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Milkfish (*Chanos chanos Forskal*) Traditional Pond Stability Based on Microalgae Periphyton Availability and Water Quality Analyses

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ABSTRACT

Milkfish (*Chanos chanos*) is one of the highly commercial fisheries commodities in Indonesia. Pond stability of milkfish especially in the juvenile phase can be influenced by several factors including periphyton availability and water quality. This recent study aimed to assess the milkfish traditional pond stability in the fingerling phase based on microalgae periphyton availability and water quality aspects. The research was conducted in a traditional pond located in UPT Fisheries Brackish and Saline Water Probolinggo for three months. Microalgae periphyton and water quality analyses were conducted in situ and ex situ, respectively. The results show that Microalgae periphyton was from sub division Bacillariophyceae and Chlorophyceae were found during the research. However, the abundance of Bacillariophyceae is significantly higher than another descriptively. Furthermore, several parameters of water quality are in good condition (stable) except for ammonia, TOM, and orthophosphate. PCA analyses depicts the relation between microalgae periphyton and water quality which transparency, DO, TOM, temperature, and ammonia were the more influenced factors to the abundance of microalgae periphyton in pond.

Keywords: fingerling, milkfish, periphyton, traditional pond

1. Introduction

Milkfish are widely cultured in Indonesia which belongs to big ten commodities with high production (KKP, 2015; Suharno et al, 2017). They are hardy and one of the cheapest sources of protein, which are economically acceptable to the consumer within the country (Baliao et al., 1999; WWF, 2014). These species are more stable on their growth than shrimp. Besides, the culture process is less complicated because most of the culture system is held traditionally. Characterization of traditional culture system is low species density in a pond and no water quality control during the culture period (Prasetio et al, 2010; Arsad et al, 2017). In general, milkfish culture consists of several phases: hatchery, fingerling and rearing phase at the end. Naturally, these organisms consume natural feed such as plankton and periphyton in pond depend on their size and age. Natural feed types availability influenced by environment water quality. Diatoms would be abundant when the water quality in the pond is good enough. However, Cyanophyta would be dominant when the water quality is on poor condition.

The aim of the present study was to assess the milkfish traditional pond stability in the fingerling phase based on microalgae periphyton availability and water quality aspects. These aspects are very important during milkfish growth and their production as well as their food habit.

2. Materials and Method

The research was carried out in milkfish fingerling traditional pond during three months in UPT Fisheries Brackish and Saline Water Probolinggo (Fig 1). Both microalgae periphyton and water quality samples were collected for three times with two sites (inlet and outlet) every two weeks during the research. Several water quality measurements were conducted *in situ i.e* temperature (°C, DO meter 5510), transparency (cm, Secchi disk), salinity (‰, Refractometer HTC), dissolved oxygen (mg L^{-1}, DO meter 5510), pH (pH meter Hanna), and CO_2 (mg L^{-1}, Titration technique). Furthermore, Nitrate (mg L^{-1}), Orthophosphate (mg L^{-1}), Total Organic Matter (TOM, mg L^{-1}), Ammonia (mg L^{-1}), microalgae periphyton identification, composition, and abundance (Ind cm^2) were measured *ex situ*.

Fig 1. Fingerling Traditional Pond of Milkfish (Research documentation, 2017)

2.1. Microalgae Periphyton Sampling and Analyses

In the beginning, the artificial substrate (ceramic 20x20 cm^2) was placed in the bottom of the pond and leaved it for 14 days. Furthermore, the artificial substrate was taken to the surface to remove the periphyton which attached in the substrate by using smooth teeth-brush into the pail while rinsing the ceramic with water (Weitzel (1979), Biggs and Kilro (2000) modified, personal comm. Arfiati, 2017). This process was done each two weeks for three times. Moreover, the water containing periphyton is pulled into the bottle film and preserved by adding lugol and transported to the laboratory for further analyses.

