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Physicochemical and Biological Analysis in Busmetik Application System on Vannamei Shrimp (*Litopenaeus vannamei*) Culture in Pasuruan Regency

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ABSTRACT
The method of intensive *Vanname* shrimp cultivation in Pasuruan Regency is carried out using the *Budidaya Udang Skala Mini Empang Plastik* (BUSMETIK) system. BUSMETIK system for *Vannamei* shrimp cultivation is a very productive economic activity, but the quality of the cultivation environment determines its sustainability. Moreover, BUSMETIK system tends to increase from year to year. For example, during the last five years (2016-2020) increased by 7.98 percent. As a result, the number of cultivators who were initially only one group in Lekok District has become 18 groups spread over several areas such as Bangil, Kraton, Lekok and Rejoso. To examine this condition, the purpose of this study was to determine the environmental quality of the Busmetik system of shrimp culture based on physical, chemical and biological factors. This research was conducted on four locations of BUSMETIK shrimp pond system. It was Lekok, Rejosa, Kraton, and Bangil, Pasuruan Regency. The location was chosen purposively with consideration that Pasuruan Regency developed a BUSMETIK system on shrimp culture. The data was collected during the operational cycle period of shrimp culture from march to June 2021. The water quality assessment parameters analyzed were; pH, temperature, dissolved oxygen, biochemical oxygen demand, turbidity, total suspended solids, phosphate, ammonia, nitrate and nitrite. Biological characteristics test includes pathogenic bacteria and plankton identification. The results data from field research analysis results showed that Physical and chemical factors were at the threshold of the quality standard designation for cultivation. In contrast, biological factors show the existence of *Vibrio alginolitycus, V. mimicus, V. fluvialis* bacteria. The abundance of both harmful and beneficial plankton was also found in all sample locations, which means that the nutrients contained are high. So, it can be concluded that the bacteria in ponds are bioecological responses from increased nutrient loads.

Keywords: *Busmetik system, biological factor, physicochemical factor*

1. INTRODUCTION

At the beginning of its development, Shrimp culture is a business activity that provides large profits due to high production and land productivity. This condition is also supported by the high economic value of shrimp (high economic value) and high market demand (high demand product). It attracts a lot of interest from the public and entrepreneurs to invest in this business. *Vannamei* shrimp productivity in Indonesia at the beginning of its introduction (2000-2004) showed relatively high productivity, around 15-20 tons/ha [1]. This production exceeds Black tiger shrimp (*Penaeus monodon*) which is only around 5-6 tons/ha. Cultivation of *vannamei* Shrimp (*Litopenaeus vannamei*) is a commodity currently a prima donna because it is increasingly being developed, especially in Pasuruan Regency.

The intensive *Vanname* shrimp cultivation method in Pasuruan Regency is carried out using the BUSMETIK system. *Vannamei* shrimp cultivation with the BUSMETIK system is a very productive economic activity in improving community welfare and regional income, but the quality of the cultivation environment determines its sustainability. Based on data from the Fisheries Service of Pasuruan Regency, in 2020, the land area for *vanname* shrimp cultivation with the

BUSMETIK system reached 61.58 hectares with 769 plots, and total production reached 2,128.3 tons. The size of land, the number of plots, and the amount of production of *vanname* shrimp culture with the BUSMETIK system tend to increase from year to year. As a comparison, the land area during the last 5 years (2016-2020) increased by 7.98 percent. The number of cultivators who were originally only one group in Lekok District now become 18 groups spread over several areas such as Bangil, Kraton, Lekok and Rejoso.

Vannamei shrimp cultivation activities with BUSMETIK system will produce organic waste, mainly from feed residues, feces, and dissolved cultivation materials that are wasted in the aquatic environment. In *vanname* shrimp cultivation in an incentive manner with the BUSMETIK system, not all of the feed given is consumed by shrimp, but only about 25-30% TN and 10% TP and 30% TC are retained in shrimp meat [2]. The rest will be wasted in the body of water in the form of feces. Vannamei shrimp culture with the BUSMETIK system completely relies on feed input in pellets, which reaches the range of 60%-70% of operational costs with feed conversion rate between 1.3-1.6 [3]. The shrimp will utilize most of the feed provided. Through the digestive process, energy and nutrients will be obtained stored in the shrimp tissue as biomass. This can reduce the quality of aquaculture waters and lead to the emergence of pests and diseases in shrimp which are obstacles that often interfere and are detrimental in aquaculture. Pests can be divided into three groups: predators, competitors, and intruders. Meanwhile, the disease is defined as anything that can disrupt a function or structure of an organ of the body, either directly or indirectly [4].

