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Study on Pond Culture Water Quality Based On Several Physical and Chemical Parameters in Tambak Oso Village, Sidoarjo Regency

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ABSTRACT: Sidoarjo Regency holds significant potential for pond culture, particularly in Tambak Oso Village, Waru District. Despite this, there has been a decline in pond production in recent years, possibly caused by deteriorating pond culture water quality. Consequently, a study was undertaken to assess the quality of pond culture water and the source water in Tambak Oso Village. The study was conducted at six ponds and two rivers. The irrigation source of ponds 1, 2, and 3 are supplied by the Tambak Oso River, while ponds 4, 5, and 6 are supplied by the Buntung River. Parameters examined included water temperature, water brightness, pH, nitrate (NO_3), Dissolved Oxygen (DO), and Total Organic Matter (TOM). The results indicated that all six ponds met the required quality standards, except for water temperature. The Buntung River met the quality standards for pond source water, whereas the Tambak Oso River fell short only in terms of pH. The t-test results revealed differences in water quality between pond 3 and the Tambak Oso River, as well as pond 6 and the Buntung River.

KEYWORDS: Pond Culture; Water Quality; Milkfish; Vannamei Shrimp; Pond Water Source

I. INTRODUCTION

Sidoarjo Regency possesses significant potential in fisheries pond culture. Records indicate that the yield from pond milkfish (*Chanos chanos*) cultivation amounted to 19.942.384 kg in 2019. The total pond area in Sidoarjo spans approximately 15.513,41 ha. This industry holds promise for enhancing the livelihoods of over 6.500 farmers and pond laborers (Badan Pusat Statistik Sidoarjo, 2020).

Tambak Oso Village, located in Waru District, Sidoarjo Regency, covers an area of 2.278,309 hectares. Approximately 86.49% of the land is dedicated to pond cultivation, focusing on milkfish and vannamei shrimp known as whiteleg shrimp (*Litopenaeus vannamei*). The pond area in Tambak Oso is the most extensive in Waru District, spanning 490,47 ha. The combined production of milkfish and vannamei shrimp in 2021 amounted to 20.234 ha, highlighting the significant potential of pond cultivation and its pivotal role in the local economy (Badan Pusat Statistik Sidoarjo, 2023).

Pond culture in Tambak Oso Village, Waru District, known to provide an opportunity for the community and a contributor to the region. Yet, according to local farmers, there has been a decline in pond output, likely caused by water quality issues. Farmers noted a deterioration in the river water quality utilized for pond irrigation, marked by turbidity and an unpleasant smell, leading to a decrease in pond productivity.

During the period 2019-2021, pond production results in Tambak Oso Village fluctuated. Milkfish production in 2019 was 10.245 Ha, increased to 59.402 ha in 2020, and then decreased to 53.917 ha in 2021. Similarly, milkfish production quantities varied. In 2019, it was 346.600 ha, dropping to 248.625 ha in 2020, and further declining to 213.064 ha in 2021 (Badan Pusat Statistik Sidoarjo, 2023).

Tambak Oso River and Buntung River serve as tributaries of the Brantas River. They function as irrigation sources for ponds in Tambak Oso Village, traversing industrial zones, heavily populated areas, and pond regions. This situation leads to signs of deteriorating river water quality due to industrial and domestic waste as well as litter. The degradation of river water quality poses a risk to the quality of pond water, a crucial element in aquaculture.

Optimal water quality encompasses crucial physical and chemical parameters that significantly impact the sustainability and productivity of shrimp and fish aquaculture. Deterioration in water quality can adversely affect the aquaculture operations, food safety, and aquatic organism health. Research on water quality in the ponds of Tambak Oso Village, as well as the Tambak Oso River and Buntung River used for irrigation, remains limited. Hence, there is a necessity for a study to assess the compliance of pond water quality and source water quality with the standards outlined in Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 75 of 2016. This study is also aimed to determine the difference in quality between pond water and river water for pond irrigation purposes.