Microalgae periphyton types were identified by manual book identification of Prescot (1978) and Davis (1955). Microalgae periphyton abundance then determined by using APHA (2005) by the following equation:

$$\mathrm{K}=\frac{\mathrm{n.At.Vt}}{\mathrm{Ac.Vs.As}} \text{ .... (1)}$$

Where *K* is the periphyton abundance (Ind cm^{-2}), *n* is the number of periphyton observed (Ind), *As* is substrates wide (20x20 cm^2), *At* is *cover glass* wide (20x20 mm^2), *Ac* is width field of view (mm^2), *Vt* is sample volume of periphyton (mL), and *Vs* is the sample volume observed (mL).

Relative abundance (%) was also measured to see the presentation of each division found during the study in the following equation (Prescott, 1970):

$$KR = \frac{ni}{N} x\ 100\% \text{ .... (2)}$$

Where *KR* is relative abundance (%), *ni* is the individual number in the genus (Ind), and *N* is the total of individual observed.

Diversity index was calculated to categorize the pond stability based on periphyton abundance by using Shanon Wiever (1949) formula (Sournia, 1978):

$$\mathrm{H'} = \mathrm{Pi}\log 2\ \mathrm{pi} \text{ .... (3)}$$

Where *H'* is the diversity index, *Pi* is ni/n, and $\log_2$ *pi* is the determined value by Shanon Wiever Table category.

2.2. Water Quality Indices

Nitrate and orthophosphate were analyzed by using Spectrophotometry principle (BSN, 2011 and Boyd, 1982), correspondingly. In addition, Total Organic Matter (TOM) was analyzed using Permanganate method (BSN, 2004) and

Ammonia (NH_3) was quantified by using Boyd (1982).

2.3. Statistical Analyses

All the data were analyzed statistically by using Ms. Excel. 2016 and Minitab 18. According to Sawono (2017), PCA analysis is used to reduce existing variables to fewer principal variables and detect the relationships between variables based on similarity characteristics. PCA analysis could show the more significant variable of ten water qualities which influence the presence of microalgae periphyton.

3. Results and Discussion

3.1. Microalgae periphyton Composition and Abundance

Identification result of composition and abundance measurement of microalgae periphyton in fingerling milkfish traditional pond for 6 weeks resulting microalgae periphyton composition *i.e* Bacillaryophyceae (10 genus) and Chlorophyceae (3 genus). From Bacillaryophyceae, the genus identified consisted of *Navicula*, *Nitzchia*, *Coconeis*, *Cymbela*, *Cyclotella*, *Pinnularia*, *Amphora*, and *Surirella*. Therefore, *Chlamydomonas, Schroederia,* and *Ulothrix* were identified from Chlorophyceae. Total microalgae periphyton abundance was found in first week of observation was 7,352,090,615 Ind cm^{-2}, meanwhile for week-2 and week-3 the abundance was 5,652,359,679 and 7,724,221,056 Ind cm^{-2}, sequentially. Most of the microalgae periphyton found was from sub division Bacillariophyceae. Junda et al (2013), mentioning that microalgae periphyton organisms tend to live in the water area which there is enough of light radiance. The relative abundance (KR) composition of autotroph periphyton illustrates in Fig. 2.

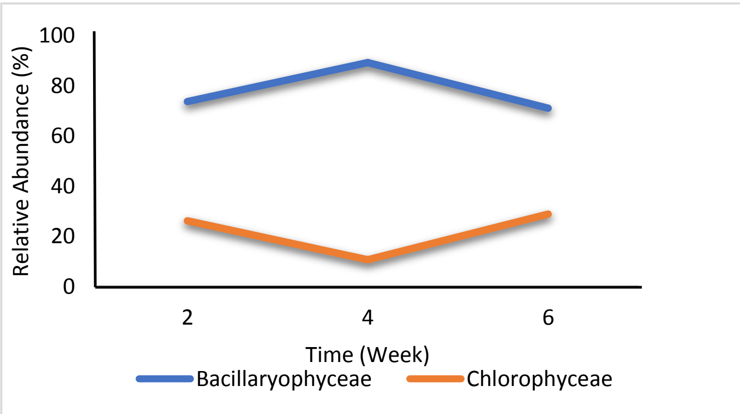

Fig. 2. Relative abundance (%) of microalgae periphyton in pond

Based on Fig 2., the relative abundance of Bacillariophyceae was more than 70%, whereas Chlorophyceae was only under 30%. It could be explained by their characteristic. Bacillariophyceae is tending to attach to the substrates because they have mucilage short or long gelatin with hard semi round shape. It's also belonged to microalgae, which adapt easily to the environment and they are distributed widely in the aquatic environment (Werner, 1977). This sub division plays an important role as phytoplankton or periphyton because of their function as a food source for zooplankton or herbivore fishes (Reynold, 1990). This is one of the reasons why Bacillariophyceae is very abundant in the water environment.

