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Contribution of *Gracilaria verrucosa* on water quality improvement at fishpond in Muara Gembong coastal waters, Bekasi Indonesia

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Abstract

The waste present in the pond comes from inside (can be NH_4 , NO_3 , and PO_4) and outside the pond (Pb). One of the ponds that experience this is a pond in the Muara Gembong coastal waters. To remediate these wastes can use algae *Gracilaria verrucosa* in one cultivation cycle. The result obtained is a NH_4 of 0.89-22.5 ppm, NO_3 of 3.05-93 ppm, and PO_4 of 0.01-0.52 ppm. The t-test result, in general, is $x > 0.05$, which means the water quality of the control pond and the treatment pond are no different. Algae *Gracilaria verrucosa* in pond treatment absorbs lead heavy metals (Pb). The test result of the ratio is the ratio of Pb A > the ratio of Pb B, which means the Pb in Algae comes from pond water. The presence of *Gracilaria verrucosa* algae in ponds does not contribute to improving the quality of pond water.

Keywords: Algae, water quality, Pb, pond, Muara Gembong

1. Introduction

Pond water quality plays an essential role as a living medium for biota cultivation. Therefore, water quality parameters such as temperature, dissolved oxygen (DO), and degree of acidity/pH should be within the recommended range for the life and growth of the biota. Water quality outside the optimum range of living needs will cause stress so that it can result in biota being more susceptible to disease. The water quality conditions must be considered to stay normal (Kordi, 2007) ^[17].

Aquaculture of pond waters goes into a transitional ecosystem, where the mixing of freshwater and marine water sources is mixed. These ecosystems receive pressure from both water sources, making it sometimes difficult to meet optimal water quality needs (Komarawidjaja, 2005) ^[16]. It can affect the growth and survival of cultivated biota.

The feed given to farm cultivation biota is one of the main factors that affect the growth of the biota (Boyd, 1990) ^[5]. In fishery cultivation in general, only 30% of the total feed can be absorbed as nutrients by the body of the cultivated animal, and the remaining 70% is not absorbed and produces waste from the results of its metabolism (Ihsan *et al.*, 2015) ^[13]. The type of waste produced in aquaculture activities in the form of waste metabolites or waste in the form of feces and ammonia derived from the decomposition process of organic matter, inedible feed waste, and dead plankton populations, contains nutrients high in the form of nitrogen compounds (proteins, amino acids, urea), carbohydrates, vitamins, and fats (Soelistyowati *et al.*, 2014) ^[27] which can be an environmental factor for growth or death for specific biota in the pond.

The waste in the pond comes not only from the pond's waters but also from the outside waters that enter it. Water input on ponds usually comes from land and sea that contain anthropogenic wastes, including industrial waste, such as in the waters of Muara Gembong in the Bekasi area. This area receives pressure and waste burden directly from industrial activities. Waste from outside Bekasi also entered these waters, so pollution increased (Hardiani, 2005) ^[12]. One of them is sediment or mud from the dredging of Tanjung Priok port ponds because this discarded sediment or mud is reported to contain heavy metals with fairly high levels (Perumpel 1990, in Bengen *et al.*, 1994) ^[4].

Pollution in the waters of Muara Gembong can cause a decrease in water quality so that it will have an ecologically negative impact, and there can be an accumulation of heavy metals in the bodies of biota living in these waters. Water quality conditions in Muara Gembong enter into the status of moderately polluted water quality for marine life (Hardiani, 2005) [12].

According to MacFarlane (2001) [18], one of the most heavily issued heavy metals industries is Lead (Pb). Lead is a dangerous toxic heavy metal (Ika *et al.*, 2012) [14]. Pb can be accumulated directly from water and sediment by organisms living in that environment. According to the Ministry of Environment (KLH) [15], the safe limit of lead (Pb) for seawater is 0.008 ppm, while the lead content in Muara Gembong has exceeded the safe limit (Pribadi *et al.* 2017) [23]. Therefore, efforts must be made to improve the quality of its main waters in the pond water of Muara Gembong. The use of algae as a waste reduction agent can be one of the efforts because the use of algae is part of the method of handling waste in the waters biologically and using the help of enzymes, bacteria, and fungi. Algae can also be mandated to reduce other types of waste, such as cultivated waste and heavy metals (Baihaqi *et al.*, 2017) [3]. Algae that can be used in remediation is *Gracilaria* (Ihsan *et al.*, 2015 [13]; Komarawidjaja, 2005 [16]). *Gracilaria* is easy to cultivate because it can live in about 15-50 ppm (Soelistyowati, 2014) [27]. Algae in Muara Gembong is *Gracilaria verrucosa*.