Diseases in shrimp can be caused by parasites, bacteria, fungi or viruses. Parasites attack vannamei shrimp when pond water quality is terrible, especially in conditions of high organic matter content. The presence of parasites can be prevented by replacing pond water, using probiotics, and managing feeding [5]. Diseases caused by pathogenic microorganisms, either bacteria, viruses, or protozoa, are limiting factors in vannamei shrimp culture. Prevention and control of shrimp disease can be done by increasing the body's defense system by using immunostimulants, vitamins and hormones [6]. To overcome the decline in the quality of the aquaculture environment and to prevent disease, it is necessary to have early detection of physical factors, water chemistry and biological factors related to the content of bacteria, especially *Vibrio sp*. bacteria in shrimp ponds with the BUMETIK system in Pasuruan district. Therefore, the purpose of this study was to analyse physicochemical through water quality factor determine the suitability of water for a particular designation by comparing the status of water quality with water class/water quality standards and biological factors through the identification of bacteria and abundant of plankton.

2. MATERIALS AND METHOD

This research was conducted on four locations of BUSMETIK shrimp pond system, it was Lekok, Rejosa, Kraton and Bangil, Pasuruan Regency. The location chosen purposively with consideration that Pasuruan Regency developed a BUSMETIK system on shrimp culture. The data collection during the operational cycle period of shrimp culture from march to June 2021.

2.1. Physicochemical characteristics test

Several samples were analysed in situ on shrimp pond and other samples were analyzed within 4 hours after collection on UPT laboratory of fish health and environmental (LKIL) Pasuruan. The water quality assessment parameters analysed were; pH, temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), turbidity, total suspended solids (TSS), phosphate, ammonia, nitrate and nitrite. Parameter such as temperature, pH and DO was measured in situ using pH meter and DO meter, which was done during the water sampling at the site by dipping it inside the water for a few minutes. BOD using specification method from IKM/7.2.31/UPT-LKIL (oxitop), TSS using colorimetric, Turbidity was done in accordance to Standard Method 2130B using Turbidity meter. Spectrophotometry methods analysed other parameters according to APHA 2005.

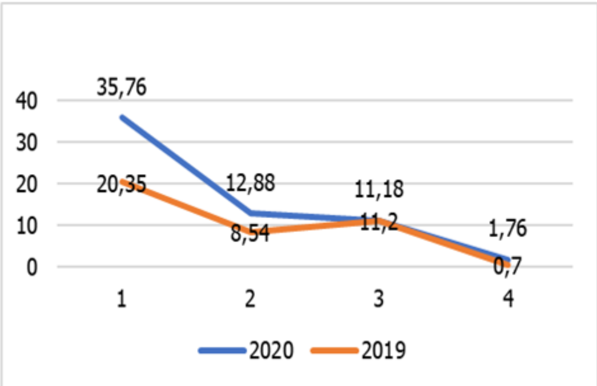
2.2. Biological characteristics test

Biological characteristics test includes pathogenic bacteria and plankton identification. Water samples for biological analysis were analyzed aseptically. Identification of the pathogenic bacteria was performed by serial dilution. The media used to culture the bacteria was media agar 2216 (Difco, United States). 100 microliter for each dilution transferred using micropipette into Petri dishes containing media agar and label as 10^{-1} to 10^{-10}. Using the spread plate method, the samples were spread evenly on the agar, then incubated in an incubator for 48 hours and incubated at 28°C (room temperature) for bacteria growth until the colonies appeared media agar. Sub-culturing was done many times to achieve pure culture. Once a bacterium has been obtained in pure culture, it has to identify—a gram of bacteria characteristic staining method classified bacteria into gram-positive or harmful bacteria.