II. RESEARCH METHODS

A. Study Area

This study was located in Tambak Oso Village, Sidoarjo Regency, East Java. Water sampling points were determined

through purposive sampling, a method based on individual or researcher considerations at the research location (Sugiyono, 2013). Sampling points were identified in six polyculture ponds for milkfish and vannamei shrimp cultivation, as well as in two rivers, the Tambak Oso River and the Buntung River, which serve as irrigation sources for the ponds. The Tambak Oso River supplies water to ponds 1, 2, and 3, while the Buntung River irrigates ponds 4, 5, and 6. Each pond's sampling point was established at 50 m intervals from the river. Sampling in the ponds occurred three times: at the inlet, middle, and edge. River water sampling was conducted at the edge, middle (0-20 cm depth), and middle (20-40 cm depth) of the river.

B. Measurement of Water Parameters

Water temperature and brightness parameters were directly measured in ponds and rivers, while pH, nitrate (NO_3), Dissolved Oxygen (DO), and Total Organic Matter (TOM) measurements were conducted at the Land Resources Laboratory, Faculty of Agriculture, Universitas Pembangunan Nasional "Veteran" Jawa Timur, Surabaya.

The water temperature was gauged with a thermometer, water brightness with a secchi disk, pH and DO were measured conductometrically using pH and DO meters, nitrate was assessed using the brucine method following Balai Pengujian Standar Instrumen Tanah dan Pupuk (2023) and Total Organic Matter (TOM) was determined through the titrimetric method following SNI 06-6989.22-2004.

The research parameters consist of physical and chemical characteristics of water to assess its suitability for pisciculture ponds and its source water.

Table 1. Parameters for Evaluating Pond Water and Pond Source Water Quality Based on Several Water's Physical and Chemical Characteristics

Parameters	Quality Standard	Unit
Temparature	28 – 32	°C
Brigthness	30 – 45	Cm
pH	7,5 – 8,5	-
Nitrate (NO_3)	<0,5	mg/L
Dissolved Oxygen (DO)	>3,0	mg/L
Total Organic Matter (TOM)	<55	mg/L

Note: The water quality assessment provided is grounded in Regulation Number 75 of 2016 from the Minister of Maritime Affairs and Fisheries of the Republic of Indonesia, which pertains to water quality standards for fisheries cultute.

C. Data Analysis

The acquired physical and chemical parameters of water are analyzed descriptively by presenting the measurement data. An evaluation is conducted by comparing the sample values with the water quality standards specified in the Regulation of the Minister of Marine Affairs and Fisheries of the Republic of Indonesia Number 75 of 2016, utilized as a standard for maintaining vannamei shrimp and milkfish cultivation in ponds. Subsequently, a t-test analysis was performed using Microsoft Excel 2016 to ascertain any differences between pond water quality and river water quality.

III. RESULT AND DISCUSSION

The study took place in separate ponds situated in Tambak Oso Village, Waru District, Sidoarjo Regency. These ponds, which operate under a semi-intensive polyculture management system, focus on cultivating vannamei shrimp and milkfish.

The ponds are supplied with river water. Ponds 1, 2, and 3 are irrigated from the Tambak Oso River, while ponds 4, 5, and 6 are supplied by the Buntung River. Irrigation involves directing river water through a channel connected to the pond inlet. Water changes are conducted twice monthly by draining water through the outlet. Additionally, water changes are performed by circulating river water through the pond water inlet.

A. Water Quality

1) Water Temperature

Temperature measurements in the six research ponds yielded results ranging from 32 to 33°C, whereas the water temperature in the two rivers peaked at 31 - 32°C. According to Regulation No. 75 of 2016 from the Minister of Marine Affairs and Fisheries, the water temperature in ponds 1, 2, 3, and the two rivers is conducive for cultivating vannamei shrimp and milkfish. Conversely, the water temperature in ponds 4, 5, and 6 falls below the required quality standard.

