**EVALUATION THE EFFECT OF DUMBO CATFISH (*Clarias gariepinus*)
CULTIVATION AGE ON CHANGES IN POND WATER QUALITY USING
PLANKTON AS BIOINDICATOR IN GONDOSULI VILLAGE, TULUNGAGUNG
REGENCY**

**EVALUASI PENGARUH UMUR BUDIDAYA IKAN LELE DUMBO (*Clarias gariepinus*)
TERHADAP PERUBAHAN KUALITAS AIR KOLAM DENGAN PLANKTON
SEBAGAI BIOINDIKATOR DI DESA GONDOSULI, KABUPATEN TULUNGAGUNG**

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ABSTRACT

Catfish is a freshwater fish that is widely cultivated but overfeeding causes organic pollution. This study aims to evaluate the water quality profile based on physicochemical and plankton as bioindicators in catfish ponds in Gondosuli Village, Tulungagung Regency. This type of research was ex post facto by monitoring the physicochemical parameters of water and the structure of the plankton community in control ponds, ponds with catfish aged <1 month, 2-3 months, and 3-4 months each with three replications. Water samples for each pond were measured on the physicochemical water quality included water temperature, conductivity, pH, water transparency, DO, BOD, and turbidity. Plankton identified and analyzed to determine community structure (Abundance, Frequency, Relative Abundance, Relative Frequency, Important Value Index) and biotic index (H' , TDI, and %PTV) for water quality. The results of measurements of each physicochemical parameter between locations were analyzed by inferentially statistics using One-Way ANOVA. The interaction between the plankton community structure and the physicochemical of water quality was analyzed using biplots. The results showed that ponds with the age of catfish ready to harvest had an impact on decreasing water quality. This condition was indicated by the high organic matter pollution reflected by the high BOD, high turbidity levels, and low DO values. Catfish pond waters quality based on the H' value of plankton community showed indicate that there is no toxic pollution. Based on TDI values, catfish pond waters were categorized as poor status (hyper-eutrophic) and based on the %PTV index in ponds with catfish age 2-3 and 3-4 months were classified as high levels of organic matter pollution.

Keywords: Catfish ponds, plankton, water quality

ABSTRAK

Ikan lele adalah ikan air tawar yang banyak dibudidayakan tetapi pemberian pakan berlebih menyebabkan terjadinya pencemaran organik. Tujuan dari penelitian ini melakukan evaluasi profil kualitas air berdasarkan parameter fisika kimia dan plankton sebagai bioindikator pada kolam ikan lele berbagai umur di Desa Gondosuli, Kabupaten Tulungagung. Jenis penelitian adalah ex post facto dengan melakukan pemantauan parameter fisika dan kimia air serta struktur komunitas plankton pada kolam kontrol, kolam dengan ikan lele umur < 1 bulan, 2-3 bulan dan 3-4 bulan masing-masing tiga ulangan. Setiap kolam diukur sifat fisika kimia air meliputi suhu air, konduktivitas, pH, kecerahan, DO, BOD dan turbiditas. Plankton diidentifikasi dan dianalisis untuk penentuan struktur komunitas (K , F , KR , FR , INP), dan indeks biotik (H' , TDI, %PTV) untuk kualitas air. Hasil pengukuran setiap parameter fisika kimia air antar lokasi dianalisis secara statistik inferensial menggunakan uji beda. Interaksi antara struktur komunitas plankton dan kualitas fisika kimia air dianalisis menggunakan Biplot. Hasil penelitian menunjukkan bahwa, kolam dengan umur lele yang semakin tua terjadi penurunan kualitas air. Hal ini ditunjukkan oleh tingkat pencemaran bahan organik yang semakin tinggi dicerminkan oleh kadar BOD dan turbiditas yang tinggi serta nilai DO yang rendah. Perairan kolam lele berdasarkan nilai H' dari plankton menunjukkan tidak terjadi pencemaran toksik. Berdasarkan nilai TDI, perairan kolam lele termasuk kategori status buruk (hyper-eutrophic), dan berdasarkan indeks %PTV pada kolam dengan umur ikan lele 2-3 dan 3-4 bulan tergolong tingkat pencemaran bahan organik yang tinggi.

Kata kunci: Kualitas air, kolam ikan lele, plankton

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INTRODUCTION

African catfish (*Clarias gariepinus*) is one of the most cultivated freshwater fish in Indonesia. The advantages possessed by catfish include easy processing, high nutrition, and low selling value so that it is attracted by the public [1]. The fast growth is also the reason for fish farmers to develop catfish farming [2]. According to [3], the fisheries sector has the potential to accelerate the development of the national industry. Therefore, the Ministry of Marine Affairs and Fisheries created a minapolitan area or fishery area, one of which is in Gondosuli Village, Tulungagung Regency.