Diversity index in pond ranged from 2.631 to 3.015. It indicates that he community of microalgae periphyton belongs to moderate to stable condition. If H' < 1 illustrate that the community is not stable, while H' is between 1-3 is moderate, and H'>3 assumes that the community is stable. Low diversity index represents that there is a dominance of such species in the water pond, whereas high diversity index shows that the water environment is appropriate with algal growth.

3.2. Water Quality Parameters

Water quality parameters were measured in inlet and outlet that considerably representatives for describing all the water quality in the pond (Table. 1). Minimum, Maximum, STDEV, and Variation Coefficient (CV) are presented in Table 2. Based on CV value, several water quality parameters i.e. temperature, transparency, pH, DO, and nitrate were relative stable during 6 weeks of measurement and CO_2 value was undetectable (zero). In contrast, TOM, ammonia, and orthophosphate were varied during the research. Patel and Shiyan (2001) stated that the critical limit of CV based on most of the field experience in different spatial and temporal is 33%.

The TOM ranged between 139.04 and 379.20 mg L^{-1}, which is noticeably high. Afu (2005) expressed that normal TOM's value is approximately 0.01-30 mg L^{-1}, and when the value higher than the range means that water environment is polluted by organic matter. Variation in TOM tends to increase from Week 2 to Week 4 then finally decrease in Week 6.

Table 1. Water quality result in pond.

No.	Parameter	Observation period		
		Week 2	Week 4	Week 6
1	Temperature (^{0}C)	28.10	32.80	33.00
2	Transparency (Cm)	44.35	31.85	43.25
3	pH	7.80	8.20	8.10
4	DO (mg L^{-1})	5.66	8.62	5.57
5	CO_2 (mg L^{-1})	0.00	0.00	0.00
6	TOM (mg L^{-1})	145.36	331.8	202.24
7	Ammonia (mg L^{-1})	0.07	0.08	0.27
8	Salinity ($^0/_{00}$)	21.00	15.50	27.00
9	Nitrate (ppm)	0.11	0.14	0.13
10	Orthophosphate (mg L^{-1})	0.04	0.07	0.004

Table 2. Detail of Water Quality Value in pond

Water Quality indices	Min	Max	STDEV	CV
Temp (^{0}C)	28.00	33.10	2.63	8.50
Transp (Cm)	31.30	44.50	6.20	15.58
pH	7.80	8.20	0.19	2.32
DO (ppm)	5.32	8.68	1.57	23.69
CO_2 (ppm)	0.00	0.00	0.00	0.00
TOM (ppm)	139.04	379.20	92.06	40.65
Ammonia (ppm)	0.02	0.33	0.11	81.41
Sal ($^0/_{00}$)	15.00	27.00	5.15	24.35
Nitrate (ppm)	0.08	0.16	0.03	25.41
Orthophosphate(ppm)	0.004	0.07	0.026	82.84

The fluctuated value of ammonia and orthophosphate (Table. 2) indicates that organic decomposition is not going well as it supposed to be. This could provoke the presence of toxic compounds such as ammonia and high abundance of orthophosphate.

Ammonia value ranged from 0.02 to 0.33 mg L^{-1}. Based on PP RI No. 82 (2001), quality standard ammonia compound is 0.5 mg L^{-1}. In addition, Lind (1979) estimated that ammonia in the unpolluted water and well-oxidized normally less than 1 mg L^{-1}. This indicates that concentration of ammonia observed in milkfish pond is still under the minimum quality standard. On the other side, orthophosphate is the limiting factor of algal growth. A high value of orthophosphate will cause blooming phenomenon. An optimal value of orthophosphate in water pond ranged from 0.051 to 0.1 mg L^{-1} (Kadim and Arsad, 2016). In our study, the orthophosphate value in the pond was categorized as low (0.004-0.07 mg L^{-1}). However, less orthophosphate in pond could be caused by organic decomposition process is not going well.