The study aims to analyze the contribution of *G. verrucosa* algae in improving the quality of pond water in Muara Gembong and analyze the presence of accumulated lead heavy metals (Pb) and estimates absorbed by *G. verrucosa* algae in ponds in Muara Gembong.

2. Materials and Methods

2.1 Time and Place

This study was conducted in October - December 2018, with sampling conducted on ponds in Muara Gembong, Bekasi Regency. Water quality tests and lead-heavy metal content (Pb) in algae, water, and sediments were conducted at the Department of Soil and Land Resources Laboratory, Faculty of Agriculture, IPB. Cod tests are conducted in Proling, FPIK, IPB.

2.2 Data Retrieval and Sample Handling

The data measured in this study was the water quality and heavy metal content of lead (Pb) in algae, water, and sediment. Sampling was carried out at one cycle of cultivation, namely at the beginning of the nursery, the middle of the cycle, and during the harvest, with each of 3 spatial

repeats. The water quality analysis taken was temperature, pH, salinity, COD, NH4, NO3, PO4.

The determination of sampling location is adjusted by considering the survey results at the Initial Observation Stage in the field. The needs expect the principle of determining this location of this study:

1. The control pond was a productive pond that contains biota cultivation (Bandeng fish).
2. The treatment pond was a productive pond that contains biota cultivation (Bandeng fish), and there are *algae G. verrucosa*.

With an average area per pond ± 1 Ha or with a size of 100m x 100m, the measurement was conducted three times, namely near the water input, the middle of the pond, and near the disposal of water furthest point from the water input.

Testing heavy metal content on samples of water, algae, and sediments using the AAS method was carried out in the laboratory. Information about the advantages and problems of propagation in Muara Gembong was conducted through interviews with the owners and managers of the pond.

2.3 Data Analysis

Water quality data were analyzed with the t-test analysis method (Priyatno, 2010) [24] to see a real difference between the quality of the control pond water with the treatment pond. Based on probability:

H₀ research is accepted if significant > 0.05

H₀ study is rejected if significant < 0.05

Lead heavy metal (Pb) data was analyzed based on the ratio of each lead-heavy metal (Pb) content in water, sediment, and algae samples from control ponds and treatment ponds (Tampubolon *et al.*, 2013) [29]. It is done to see that the uptake of Pb in algae is thought to come from sediment or pond water.

$$\text{Ratio Pb A} = \frac{\text{Pb concentration in algae}}{\text{Pb concentration in water}}$$

and

$$\text{Ratio Pb B} = \frac{\text{Pb concentration in algae}}{\text{Pb concentration in sediment}}$$

If the Ratio of Pb A > The Ratio of Pb B, then the Pb in algae comes from pond water; if the Ratio of Pb A < the Ratio of Pb B, then the Pb in algae comes from pond sediments.

3. Results and Discussions

3.1 Water Quality Analysis

Table 1: Measurement Results of Temperature Parameters, pH, and Salinity

Sample	Parameter					
	Temperature (°C)	QS	pH	QS	Salinity (ppm)	QS
Beginning	36-39	Alga	7.5-8.6	Alga	32-39	Alga
Middle	31-39		7.8-8.4		6.8-9.0	
End	30-32	Cultivation	8.0-8.2	Cultivation	28-30	Cultivation
		28-32		7.0-8.5		5-35

Information

QS: *Quality Standard* (Anggadiredja *et al.*, 2009; SNI 01.6148.1999) [2, 26].

The water temperature measurements on all sampling ponds range from 30-39 °C. Temperature differences in waters are caused by different data retrieval times and are influenced by solar radiation and air temperature at all times (Boyd, 1990 [5];

Wulan *et al.*, 2013) [30]. These temperature conditions are not the optimal temperature for the growth of *algae G. verrucosa* which ranges from 20-30 °C (Anggadiredja *et al.*, 2009) [2] and is higher than the water quality pond of bandeng fish

farming which is 28-32 °C (SNI 01.6148.1999) [26]. This high temperature was also caused by a prolonged drought when this study was conducted. It can affect the adsorption of heavy metals in water because high temperatures can dissolve heavy metals in water (Palar, 2012) [22].