Efforts to increase the production and quality of catfish can be made, among others, by maintaining food intake. The feed often used is generally a pellet type [4]. However, overfeeding can cause organic matter contamination in pond water. A large amount of organic matter in the pond provides nutrients to plankton to carry out cell metabolism, resulting in algal eutrophication [5]. The impact is sunlight blocking to enter to the water body of the pond, and there is a decrease in oxygen levels in the pond water [6].

Changes in water quality can be identified using a water bio-indicator, namely plankton. Plankton has a short life cycle and responds very quickly to environmental changes [7]. Therefore, the growth rate of plankton can indicate the quality of the water in the pond. Furthermore, the effect of organic matter content and sunlight is one of the factors of plankton growth [8]. Therefore, using plankton as a bioindicator, it is necessary to analyze water quality in catfish ponds with various age differences in Gondosuli Village, Tulungagung Regency.

METHODS

This research was conducted in July-December 2019. In July, water and plankton sampling was carried out in a catfish pond, Gondosuli Village,

Tulungagung Regency. Plankton identification and data analysis were carried out from August to December at the Laboratory of Ecology and Animal Diversity, Department of Biology, Faculty of Mathematics and Natural Sciences, Brawijaya University, Malang.

Gondosuli is a village used as the center of the minapolitan area, located in Gondang District, Tulungagung Regency. In Gondosuli Village, the dominant fish culture was catfish using tarpaulin ponds. The water used for fish ponds came from bore wells directly from the ground. The catfish pond in Gondosuli had an average depth ranging from 50-120 cm. Fishpond wastewater was discharged directly into the river. Catfish farming ponds were divided into three ponds categories: ponds with fish age <1 month, ponds with fish ages 2-3 months, ponds with fish ages 3-4 months or ready to harvest (Figure 1).

Water sampling was carried out at four predetermined pond locations: control ponds (before being used for catfish farming), ponds with catfish aged <1 month, ponds with catfish aged 2-3 months, and ponds with aged catfish 3-4 months. In each pond, water samples were taken using a 1-liter water sampler. The physical and chemical parameters of water measured include water temperature, conductivity, pH, transparency, turbidity, DO, and BOD.

Plankton sampling was carried out using a plankton net at a predetermined location. The total number of plankton samples taken in this study was 12 samples. The sample that has been taken was placed in a sample container containing ten drops of additional liquid, namely 4% formalin and five drops of CuSO₄ solution. Then a 1 ml water sample was taken and placed in the Sedgewick-Rafter for plankton identification and counting. Plankton were observed under a microscope and identified based on identification key book [9, 10, 11, 12], 13].

Figure 1. Study area in Gondosuli Village, Tulungagung Regency. Information (K.1–K.3: Control Pond; 1.1–1.3: Ponds with fish age <1 month; 2.1–2.3: Ponds with fish ages 2-3 months; 3.1–3.3: Ponds with fish ages 3-4 months or ready to harvest)

The data obtained from the plankton identification and counting were analyzed to determine the community structure and diversity based on some ecological indices, including the Importance Value Index (IVI), the Simpson dominance index (Id), the Shannon-Wiener diversity index (H'), the Trophic Diatom Index (TDI) and Pollution Tolerant Value (%PTV). The IVI determination was based on relative abundance and frequency data. The data from the measurement of water physicochemical parameters were tabulated into Ms. Excel. The compiled data were statistically analyzed by calculating the mean and standard deviation. Determination of differences in water quality between ponds with different fish ages was carried out by performing different tests on each observed water parameter using one-way analysis of variance (One-way ANOVA). Then, one-way ANOVA was continued by the Tukey HSD test (if the data has a normal distribution and a homogeneous variance), or the Brown-Forsythe test was followed with the Howell Games test (if the data distribution was abnormal and heterogeneous variance) [14]. The interaction between the physicochemical parameter and plankton community was described using biplot analysis.

RESULTS AND DISCUSSION

The results of physicochemical parameters measurements of catfish pond water could be seen in Table 1. The water quality able to be determined using an approach with several factors such as physical and chemical characteristics. The relationship between plankton abundance and physical and chemical parameters can describe the condition of an aquatic ecosystem. The physical and chemical quality of water can result in changes in the distribution of an aquatic organism [15].