Table 3. Loading of experimental water quality variables on significant principal components

	Eigenvalue	
	F1	**F2**
Value	**6.6866**	**3.3134**
Proportion	0.669	0.331
Cumulative	0.669	1.000
	Eigenvectors	
Periphyton Abundance	-0.376	0.127
Temperature	0.197	**0.473**
Transparency	**-0.387**	-0.009
pH	0.285	0.371
DO	**0.385**	-0.049
TOM	**0.376**	0.130
Ammonia	-0.162	**0.499**
Salinity	-0.316	0.316
Nitrate	0.308	0.332
Orthophosphate	0.280	-0.379

Based on PCA analysis (Table.3), the main factors influencing microalgae periphyton abundance is transparency, Dissolved oxygen (DO), and Total organic matter (TOM) with F1 value is 66.9%. Meanwhile F2 is 33.1% showed the main water quality parameter is temperature and ammonia. Therefore, the water quality which influence the abundance of microalgae periphyton was transparency, DO, TOM, temperature, and ammonia. Determination of water quality is determined by looking at the value of the eigenvector which is considered as the largest.

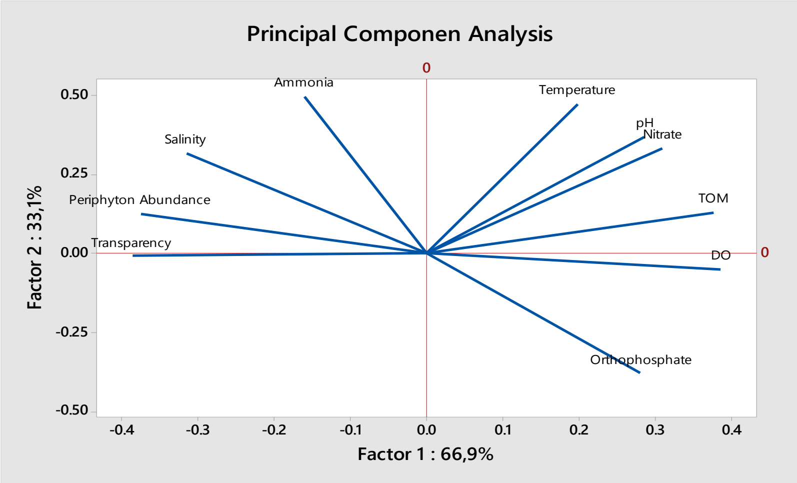

Fig. 3. Principal Component Analyses Between Periphyton Abundance and Water Quality Parameters

Fig. 3 depicts the more influenced water quality is transparency, DO, TOM, temperature and ammonia. The relationship between parameters could also be seen based on the size of the angle, where the presence of periphyton is very closely related to the salinity, transparency, and ammonia. Low transparency value will limit the penetration of light and as consequence of a decrease of photosynthetic ability (Harmoko and Krisnawati, 2018). On the other side, Hutchinson (1967) stated that chlorophyta and diatom preferred nitrogen form of nitrate and ammonia. In addition, salinity is an important environmental factor influencing microalgal growth in marine algal cultures. Changes in cellular volume and osmotic modification were noticed in microalgae within salinity variation (Kumar & Saramma, 2018). Microalgae is categorized into group of halophilic (salt requiring for optimum growth) and halotolerant (having response mechanism that permits their existence in the saline medium). In both these conditions, microalgae produce some metabolites to protect themselves from salt injury and as a balance to the surrounding osmotic pressure.

4. Conclusion

The stability of milkfish pond in terms of biological aspects (microalgae periphyton) was included into category of moderate to stable stability. It means that the research ponds are still quite good and still suitable for cultivation. Furthermore, our study indicates that microalgae periphyton abundance was mostly influenced by transparency, DO, TOM, temperature and ammonia. Therefore, high organic matter is needed to be controlled because it will affect the life of the organism and could cause toxic compounds when the decomposition process is not going well.

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