The results of water pH measurements on all sampling ponds range from 7.5-8.6, which means it is still in the range of water quality of bandeng fish pond cultivation which is 7.0-8.5 (SNI 01.6148.1999) [26], and the effect of *G. verrucosa* algae adjustment power to pH which is 6.8-9.0 (Fauziah, 2019) [8]. Variations in water pH values can be caused by several factors such as photosynthesis, primary productivity, and organic decomposition (Bragadeeswaran *et al.*, 2003) [6]. If the pH in the waters is low, it can result in decreased photosynthetic activity of phytoplankton and algae so that the dissolved oxygen produced is not so much (Manurung *et al.*, 2015) [19]. In addition, it can release toxic compounds and free elements derived from sediments into water and algae (Habeeb *et al.*, 2015) [10], this inhibiting algae growth and can cause death (Fauziah, 2019) [8].

Salinity measurement results in all pond sampling waters range from 27-39 ppm. The difference in salinity is caused by the distance of the sampling pond with the sea and the input of water from the river; the closer to the sea, the higher the salinity (Komarawidjaja, 2005) [16]. Salinity values can also be caused by water circulation patterns, freshwater supply to seawater, evaporation, rainfall, seasons, topography, tides, and river flow (Nybakken, 2000; and Nontji, 1993) [21, 20]. Salinity in sampling ponds is not the optimal condition for the growth of *G. verrucosa* algae, which ranges from 20-28 ppm (WWF-Indonesia, 2014) [31] and is higher than the water quality range of pond ponds of bandeng fish cultivation which is 5-35 ppm (SNI 01.6148.1999) [26]. Higher salinity values can lower the toxicity of heavy metals in waters (Darmono, 2001) [7].

Table 2: Results of t-Test COD, NH₄, NO₃, and PO₄

Sample	t-Test			
	COD	NH ₄	NO ₃	PO ₄
Beginning	0.556	0.028	0.286	0.145
Middle	0.859	0.209	1	0.486
End	0.386	0.130	0.651	0.388

The COD measurements on all sampling ponds ranged from 60.03-305.06 ppm. The test value of t COD in all tests was significant > 0.05. Hence H₀ this study was accepted, which means algae *G. verrucosa* does not improve the quality of pond water (COD) in Muara Gembong.

NH₄ measurement results on all sampling ponds ranged from 0.89-22.5 ppm. NH₄'s t-test value at the beginning of testing (all ponds were not algae) was significant <0.05, but at the middle and end of significant > 0.05, the H₀ of this study was accepted, which means *G. verrucosa* algae did not contribute to improving the quality of pond water (NH₄) in Muara Gembong.

The NO₃ measurements on all sampling ponds range from 3.05-93 ppm. Fertility of Muara Gembong pond waters based on NO₃ content, including high fertility, is >1,129 ppm (Vollenweidwer, 1963 in Gunawati, 1984) [9]. The test value t NO₃ in all significant tests > 0.05, then H₀ this study was accepted, which means algae *G. verrucosa* does not improve the quality of pond water (NO₃) in Muara Gembong.

The results of PO₄ measurements on all sampling ponds range

from 0.01-0.52 ppm, which means it is still in a good range for seaweed growth which is 0.09-1.80 ppm (Andarias, 1992) [1] and is still included in the range of pond water quality of ponds of bandeng fish cultivation which is 0-1 ppm (SNI 01.6148.1999) [26]. PO₄ values can be affected by currents and stirring of water masses, causing the rise of PO₄ content from the base to the water level (Simanjuntak, 2006) [25]. The test value t PO₄ in all tests is significant > 0.05, so the H₀ study was accepted, which means algae *G. verrucosa* does not improve the quality of pond water (PO₄) in Muara Gembong.

3.2 Pb Content Analysis

Table 3: The average concentration of Pb metal in water, sediment, and algae in the pond waters of Muara Gembong

Sample	Quality Standard ^{*)}	ppm			
		Control 1	Control 2	Treatment 1	Treatment 2
Air	0.008	0.07	0.04	0.05	0.07
Sediment	30.2	2.78	2.34	2.58	2.47
Alga	-	-	-	6.84	7.06

Information:

^{*)} Ministry of LH No.51/2004 [23]

Lead metal (Pb) is commonly used as batteries, cables, pesticides, ceramic and porcelain glass coatings, and gasoline fuel in everyday life (Pribadi *et al.*, 2017) [23]. Pb pollution in the waters in the estuary can come from rivers, seas, and air. Pb pollutants in the air can enter the waters with the help of rainwater (Palar, 2012) [22]. The presence of Pb in the waters can be harmful to the biota of these waters.