Water quality profile based on physicochemical parameters in catfish ponds of different ages in Gondosuli Village. The highest water temperature was found in a 3-4 month pond of 29.6 °C, while the lowest water temperature was in a pond <1 month of 27.6 °C. The results of different tests showed significantly different temperature values in each pond. Temperature potentially affected plankton in the water. When the temperature was high, the plankton abundance would increase because the influence of temperature can increase chemical reactions so that the rate of photosynthesis increases with increasing temperature [16]. According to [17], the optimal temperature for catfish ranges from 22-30 °C. This temperature could affect the growth rate, metabolic rate, fish appetite, and dissolved oxygen in the water.

The highest pH value was found in the control pond at 7.9, while the lowest was in the pond <1 month at 7.4 (Table 1). The results of different tests using one-way ANOVA showed a significantly different pH value in each pond. The optimal value for fish life ranges from 7-8.5 because it could maintain biological productivity. Fish became stress in water with pH values 4-6.5 and 9-11. In addition, pH with a value range between 7-7.8 was the pH range that supported the growth and development of microorganisms [17].

The highest turbidity value was found in the 3-4 month pond with a value of 1827 NTU, while the lowest was found in the control pond of 6 NTU (Table 1). Different tests using the one-way ANOVA showed that the turbidity value was significantly different in each pond. The lowest turbidity was observed at the control pond because this pond was only filled with water. The higher the age of catfish had a significant impact on increasing turbidity. This was greatly influenced by the provision of the pellet feed, which, according to farmers, was given more as the catfish getting old. The feed that catfish did not eat was a source of suspended solids so that the turbidity level would be even higher. According to [18], the turbidity level in a pond was usually caused by fish excrement, unsustainable feed residue, and plankton abundance. High water turbidity limited light penetration, photosynthesis rate, and the overproduction of macrophytes in the pond.

The highest conductivity value was found in the 3-4 month pond of 174.8 $\mu\text{S} \cdot \text{cm}^{-1}$, while the lowest conductivity value was found in the control pond of 72.6 $\mu\text{S} \cdot \text{cm}^{-1}$ (Table 1). Different tests using the one-way ANOVA showed that the conductivity value was significantly different in each pond. Furthermore, the conductivity value showed that the higher the age of the catfish would significantly increase the conductivity value. According to [19], this was due to the presence of organic and inorganic materials derived from oxidized feces and fish feed to produce electrolyte ions.

The highest transparency value was found in the control pond of 62.17 cm, while the lowest transparency value was in the 3-4 month pond of 4 cm (Table 1). Different tests using one-way ANOVA showed significantly different transparency values between the control pond and pond <1 month, 2-3 months, and 3-4 months. The transparency value showed that the greater the age of the catfish, the lower the transparency, which was inversely proportional to the turbidity value. This condition was due to the large amount of suspension solids originating from organic and inorganic materials such as manure, fish feed, and eutrophication, which inhibits sunlight penetration.

Table 1. The physicochemical quality profile of catfish pond water with different ages of catfish in the village of Gondosuli

Location	Water Chemical Physics Parameters						
	Temperature (°C)	pH	Turbidity (NTU)	Conductivity (μS.cm ⁻¹)	Transparency (cm)	DO (mg.L ⁻¹)	BOD (mg.L ⁻¹)
Control	28,7 ± 0,35 (ab)	7,9 ± 0,2 (b)	6,09 ± 3,42 (a)	72,57 ± 0,15 (a)	62,17 ± 9,51 (b)	5,58 ± 2,03 (ab)	3,55 ± 1,84 (a)
<1 month	27,6 ± 0,32 (a)	7,4 ± 0,11 (a)	364,3 ± 46,91 (b)	99,47 ± 2,53 (b)	7,83 ± 1,15 (a)	5,34 ± 0,94 (b)	11,12 ± 0,62 (b)
2-3 months	28,67 ± 0,57 (ab)	7,5 ± 0,05 (ab)	794,2 ± 67,09 (c)	150,6 ± 19,86 (abc)	4,1 ± 0,36 (a)	0,54 ± 0,24 (a)	18,72 ± 4,92 (a)
3-4 months	29,6 ± 0,44 (b)	7,8 ± 0,15 (b)	1826,7 ± 121,36 (d)	174,77 ± 19,00 (c)	4 ± 0 (a)	0,2 ± 0,11 (a)	15,9 ± 0,5 (c)

According to [19], water that looks cloudy occurred as an effect of plankton blooming, especially phytoplankton. Blooming occurred because water contained lots of nutrients, O₂, CO₂, and sunlight so that phytoplankton could carry out photosynthesis. Conditions like this caused disruption of the survival of the fish in utilizing O₂ for respiration.