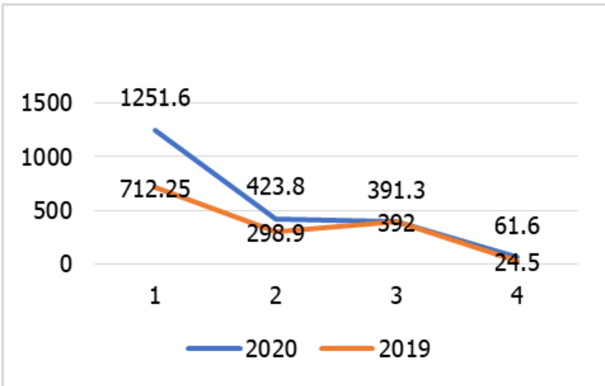
Density and diversity analyses of plankton species were calculated and identified using *Hemocytometer* microscopically with microscope Olympus based applied procedure by APHA (1980). Then plankton abundance is calculated by the formula: $\sum$cell/ml=Nx10^{-1}/1x10^{4} cm^{3}. To determine the diversity of composition and number of individual plankton, the Shannon-Wiener diversity index (Michael, 1995) uses the formula: H' = -∑ pi ln pi; pi = ni/N.

3. RESULTS AND DISCUSSION

Based on data from the Fisheries Service in 2019 and 2020, the BUSMETIK system of shrimp farming in Pasuruan regency continues to increase every year, both in terms of area (Ha) and total production (ton). However, in increasing the capacity of shrimp farming, it is necessary to monitor the physical, chemical and biological factors of water quality so that cultivation can be sustainable.



(a)



(b)

Figure 1 (a) Data of total area of Busmetik system in Pasuruan regency; (b) Data of shrimp production

3.1. Physicochemical Analysis

Physicochemical analysis showed in Table 1. In addition, analysis of water quality based on physical and chemical factors was carried out to determine the suitability of water for a particular designation by comparing the status of water quality with water class/water quality standards. Based on the observation of water quality, physical and chemical factors from Busmetik aquaculture shrimp in 4 sub-districts (Lekok, Rejoso, Kraton, Bangil) in Pasuran Regency, as shown in Table 1.

Table 1. Result data of water quality analysis

Parameters	Standard	Analysis Result (District)			
		Lekok	Rejoso	Kraton	Bangil
Physical					
1. TSS	<200	216	136	127	132
2. Turbidity	<50	30.8	42.10	50	50
3. Temperature	28-32	28.2	33.5	34.1	28.3
Chemical					
1. pH	7-8.5	7.91	7.5	8.07	7.91
2. BOD_5	<45	45	60	45	35
3. PO_4	0.015	1	1	0.5	1
4. NO_3 -N	<75	10	20	20	10
5. NO_2 -N	<0.25	0.25	0.1	0.25	0.1
6. NH4 -N	0.3	0.5	0.25	0.25	0.6
7. DO	>5	4.8	5.7	6.49	4.9

The results of water quality parameters in Table 1 show that many parameters are at the threshold of aquaculture water quality standards, both in the sub-districts of Lekok, Rejoso, Kraton and Bangil. This indicates a decrease in the quality of aquaculture water, which will lead to failure in shrimp farming if continued continuously. The results showed that the average temperature was in the range of 28.2-34.1°C. The temperature in Kraton district is the highest. The temperature of the water is essential because temperature itself influences other water quality parameters like dissolve oxygen, pH and photosynthesis production. An increase of temperature could decrease the solubility of the oxygen and other gases in water, which could affect the aquatic habitat and organisms in water. The dissolved oxygen recorded during the study was in good condition, in 4.8-6.49 mg/l. Good dissolved oxygen ranges from 4-6 ppm [7]. Likewise, according to Adiwijaya et al. [8], the optimum dissolved oxygen concentration for shrimp is above 4 mg/l, a low dissolved oxygen content below 1.5 mg/l will be lethal for shrimp.