Measuring water temperature is crucial due to its significant impact on the survival, growth, reproduction, behaviour, skin changes, and metabolism of shrimp and fish. It influences a range of biological, physical, and chemical processes in water, and can enhance the photosynthetic activity of natural feed in ponds, known as phytoplankton (Supono, 2018).

The efforts to decrease the water temperature to meet the preferred conditions for pond culture organisms involve the installation of water wheels in the pond. Despite the significant role that water wheels play in regulating water temperature, their installation in the ponds at the research site remains limited. According to Supono (2018) utilizing water wheels helps create a more uniform water temperature throughout the pond, from the surface to the bottom.

2) Water Brightness

Water brightness measurements in six ponds revealed values ranging from 35 - 40 cm. Similarly, in the Tambak Oso River and Buntung River, the range was from 30 – 40 cm (Table 2 and Table 3). This brightness range aligns with the standards for pisciculture water quality and pond water sources as per Minister of Maritime Affairs and Fisheries No. 75 of 2016. As stated by Irawan & Handayani (2021) the optimal brightness in waters falls between 30 - 45 cm. These

measurements are crucial to ensure that shrimp and fish growth is optimal for cultivation efforts (Rafiqie, 2021).

Even though the brightness level in the pond currently complies with quality standards, it is on the verge of meeting them. It may be necessary to enhance the brightness to prevent a decline in the current level that meets the standards. Suhendar et al. (2020) said insufficient brightness leads to turbidity due to colloidal and suspended substances like mud, organic and inorganic matter, and aquatic microorganisms. Consequently, it is essential to uphold the pond's brightness by regularly replacing the water to prevent the buildup of organic residues from excess pond feed.

3) pH

pH measurements in all ponds have adhered to the pH standard established by Regulation No. 75 of 2016 from the Minister of Maritime Affairs and Fisheries for shrimp and milkfish culture, remaining within the 7,5 – 8,5 range. In contrast to the ponds, the pH of the river water utilized as a water source displays a slight variance. Specifically, the pH of the Buntung River water stands at 7,58, meeting the criteria for being a suitable water source for ponds. On the other hand, despite the pH measurements in the Tambak Oso River falling below the quality standard, registering only 7,44 (Table 2 and Table 3), the pH remains close to neutral (Putri & Triajie, 2021). The lower pH value is believed to be influenced by the discharge of waste into the river, especially due to its proximity to residential areas.

In aquatic environments, pH serves as an indicator of the equilibrium and accessibility of essential chemical elements or nutrients crucial for marine life (Sahrijanna & Septiningsih, 2017). Despite pH level in the Tambak Oso River not meeting quality standards, the existing range of values still satisfies the growth needs of milkfish raised alongside vannamei shrimp in polyculture. The optimal pH range for milkfish growth falls between 7,0 – 8,5 (SNI 6148:3:2013), 6,5 – 8,5 (Koswara, 2011), and 6,5 – 9,0 (Rangka & Asaad, 2010). Regular monitoring is essential to ensure pH levels remain within the ideal range.

4) Nitrate (NO_3)

The nitrate levels at the six pond sampling sites comply with the quality criteria established by Regulation No. 75 of 2016 from the Minister of Marine Affairs and Fisheries. The standard for shrimp cultivation is a maximum of 0,5 mg/L. Nitrate concentrations in the ponds remain below 0,5 mg/L, ranging from 0,013 mg/L to 0,049 mg/L. Similarly, the nitrate levels in the Tambak Oso River and Buntung River also adhere to the quality standards, varying between 0,004 and 0,009 mg/L (refer to Table 2 and Table 3).