The highest DO value was observed in the control pond of 5.58 mg.L⁻¹, while the lowest DO value was in the 3-4 month pond of 0.2 mg.L⁻¹ (Table 1). Different tests using the one-way ANOVA showed that the DO and BOD values were significantly different in each pond. The DO value obtained shows a decrease in each pond. In 2-3 and 3-4 month ponds, the resulting DO was getting lower. This result indicated that there had been organic matter contamination. DO had a role in the reduction and oxidation process of organic and inorganic materials [20]. According to [19], the breakdown of toxic ammonia from fish waste by nitrifying bacteria became non-toxic utilized high oxygen levels. So, it could be indicated that there had been organic matter contamination in ponds 2-3 and 3-4 as indicated by a decrease in DO levels.

The highest BOD value was found in the 2-3 month pond of 18.72 mg.L⁻¹, while the lowest BOD value was found in the control pond of 3.55 mg.L⁻¹. The BOD value showed an increase in each pond. From the results of BOD in ponds 2-3 and 3-4 months, there was a degradation of organic matter carried out aerobically by bacteria to produced nutrients for phytoplankton fertility [21]. Water quality based on physicochemical parameters in catfish ponds of different ages observed, it could be concluded that at 2-3 months and 3-4 months, ponds had experienced organic matter contamination indicated by the high turbidity and low transparency, a high DO and low BOD value.

Profile of plankton community structure and diversity in catfish ponds of various ages in Gondosuli Village. The measurement of biological parameters included the community structure of phytoplankton in four catfish ponds of different ages. The phytoplankton community structures taken include Importance Value Index (IVI), Simpson Dominance Index (Id), Evenness

Index (E), Shannon-Wiener Diversity Index (H'), Trophic Diatom Index (TDI), and %Pollution Tolerant Value (% PTV) was presented in Figure 2-7. The identification and data analysis results on four catfish ponds with different ages were found as many as 24 species. Evaluation of water quality could also be carried out using biological parameters in the form of plankton. Plankton, especially phytoplankton, could be used as a biological indicator because it had limited mobility and a long life cycle so that changes in water quality could be accumulated in its body [22, 23].

The results of the Importance Value Index (IVI) were obtained (Figure 2). Dominance occurred in control and ponds <1 month, while in ponds 2-3 months and 3-4 months, several species had codominance. The most common control pond species was *Scenedesmus obliquus*, with an IVI value of 54.47%. This species was found mostly in eutrophic and hyper-eutrophic waters [23]. The most common species found at pond <1 month was *Cyclotella* sp. with an IVI value of 31.63%. *Cyclotella* sp. was a tolerant species of organic pollution [24]. In the 2-3 months pond, codominance occurred between *Cyclotella* sp. (35.11%) with *Nitzschia* sp. (33.7%). In the 3-4 months pond, there was codominance between *Scenedesmus obliquus* (25.51%) and *Nitzschia* sp. (26.19%). At ponds 2-3 months and 3-4 months, *Nitzschia* sp. was commonly found, which indicated organic matter contamination. According to [24], *Nitzschia* sp. was one type of diatom with a high level of tolerance and adaptation to the aquatic environment so that it was able to survive in polluted environments, especially caused by organic matter.

The taxa richness was ranged from 12-14 taxa. The highest taxa observed was in the control pond and <1 month as many as 14 taxa, while the lowest was in the 2-3 months pond. The total abundance values obtained ranged from 134.180-10.344.513 individuals (Figure 3). The variety of taxa richness was not too high in ponds with bigger catfish ages. However, the total plankton abundance was higher with the increasing age of the catfish.

Figure 2. Variation of the important value index in four ponds with different ages of catfish

Figure 3. Variations in the value of taxa richness and total abundance in four ponds with different ages of catfish

This was in accordance with the increase in organic matter as the catfish ages. The results of the degradation of organic matter would be the nutrients needed for the growth of phytoplankton. So that the carrying capacity of plankton would be high if the nutrient levels were high too. The highest total abundance at 3-4 months was caused by algal blooms due to the availability of nutrients for growth [12, 23].

The Simpson dominance index data informed that there were no dominant species at locations <1 month and 3-4 months (Figure 4). However, in the control pond and 2-3 months, the value increased, which means that there were dominant species. Therefore, based on the IVI results, there were species that dominated the control pond, namely *Scenedesmus obliquus*, while in the 2-3 month

pond, there was codominant between *Cyclotella sp.* and *Nitzschia sp.* [6, 10].

