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QUALITY ANALYSIS OF AQUACULTURE WASTE DISPOSAL WATER BODY IN KAMPUNG PAPUYU BANJAR REGENCY THROUGH POLLUTION INDEX AND PHYTOPLANKTON DIVERSITY INDEX

Afryal Khaidatunnisa[1]*, Herliwati[2], Pahmi Ansyari[3] and Slamet[4]

Department of Program Study Magister Natural Resources and Environmental Management, Lambung Mangkurat University, South Kalimantan, Indonesia.

***Corresponding Author: Afryal Khaidatunnisa**
Department of Program Study Magister Natural Resources and Environmental Management, Lambung Mangkurat University, South Kalimantan, Indonesia.

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ABSTRACT
Village Papuyu is a papuyu cultivation area in Banjar Regency, which has the potential to produce organic waste that can contaminate the surrounding waters. It is necessary to conduct research to determine the quality of water in the water where the aquaculture waste is disposed of by using the pollution index method and phytoplankton bioindicators. The research was conducted from March to April 2022, by taking plankton samples and physico-chemical parameters at 5 stations in the cultivation area. The results obtained are that the condition of the waters in the water bodies of aquaculture waste disposal is categorized as lightly polluted based on a pollution index of 3.1685 with parameters that do not comply with quality standards, namely color, ammonia and phosphate, and the moderately polluted category seen from the phytoplankton diversity index (H'). that is equal to 1.7055. Phytoplankton qualitative analysis obtained 20 species, consisting of 3 phytoplankton phyla, namely Cyanophyta (2 species), Chlorophyta (9 species), and Chrysophyta (9 species).

KEYWORDS: water quality, pollution index, diversity index.

INTRODUCTION
Aquaculture business carried out in an area has the potential to affect the surrounding environment and the economic conditions of the community. On the one hand the aquaculture business can have an impact in the form of additional sources of income and open new jobs for the community, but on the other hand the aquaculture business affects the condition of the surrounding aquatic environment which was initially balanced to be disrupted as a result of some of the cultivation processes themselves.

In order to increase fish production, farmers generally try to maximize their productivity with high stocking densities with intensive cultivation systems. This can cause a large amount of aquaculture waste to be produced which worsens water quality. Intensification of fish farming is carried out by increasing the stocking density of fish which has an impact on increasing the use of artificial feed. The main problem in aquaculture systems is the rate of accumulation of feed residues which produce nitrogen and phosphorus in the form of ammonia, nitrate and phosphate which are very fast. The existence of such pollution is unavoidable because fish can only absorb 20-30% of nutrients from feed (Avnimelech, 2006). The rest becomes organic waste in the form of ammonia, nitrate and phosphate (Satria et al., 2019). Waste that accumulates in the aquaculture system will become a toxin that can inhibit growth rates and can kill fish (Nur, 2011; Satria et al., 2019), an acceleration of algae growth (algae bloom) results in shifting the balance of the ecosystem which is then called eutrophication (Garno, 2012; Putra, 2018) and reduced levels of dissolved oxygen in the waters (Simbolon, 2016).

The large potential for liquid waste from fish farming to be discharged directly into the waters, the problem of increasing the accumulation of nitrogen and phosphorus wastes in the aquatic environment is the cause of a decrease in the quality of the waters physically and chemically (Sinambela & Sipayung, 2015) around the cultivation area, and will also affect the diversity of organisms in these waters, one of which is phytoplankton organisms. So there is a need for research to determine water quality through analysis of pollution index and phytoplankton diversity index. The purpose of this study was to determine the quality of aquaculture waste water bodies through pollution index and phytoplankton bioindicators with physico-chemical water quality parameters, namely temperature, color, TSS, pH, DO, ammonia, nitrate and phosphate in these waters.

MATERIALS AND METHODS

The research was conducted in Papuyu Village, Karang Intan Village, Banjar Regency in March-April 2022 with purposive sampling. Sampling was carried out 1 time taken at 5 (five) points, namely; Station I, water sampling is carried out at the inlet (water channel before entering the pool). Station II, in the aquaculture pond (3 points). Station III, outlet channel (3 points). Station IV, waters before waste water enters water bodies. Station V, receiving waters after wastewater enters the water body.

The tools and materials used include: (1) sampling tools: plankton net; sample vials; label; stationary; camera; thermometers; PH meter; DO meters (2) analytical tools in the laboratory: graded filters, loops, pipettes, glass objects, spoons or tweezers, tissues, water samples.

Insitu parameter measurements were carried out directly at the sampling site such as pH, temperature, and DO. Meanwhile, for color analysis, TSS, ammonia, nitrate, phosphate, and phytoplankton were carried out in the laboratory. Physical and chemical parameter data compared with Government Regulation no. 21 of 2021 for Class III (three) Water Quality Standards, then a Pollution Index (IP) calculation is carried out according to the Decree of the State Minister for the Environment Number 115 of 2003 concerning Guidelines for Determining Water Quality Status. The formula used to calculate the pollution index is as follows.

$$PI_j = \sqrt{\frac{(\frac{Ci}{L_{ij}})_M^2 + (\frac{Ci}{L_{ij}})_R^2}{2}}$$

where

Lij	=	concentration of water quality parameters stated in the quality standard of a water allotment (j);
Ci	=	concentration of water quality parameter measurement results;
Pij	=	Pollution Index for designation;
(Ci/Lij)M	=	Value Ci/Lij maximum;
(Ci/Lij)R	=	Nilai Ci/Lij average.