Table 2. Quality of Pond Water (Pond 1, 2, 3) and The Water Source (Tambak Oso River)

Parameters	Quality Standard	Average Values of Pond Water and Source Water (River) Parameter			
		T1	T2	T3	Tambak Oso River
Temperature (°C)	28 - 32	32*	32*	32*	31*
Brightness (cm)	30 - 45	35*	35*	35*	30*
pH	7,5 – 8,5	7,84*	7,94*	7,97*	7,44
Nitrate (mg/L)	<0,5	0,023*	0,049*	0,026*	0,004*
Total Organic Matter (mg/L)	<55	33,60*	34,97*	44,66*	25,38*
Dissolved Oxygen (mg/L)	>3	3,5*	4,3*	3,7*	3,8*

*Note: * = comply with the quality standards established by Minister of Marine and Fisheries Regulation No. 75 of 2016*
T1 = Pond 1 located 50 meters away, T2 = Pond 2 located 100 meters away, T3 = Pond 3 located 150 meters away (from the Tambak Oso River)

Table 3. Quality of Pond Water (Pond 4, 5, 6) and The Water Source (Buntung River)

Parameters	Quality Standard	Average Values of Pond Water and Source Water (River) Parameter			
		T4	T5	T6	Buntung River
Temperature (°C)	28 - 32	33	33	33	32*
Brightness (cm)	30 - 45	40*	40*	37,5*	40*
pH	7,5 – 8,5	7,72*	8,03*	7,79*	7,58
Nitrate (mg/L)	<0.5	0,023*	0,020*	0,013*	0,009*
Total Organic Matter (mg/L)	<55	32,65*	35,47*	36,13*	32,66*
Dissolved Oxygen (mg/L)	>3	3,6*	4,7*	4,4*	3,5*

Note: * = comply with the quality standards established by Minister of Marine and Fisheries Regulation No. 75 of 2016
T4 = Pond 4 located 50 meters away, T5 = Pond 5 located 100 meters away, T6 = Pond 6 located 150 meters away (from the Buntung River)

Even though the nitrate levels in the shrimp culture meet quality standards, they remain notably low for milkfish culture, by being below 0,1 mg/L. According to SNI: 01-6148 – 1999, optimal nitrate levels for successful milkfish culture range from 0,1 to 2,0 mg/L. The diminished nitrate levels in the six ponds may result from continuous nutrient absorption by phytoplankton in the water (Fitriyah et al., 2022). Firmansyah et al. (2021) mentioned the role of nitrate in phytoplankton growth in aquatic environments. Phytoplankton serves as a natural food source for pond biota. Nitrate concentrations below 0,01 mg/L and above 4,5 mg/L act as growth-limiting factors for phytoplankton. Additionally, Rumanti et al. (2014) have indicated that nitrate levels below 0,114 mg/L can also impede nitrate levels.

5. Total Organic Matter (TOM)

The Total Organic Matter levels in the six ponds and two rivers were found to be within the acceptable range, meeting the quality standards outlined in Regulation No. 75 of 2016 by the Minister of Marine Affairs and Fisheries. The values ranged from 32,65 to 44,66 mg/L in the ponds, with pond 4 recording the lowest and pond 2 the highest levels. In the Tambak Oso River, the Total Organic Matter value was 32,66 mg/L, whereas in the Buntung River, it was 25,38 mg/L.

Organic matter serves as a vital nutritional source for aquatic organisms, particularly shrimp and milkfish. Nevertheless, surpassing the prescribed quality thresholds for organic matter can detrimentally affect the aquatic ecosystem (Afiati et al., 2017). An overabundance of organic matter may lead to water pollution through elevated carbon dioxide levels. Moreover, excessive organic matter can instigate eutrophication in pond environments, affecting water components such as water turbidity and brightness. Hence, routine monitoring of pond water quality is essential. Furthermore, adhering to appropriate feeding practices and implementing water exchanges are crucial for sustaining optimal pond water conditions.

6. Dissolved Oxygen (DO)

The results of Dissolved Oxygen (DO) measurements in the six ponds and two research rivers indicated values that complied with the quality standards for shrimp and milkfish pisciculture set by the Minister of Maritime Affairs and Fisheries Regulation No. 75 of 2001, which specifies a minimum of 3 mg/L. Pond 5 recorded the highest DO level at 4,7 mg/L, while pond 1 had the lowest at 3,5 mg/L (Table 2 and Table 3). According to SNI: 01- 6148 – 1999, both vannamei shrimp and milkfish require DO levels above 3,0 mg/L for their pisciculture.