The evenness index (E) values obtained ranged from 0.6 to 0.83 (Figure 4). Thus, the data obtained from the evenness index showed that the level of evenness in the four ponds was classified as high evenness with a value >0.6 where the distribution between species was evenly distributed.

The data obtained from the Shannon-Wiener diversity index showed that the control pond and 2-3 months were classified as moderate diversity or indicate that there is no toxic pollution (Figure 5). In the control pond, the bottom of the pond or tarpaulin used was not cleaned after the previous harvesting, so that the phytoplankton was still left behind and dormant due to lost nutrients [20]. After the control pond has been prepared and filled with

water again, the phytoplankton would continue to metabolize as usual so that the H' results in the control pond are classified as moderate diversity. At the same time, the 2-3 months pond was classified as moderate diversity. This was because high BOD levels cause a struggle for oxygen between species. On the other hand, the pond of <1 month and 3-4 months were classified as having high diversity. This was consistent with the high availability of nutrients in waters, which could cause eutrophication [23].

The data obtained from the TDI index (Figure 6) showed that the four ponds of TDI values >75 were classified as bad (hyper-eutrophic), in which the level of nutrition in all ponds was always high. In the control pond, it was classified as bad because, according to the farmer, the tarpaulin used was formerly maintained so that there was still organic matter which was then degraded into nutrients by the aerobic bacteria in the pond. Ponds of <1 month had high nutritional behavior because a lot of fish feed was wasted so that it settled in the

water. Ponds 2-3 months and 3-4 months showed a decrease. According to [20], there was oxidation of organic and inorganic matter, which was carried out by aerobic bacteria to be broken down into other simple compounds and nutrients. The process required oxygen and low pH to be closer to 8.

The data obtained from the %PTV index (Figure 7) showed that the control pond and <1 month have a %PTV value of 0% and 16.06%, respectively, which was classified as free of organic pollution. The 2-3 months pond had a % PTV value of 48.94%, classified as being polluted with moderate organic matter. The 3-4 months pond had a % PTV value of 70.83%, which was classified as heavily polluted with organic matter [25]. This was indicated by the appearance of diatoms *Nitzschia* sp. and *Cyclotella* sp. as an indicator of water pollution by organic matter. This result was in accordance with the monitoring of the quality of chemical physics that the higher the age of the catfish had an impact on the higher the pollution of organic matter.

Figure 4. Variations of the Simpson dominance index value and the evenness index in four ponds with different ages of catfish

Figure 5. Variation of the Shannon-Wiener diversity index value in four ponds with different ages of catfish

Figure 6. Variation in the value of the Tropic Diatom Index in four ponds with different ages of catfish

Figure 7. Variation in the value of %Pollution Tolerant Value in four ponds with different ages of catfish

Based on the cluster and biplot analysis (Figure 8), the characteristics of the physical, chemical, and biotic parameters in each pond group were observed. The water quality profile in the four ponds and their replications was divided into three groups. Group 1 consisted of three control ponds that had the same water quality profile. Group 2 consisted of three ponds of <1 month and three ponds of 2-3 months had the same water quality profile. Group 3 consisted of three 3-4 month ponds that had the same water quality profile. The control pond was characterized by high transparency, Id (Simpson dominance index), pH, and DO values. They are also characterized by low taxa richness, BOD, and turbidity values. The Ponds of <1 month and 2-3 months were characterized by high taxa richness and DO values. It was also characterized by low pH, water temperature, and Id values. The 3-4 months pond was characterized by high BOD, turbidity, conductivity, TDI, and % PTV values. In addition, these ponds were characterized by low transparency, Id, DO, and pH values [19].

CONCLUSION

Catfish ponds with increasing age had an impact on decreasing water quality caused by the high level of organic matter. This condition was reflected by high BOD and turbidity levels and low DO values. Based on plankton community analysis, 24 taxa were found, and *S. obliquus* and *Cyclotella* sp codominance was found in all study locations except the control pond. Catfish pond waters based on the H' value showed indicate that there is no toxic pollution. Based on the TDI value, catfish pond waters were categorized as bad status (hyper-eutrophic), and based on the %PTV index in the pond with catfish ages 2-3 and 3-4 months were classified as high levels of organic matter pollution.

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A

B

Figure 8. Water quality grouping and plankton community structure in catfish ponds (A) Cluster Analysis, & (B) PCA Analysis

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