The average value of the measurement of Pb content in water in pond waters in Muara Gembong ranges from 0.04-0.07 ppm, which means that it far exceeds the quality standards set in the Ministry of LH No.51 of 2004 [15], which is 0.008 ppm. The high content of Pb in water can be caused by ponds adjacent to the Citarum river flow that is suspected of receiving much industrial waste such as textiles, plastics, pharmaceuticals, motor vehicles, workshops, and more. The results of the study by Permanawati *et al.* (2013) (in Pribadi *et al.*, 2017) [23] showed that the average Pb content of 15 research stations in Jakarta Bay (Tanjung Kait Waters and Muara Gembong) in 2010 ranged from 0.005-0.011 ppm, which means an increase of up to 7 times in 2018.

The average value of the measurement of Pb content in sediments in pond waters in Muara Gembong ranges from 2.34-2.78 mg/kg. The minor Pb content in the sediments in this study can be caused by prolonged drought resulting in high enough temperatures at the site of this study so that the heavy metal content in the sediment dissolves into the waters. The results of the study Permanawati *et al.* (2013) (in Pribadi *et al.*, 2017) [23] showed the average Pb content of 15 research stations in Jakarta Bay (Tanjung Kait Waters and Muara Gembong) in 2010 ranged from 14-58 mg/kg.

The average value of the measurement of Pb content in algae in pond waters in Muara Gembong ranges from 6.84-7.06 mg/kg. The accumulation of Pb in *G. verrucosa* is caused by organic matter, or functional groups on the cell wall of algae able to bind to heavy metals, and heavy metals have properties quickly bonded with organic matter (Surahman, 2011; Harahap, 2001) [28, 11].

The treatment of the Pb A ratio (algae/water) is greater than the Ratio of Pb B (algae/sediment), which means that the Pb in *G. verrucosa* algae in this study came from water in the pond waters of Muara Gembong (Figure 2).

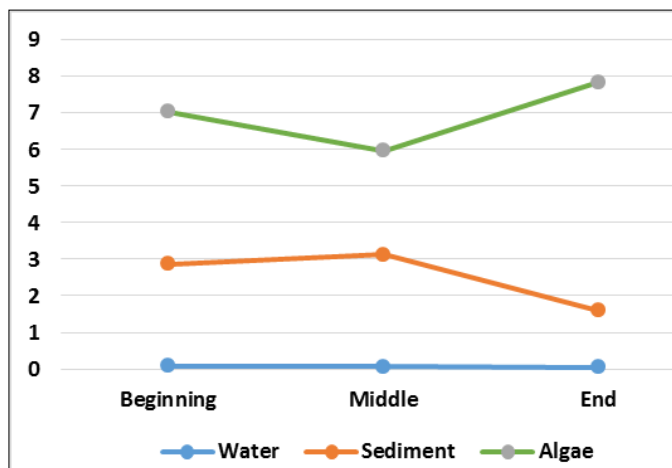


Fig 1: Pb Content Graph in Water, Sediment, and Algae

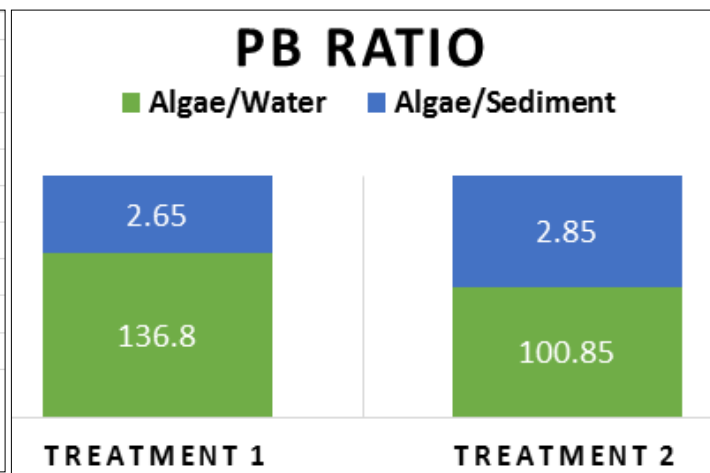


Fig 2: PB Content Ratio Test Graph

4. Conclusion

The presence of *G. verrucosa* algae in ponds does not contribute to improving the quality of pond water. However, heavy metal lead (Pb) accumulates in the algae. The PB content in the algae *G. verrucosa* is thought to come from pond water. It can be utilized by farmers to reduce the absorption of lead-heavy metals by pond cultivation biota in the waters of Muara Gembong.

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