DO serves as a crucial indicator of water quality, influencing the oxidation and reduction processes of organic and inorganic substances. Inadequate DO levels can lead to fatality in aquatic organisms. Dahril et al. (2017) highlighted that DO concentrations below 0,5 mg/L can be fatal to fish. Similarly, Siegers et al. (2019) noted that insufficient DO levels can cause milkfish to suffocate. Hence, monitoring DO concentrations in ponds is essential to sustain pond productivity.

B. Differences in Pond Water Quality and River Water Quality

The statistical analysis of pH measurements using the t-test revealed no significant difference between the pH values of ponds 1, 2, and 3 supplied by the Tambak Oso River, and ponds 4, 5, and 6 supplied by the Buntung River for irrigation. This lack of significant variance might be caused by the recent water replacement in the ponds during the measurement period. Information provided by local pond farmers indicates a consistent similarity in the quality of pond water and the river water used for irrigation.

The outcomes of the t-test comparing nitrate values between ponds 1, 2, 3, and the Tambak Oso River, as well as between ponds 4, 5, 6, and the Buntung River indicated no significant variance, except for pond 6. The lack of a significant distinction between the ponds and rivers was due to the exchange of pond water with fresh river water, leading to a tendency for uniformity in water conditions. Conversely, the t-test results revealing a significant difference between pond 6 and the Buntung River could be due to the greater distance of pond 6 from the river, which served as its water source. Aswadi et al. (2019) identified a positive relationship between distance and nitrate levels in the samples, indicating that nitrate levels decrease as the distance from the source increases.

The results of the statistical analysis (t-test) comparing Total Organic Matter (TOM) values between ponds 1 and 2 with the Tambak Oso River, and ponds 4, 5, and 6 with the Buntung River as the irrigation source did not reveal any significant differences. However, a significant difference was observed between pond 3 and the Tambak Oso River. This lack of significant variance was due to pond activities. During sampling, farmers mentioned recently changing the water, preventing organic matter accumulation. The uniformity between pond and river water is believed to explain the absence of differences. In contrast, the distance of pond 3 from the river (approximately 150 m) likely caused the difference with the Tambak Oso River. Water quality changes as distance increases due to various environmental factors and human activities affecting physical, chemical, and biological characteristics during water transportation.

The statistical analysis of Dissolved Oxygen (DO) levels using the t-test between ponds 1, 2, and 3 supplied by the Tambak Oso River, and ponds 4, 5, 6 supplied by the Buntung River for irrigation purposes revealed no statistically significant variances. The absence of significant distinctions was due to pond activities. During sampling, the pond farmer mentioned a recent water change. Moreover, the low DO levels were due to elevated water temperatures. Since measurements were conducted at noon, DO levels appeared

diminished. Higher oxygen solubility is associated with lower temperatures, while elevated temperatures lead to reduced oxygen solubility (Patty & Huwae, 2023).

CONCLUSION

The water quality analysis results of vannamei shrimp and milkfish cultivation ponds in Tambak Oso Village meet the quality standards set by the Minister of Marine Affairs and Fisheries No. 75 of 2016, except for the pond water temperature parameters 4, 5, 6. The Buntung River water quality, used as the pond's source water, also meets the established standards for pond cultivation maintenance. However, in the Tambak Oso River, only the pH parameter fails to meet the quality standards. According to t-test, variances in water quality were observed between pond 3 and the Tambak Oso River, as well as between pond 6 and the Buntung River. The farther the pond is from the water source, the more visible and significant the differences or variations between ponds.

Based on the analysis results, the water quality in the ponds and the river still tends to meet the standards. The decline in production in ponds could be caused by factors other than water quality, such as poor pond management. Therefore, improving overall management and consistently monitoring water conditions in both ponds and rivers as a source of pond irrigation is essential

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