Dissolved oxygen, which is often abbreviated as DO as a hydrobiological parameter, is considered very important because its presence determines the life and death of organisms. The availability of oxygen in the water determines the life of shrimp, both for survival and for growth. Low oxygen content in ponds often occurs during dry, windless periods. In addition, at night, where the temperature becomes low, followed by increased phytoplankton activity, it usually decreases oxygen content [9]. Efforts to improve the DO number are carried out by using a waterwheel. DO indicates the amount of oxygen that is available in the water. The high value of DO indicates the high quality of the water. If the value of DO is low, it might be because of the organic matter contained in the water because organisms in the water use oxygen to break down and decompose the organic matter.

As with other water quality parameters, pH also has a vital role in the aquaculture process. pH is an important ecological factor that provides crucial information about many types of geochemical equilibrium or solubility calculation that affects flora and fauna of the aquatic system. Changes in the pH value will affect the distribution of water chemical factors. According to the Drinking Water Quality Standard, pH of drinking water has to be in the range of 6.5-9.0. Because pH more than the range could cause irritation and worsen the skin condition [10]. The pH of the water rarely drops below 6.5 or increases to a value of 9, so adverse effects on cultivation are rare [11]. The pH in this study was still in the range of 7.5-8.07.

Total suspended solids (TSS) are solids that do not pass through 20 m filter paper or are not soluble in water and only float around [12]. TSS at study sites ranged from 127–216 mg/L. When compared to the quality standard, all sub-districts are below the quality standard, except for the Lekok sub-district which has a TSS value above the quality standard. These results indicate that the vannamei shrimp culture activity with the BUSMETIK system can increase pond water's total suspended solids content through the accumulation of feed residues and the excretion of shrimp metabolism products in the form of other suspended materials. According to Ray et al. [13], although suspended solids have an essential role in providing substrate for the microbial community, at high concentrations, it can result in an increase in oxygen demand and reduce the growth rate of vannamei shrimp.

3.2. Biological Analysis

Biological analysis of the Busmetic system of shrimp ponds, identification of pathogenic bacteria and identification, and plankton abundance were carried out. Bacteria are the most common disease agents [14]. The results showed that at 4 sample locations observed the presence of *V. mimicus* bacteria was detected; *V. alginolyticus* and *V. fluvialis. Vibrio sp.* is a type of gram-negative bacteria that is opportunistic pathogenic towards vannamei shrimp [15]. Kent [16] stated that Vibrio bacteria can develop as an opportunistic pathogen. According to Otta and Karunasagar [17], this can occur if there is an increase in organic material sourced from feed and feces, which encourages microflora to develop into opportunistic pathogens. The physical-chemical quality factor of poor water is the main trigger for the vibrio abundance in intensive ponds [18].

Table 2. Pathogenic bacteria identification

Sample Location	Pathogen Bacteria
Lekok	*Vibrio mimicus*
Rejoso	*Vibrio alginolyticus*
Kraton	*Vibrio alginolyticus*
Bangil	*Vibrio fluvialis*

Table 3. Analysis of Plankton Types and Numbers

Location	Beneficial	Harmful
Lekok	*Navicula* sp. ($4x10^4$) *Gyrosigma* sp. ($2x10^4$) *Frustulia* sp. ($2x10^4$)	*Nitzschia* sp. ($2x10^4$) *Oocystis* sp. ($1x10^4$)
Rejoso	*Navicula* sp. ($3x10^4$) *Frustulia* sp. ($1x10^4$) *Cyclotella* sp. ($1x10^4$)	*Nitzscia* sp. ($6x10^4$) *Oocystis* sp. ($1x10^4$)
Kraton	*Navicula* sp. ($4x10^4$) *Cyclotella* sp. ($4x10^4$)	*Coscinodiscus* sp. ($1x10^4$) *Oscillatoria* sp. ($1x10^4$)
Bangil	*Pleurosigma* sp. (4.7x105) *Chorella* sp. ($1.4x10^5$) *Navicula* sp. ($1x10^5$)	*Coscinodiscus* sp. ($6x10^4$) *Microcystis* sp. ($1x10^4$) *Nitzschia* sp. ($1x10^4$)

