific white shrimp can grow well or optimally at salinities of 15-25 ppt, and are even still suitable for growth at salinities of 5 ppt (Soemardjati and Suriawan, 2007).

Alkalinity

Alkalinity is a measure of water's capacity to neutralize acid, or the quantity of anions in water that can neutralize hydrogen cations. Alkalinity is also defined as the buffering capacity of water against changes in pH. The higher the alkalinity, the greater the water's buffering capacity, resulting in lower pH fluctuations. Alkalinity is usually expressed in units of ppm (mg/L) of calcium carbonate (Yulfiperus *et al*., 2004). The results of alkalinity measurements can be seen in Table 5.

Based on the alkalinity measurement results above, the obtained value ranges from 125.0 to 169.6 ppm. These results indicate that this value is still good for the growth of pacific white shrimp. This follows the statement (Kilawati, 2014), which states that the optimal alkalinity for pacific white shrimp cultivation ranges from 100 to 150 ppm. The harder the water, the better for shrimp cultivation, with an optimal value of 120 mg/L and a maximum value of 200 mg/L.

Table 5. Alkalinity Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	139,3	128,6	128,6	126,8	125,0
B14	132,1	132,1	126,8	128,6	126,8
B15	169,6	162,5	164,3	158,9	160,7

Table 6. TOM Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	72,6	76,3	70,4	73,5	79,2
B14	70,4	71,3	74,8	76,8	78,8
B15	74,4	74,1	73,6	77,2	78,3

Total Organic Matter (TOM)

TOM describes the total organic matter content of water, consisting of dissolved, suspended (particulate), and colloidal organic matter dissolved in the water. The results of TOM measurements can be seen in Table 6.

Based on the TOM measurement results above, a value of 70.4 - 79.2 ppm was obtained. This indicates that the TOM value in this pool is quite good, because according to Adiwijaya, D, (2008), the normal limit for TOM is <150 ppm.

Dissolved Oxygen (DO)

According to Kordi (2007), the DO (Dissolved Oxygen) value indicates the amount of dissolved oxygen in water. The oxygen required by aquatic biota for respiration must be dissolved in the water, as shrimp cannot utilize oxygen directly from the air. Oxygen is a limiting factor; if its availability in the water is insufficient to meet the needs of cultivated biota, all biota activities will be hampered. This measurement uses a DO meter inserted into the pond. The results of the DO measurement can be seen in Table 7.

Based on the DO measurement results above, the value obtained ranges from 4.32 to 4.98 ppm. This follows the opinion of Suharyadi (2011), for the minimum DO value in pond waters is 3 ppm. The DO value above is quite good. During the day, ponds will have a DO figure that tends to be high due to the photosynthesis process of plankton that produces oxygen. The opposite situation at night and in the morning, plankton do not carry out photosynthesis. According to Kordi (2007), oxygen solubility at night is reduced because it is consumed by shrimp, also used by other biota such as phytoplankton, zooplankton, including moss, detritus, and bacteria. Dissolved oxygen content below 3 ppm can reduce the ability or willingness to eat and the growth of shrimp being raised, causing stress and death in shrimp (Pangkey, 2008).

Table 7. DO Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	4,49	4,79	4,50	4,46	4,32
B14	4,34	4,43	4,75	4,45	4,45
B15	4,66	4,98	4,86	4,72	4,40

Table 8. Phosphate (PO_4) Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	0,25	0,25	0,5	0,25	0,5
B14	0,25	0,25	0,25	0,25	0,25
B15	0,5	0,5	0,25	0,25	0,25

Phosphate (PO_4)

Phosphate is a form of phosphorus that can be utilized by plants and is an essential element for higher plants and algae, thus affecting aquatic productivity (Bahri, 2006). Phosphate is widely found in water in inorganic and organic forms, such as solutions, dust, and the bodies of organisms. The results of phosphate measurements can be seen in Table 8.

Based on the phosphate (PO_4) measurement results above, the value obtained is 0.25 – 0.5 mg/L. These results indicate that the phosphate value in this pond is following the PP No. 82 of 2001 concerning the quality standards for water quality management and water pollution control, which is 1 mg/L.

Nitrit (NO_2)

Nitrite is a partially oxidized form of nitrogen. Nitrite comes from corrosive materials and is widely used. According to Suharyadi (2011), the nitrite content in water should be less than 0.3 ppm. High nitrite levels in water are very dangerous for shrimp and fish because nitrite in the blood oxidizes hemoglobin into methemoglobin, which is unable to circulate oxygen. Nitrite is a partially oxidized form of nitrogen. Nitrite comes from corrosive materials and is widely used. According to Suharyadi (2011), the nitrite content in water should be less than 0.3 ppm. High nitrite levels in water are very dangerous for shrimp and fish because nitrite in the blood oxidizes hemoglobin into methemoglobin, which is unable to circulate oxygen.

Based on the nitrite (NO_2) measurement results above, the value obtained was 0.013 – 0.085 mg/L (Table 9). This follows the opinion of Suharyadi (2011), who stated that the nitrite content in water should be less than

Table 9. Nitrite (NO_2) Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	0,021	0,034	0,032	0,047	0,050
B14	0,013	0,042	0,074	0,077	0,079
B15	0,015	0,046	0,079	0,082	0,085

Table 10. Nitrate (NO_3) Values in Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	0	0	0	0	0
B14	0	0	0	0	0
B15	0	0	0	0	0

0.3 ppm. High nitrite content in water is very dangerous for shrimp and fish, because nitrite in the blood oxidizes hemoglobin into methemoglobin, which is unable to circulate oxygen.