Vibriosis is a disease caused by Vibrio sp. bacteria, and can cause death in vaname shrimp (*L. vannamei*) aquaculture activities [19]. Vibriosis attacks can cause death up to 100% in larval or juvenile stages [20]. Jayasree, et al. [21] reported several types of bacteria of the Vibrio genus that cause vibriosis in shrimp include V. *harveyi, V. parahaemolyticus, V. alginolyticus, V. anguillarum, V. vulnificus,* and *V. splendidus*. Shrimp infected with clinical vibriosis is characterized by red carapace, melanosis of the skin, necrosis on tail and hepatopancreas are dark red, and lesions are found [22]. Management of handling poor water quality is the main reason vibrio is so diverse and plentiful in intensive aquaculture waters [23]. To overcome the level of pathogenicity vibriosis on ponds, it can be carried out both chemically, physically, and biologically according to environmental conditions, culture methods and financial capabilities [24].

The results of research on the Busmetik system ponds on shrimp farming in Pasuruan district show that there is a lot of abundance of plankton from various genera, both beneficial and detrimental. The harmful plankton found were *Nitzschia sp., Oocystis sp., Coscinodiscus sp., Oscillatoria sp., and Microcystis sp*. Plankton are microscopic organisms that live floating in water, do not move or move slightly and always follow the current. Plankton are divided into 2 groups;

namely plant nature called phytoplankton and animal species called zooplankton [25]. Its ecological function as a primary producer and the beginning of the chain in the food chain causes phytoplankton to be often used as a measure of the fertility of a waters, in addition to functioning in the balance of aquaculture ecosystems, phytoplankton also functions as the main producer and natural feed in shrimp farming [26]. *Oschillatoria* is a plankton that belongs to the *cyanophyta*, which is the genus and the lowest. The discovery of this genus is because this genus has a remarkable ability to tolerate environmental changes such as temperature, salinity and pH so that it can live in various environmental conditions. Although many are found, *oschillatoria* is not profitable if there is a bloom, it can cause water conditions to turn bluish-green and release toxins. cyanotoxin) which is harmful to the survival of shrimp. This is because Oscillatoria can adapt to extreme environments and is able to live at low light intensity [27].

Beneficial plankton are found in the class chloropyta, genus chlorella. The existence of chlorella is thought to be caused by environmental conditions, especially the quality of pond water that is by their habitat. Chlorella has a chloroplast used for the photosynthesis process where body cells contain chlorophyll so that these autotrophic organisms can photosynthesize directly and are natural food contributors in pond waters [28]. The abundance of Chlorophyceae is because they can carry out photosynthesis and live from inorganic nutrients and produce organic substances from CO_2 by photosynthesis. The quantity of phytoplankton seen from each class shows that the high number in the Chlorophyta class dominates over the cyanopyta, diatom, and dinoflagellate classes. Class Bacillariophyceae was also found in ponds in every sub-district observed. The class Bacillariophyceae dominates ponds due to the availability of essential nutrients for growth in the form of ammonia, nitrate and nitrite due to feeding and waste. This is in accordance with the results of research conducted by Widjaya [29] that one of the beneficial phytoplankton that is expected to grow in ponds is the Bacillariophyceae class which grows optimally at the age of shrimp between 70 and 90 days were conditions like this experience enrichment of nutrients so that changes in ecology and productivity changes. However, because the abundance is relatively high, it shows that the nutrients in the pond are very high.

4. CONCLUSION

The conclusion of this study shows that the water quality of the Busmetik system of shrimp pond culture in Pasuruan district, through physical, chemical and biological parameters, shows that the quality of aquaculture water is starting to decline. Physical and chemical factors showed the analysis results were at the threshold of the quality standard designation for cultivation, while from biological factors, *V. alginolitycus, V. mimicus, V. fluvialis* bacteria were found in Lekok, Rejosa, Kraton and Bangil sub-districts. The abundance of both harmful and beneficial plankton was also found in all sample locations, which means that the nutrients contained are high. The harmful plankton were *Nitzschia sp., Oocystis sp., Coscinodiscus sp., Oscillatoria sp.,* and *Microcystis sp.,* which is harmful to the survival of shrimp.

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