Nitrat (NO_3)

Nitrate is the primary form of nitrogen in water and is a key nutrient for plant and algae growth. Nitrate nitrogen is highly soluble in water and is stable (Bahri, 2006). The results of nitrate (NO_3) measurements can be seen in Table 10.

Based on the nitrate (NO_3) measurement results above, the value obtained was 0 mg/L. This result still indicates that the nitrate (NO_3) level is still good for white shrimp. This follows the water quality standards for Pacific White Shrimp cultivation from (WWF-Indonesia, 2011), which states that NO_3 in white shrimp cultivation is <75 mg/L. According to Effendi (2003), nitrate is the main nutrient for the growth of natural feed.

Ammonia (NH_3)

Ammonia is a gaseous waste product of shrimp. High levels of ammonia in water can directly kill aquatic organisms by affecting cell permeability, reducing ion concentration in the body, damaging gills, and reducing the blood's ability to transport oxygen (Nurjanah, 2009). The results of ammonia (NH_3) measurements can be seen in Table 11.

Based on the ammonia measurement results above, the value obtained was 0.00–0.066 ppm. These results indicate that ammonia (NH_3) levels are still good for the growth of vannamei shrimp. This is indicated by the maximum NH3 allowed for shrimp cultivation, which is $\leqslant$ 0.1 ppm (Mintardjo & Sunarjanto, 1986). Ammonia levels greater than 0.45 ppm in pond waters can inhibit shrimp growth by up to 50% (Suharyadi, 2011).

Table 11. Ammonia (NH_3) Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	0,00	0,000	0,000	0,050	0,054
B14	0,00	0,000	0,000	0,079	0,022
B15	0,00	0,027	0,027	0,085	0,066

Table 12. Ammonium (NH_4) Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
B13	0,00	0,00	0,00	0,00	0,50
B14	0,00	0,00	0,00	0,00	0,25
B15	0,00	0,25	0,25	0,00	0,50

Ammonium (NH_4)

Ammonium is naturally present in surface water, groundwater, and wastewater. Nitrogen is mostly formed by microorganisms decomposing organic matter that contains nitrogen and by the hydrolysis of urea. Anaerobic conditions naturally reduce nitrate to produce ammonium. Therefore, the presence of ammonium is an indicator of organic pollution in water bodies (Taras *et al*., 1971). The results of ammonium measurements can be seen in Table 12.

Based on the ammonium (NH_4) measurement results above, the value obtained was 0.00 – 0.50 ppm. The above results meet the standards set by this laboratory, which ranges from <1 ppm. If the ammonium (NH_4) value is not controlled, it can cause major problems in aquatic environments because Total Ammonia Nitrogenn (TAN) toxicity can suddenly increase following changes in water quality factors, such as pH, temperature, ion load, salinity, and dissolved oxygen (DO), (Royan *et al*., 2019).

Plankton

The presence of plankton in ponds is not only useful for shrimp feed, but it can also be used as an ecological parameter to describe the condition of the water. According to Amin (2010), one characteristic of phytoplankton is that they form the basis of the aquatic food chain, so that the dominance of phytoplankton groups that are indicates more good ecological conditions than the dominance of groups associated with polluted or eutrophic waters. Therefore, the presence of plankton in a body of water can indicate whether the body of water is fertile or not, and changes in the composition and dominance of plankton groups can be related to fluvtuations in physical and chemical parameters. The results of the plankton count can be seen in Table 13.

Based on the plankton count above, the results range from 2,500 to 282,500. This figure meets the laboratory's standard of 500,000 to 700,000, which indicates that plankton abundance is still within the range that can support shrimp growth. The total of plankton count includes green algae, blue-green algae, dinoflagellates, diatoms, euglena, and protozoa.

Table 13. Plankton Values of Plots B13, B14 & B15

Plot	3/10	10/10	17 /10	24 /10	31 /10
			Green Algae		
B13	282.500	232.500	222.500	260.000	222.500
B14	302.500	250.000	237.500	240.000	230.000
B15	262.500	250.000	230.000	230.000	235.000
			Blue Green Algae		
B13	12.500	5.000	12.500	7.500	7.500
B14	12.500	25.000	10.000	7.500	15.000
B15	10.000	5.000	10.000	12.500	15.000
			Dinoflagellates		
B13	5.000	2.500	2.500	0	5.000
B14	5.000	5.000	7.500	5.000	5.000
B15	0	10.000	5.000	2.500	0
			Diatom		
B13	2.500	15.000	10.000	15.000	10.000
B14	10.000	12.500	12.500	5.000	5.000
B15	25.000	10.000	12.500	5.000	7.500

Conclusion

From the results of research at CV. Cemarasewu Sumber Rejeki, Jetis Village, Nusawungu District, Cilacap Regency, Central Java, regarding Water Quality Monitoring in Pacific White Shrimp (*Litopenaeus vannamei*) Cultivation Ponds, it can be concluded that the water quality in pond plots B13, B14, and B15 of CV. Cemarasewu Sumber Rejeki has met good standards for Pacific white shrimp cultivation. The results of the water quality parameters measured in this study include: brightness 35 cm, temperature ranging from 27-29 ºC, pH ranging from 7.6-8.3, salinity ranging from 14-22 ppt, alkalinity ranging from 125-169.6 ppm, TOM ranging from 70.4-79.2 ppm, DO ranging from 4.32-4.98 ppm, phosphate ranging from 0.25-0.5 ppm, nitrite ranging from 0.013-0.085 ppm, nitrate 0 ppm, ammonia ranging from 0.00-0.085 ppm, ammonium ranging from 0.00-0.50 ppm and plankton ranging from 2,500-282,500.

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