The diversity index (Evenness Index) is calculated using the Shannon-Winner diversity index formula proposed by Ludwig & Reynolds (1988), namely.

$$H' = -\sum(pi.\ln pi)$$

Where

H' = Shannon–Wiener Diversity Index

pi = ni / N = Probability function for each type as a whole

ni = Number of individuals in species I

N = Total importance scores (individual total)

RESULTS AND DISCUSSION

A. Water Quality Physics Chemistry

The results of water quality analysis (physics-chemistry of waters) are presented in Table 1 below.

Table 1: Analysis of Water Quality and Pollution Index.

Parameter		observation station									quality standards PP 22/2021
		1	2A	2B	2C	3A	3B	3C	4	5	
DO	ppm	2.69	2.18	4.20	10.90	5.89	4.53	5.26	5.16	4.75	≥ 3
pH		7.30	7.18	7.25	8.95	7.65	7.42	7.60	7.46	7.07	6 - 9
odor		TB	TB	TB	TB	TB	TB	TB	TB	TB	TB
Color	PT - Co	76	81	160	662	96	145	260	94	119	100
TSS	ppm	10	5	25	73	7	20	47	11	18	100
Ammonia	ppm	0.13	0.44	0.11	0.18	0.56	0.09	0.17	0.15	0.53	0.50
phosphate	ppm	0.02	0.10	0.20	0.06	0.26	0.18	1.68	0.12	1.69	1.00
Nitrate	ppm	0.01	0.01	0.30	0.02	0.01	0.01	0.01	0.02	0.05	20.00
IP		0.5621	0.6699	1.4628	3.6889	0.9232	1.3049	2.2633	0.6853	1.6048	
Water Quality Status		Meet Quality Standards	Meet Quality Standards	Light Polluted	Light Polluted	Meet Quality Standards	Light Polluted	Light Polluted	Meet Quality Standards	Light Polluted	

Table 2. Pollution Index Value Criteria

IP Value	Water Status
$0 \leq PI_j \leq 1$	Meet quality standards (good condition)
$1 \leq PI_j \leq 5$	Light polluted
$5 \leq PI_j \leq 10$	Moderately polluted
$PI_j > 10$	Heavily polluted

Source: Minister of Environment Decree No. 115 of 2003

Based on Table 1. and Table 2. above, the analysis of the pollution index illustrates that the observation stations that meet the quality standards are Stations 1, 2A, 3A and 4. Meanwhile, stations 2B, 2C, 3B, 3C and 5 are classified as lightly polluted. The results of the measurement of physico-chemical parameters which were slightly higher than the quality standard had an effect on the calculation of the pollution index analysis which was classified as lightly polluted. This is presumably due to the presence of organic waste from inedible leftover feed, excretion and metabolism of organisms in the form of ammonia, nitrate and phosphate produced (Satria et al., 2019) during the cultivation process. The results of measurements of physical and chemical parameters are an illustration of environmental changes at certain times that occur at the time of measurement, because basically the physical and chemical conditions of waters are dynamic which can change depending on the environmental conditions that affect them (Aryawati et al., 2021).

One of the factors that play a role in triggering or inhibiting the growth of living things in the waters is temperature (Ridwan et al., 2016). In waters that are not too deep and not too big, the water temperature is mainly influenced by sunlight and wind (Utomo & Chalif, 2014). Changes in temperature that occur in the waters affect the chemical, physical and biological processes of the waters (Makmur & Fahrur, 2011). The water temperature at the observation sites varied between 29.80 - 33.40oC with an average of 31.73oC. Based on the quality standard in PP No. 22 of 2021 that normal temperature with a deviation of 3oC, namely 28.73 - 34.73oC. The water temperature at each observation station can still support the metabolism of living things in the waters (Nybakken, 1992 in Ridwan et al., 2016) and is still within the quality standards required for aquaculture activities.

Aruan & Siahaan (2017) state that the dissolved oxygen level in unpolluted waters is a minimum of 2 ppm, while the dissolved oxygen level based on Government Regulation Number 22 of 2021 dissolved oxygen (DO) for aquaculture activities is at least 3 ppm. Based on Table 1. it is known that DO levels at the observation sites ranged from 2.18 ppm – 10.90 ppm. Station 1 as a source of irrigation for cultivation activities, the measured DO value is 2.69 ppm. The low DO value is thought to be influenced by the time of measurement which is still early in the morning, where in the morning when the intensity of sunlight is not yet high, the plankton cannot carry out photosynthesis so it does not produce oxygen in the water. Oxygen levels in water sources used for aquaculture activities can be increased by implementing maintenance with heavy water ponds, where water changes are carried out continuously (Khairiman, et al., 2012). The oxygen level in this study increased as the measurement time got longer (Maniagas, et al., 2013), where the intensity of sunlight was quite high. This is presumably because at the time of measurement, the dissolved oxygen levels in the waters were produced by plankton which carry out the process of photosynthesis and diffusion from the air during the day. Increasing the temperature which is still within tolerance limits will increase the metabolic rate and photosynthetic activity of phytoplankton (Asriyana & Yuliana, 2012 in Rahmah, et al., 2022).

The pH value is an important factor in waters to determine the conditions and properties of the water, the pH value that is suitable for biota in waters depends on the type of biota (Djoharam, et al., 2018). Table 1. shows that the pH of the water at the observation site ranges from 7.07 - 8.95 so that it still meets the required quality standards. The pH quality standard of water required for aquaculture activities is in the range of 6 - 9. The difference in pH values is thought to be due to differences in organic matter content and the process of photosynthesis (Naillah, et al., 2021). During the process of photosynthesis the pH value is affected by the amount of CO2 concentration which decreases during the day. During the day the water gets a lot of intensity of solar heat which will increase the surface temperature of the water to rise, when the water temperature rises, the solubility of CO2 will also decrease so that the pH of the water will increase, and conversely the pH will decrease when the CO2 concentration increases at night where all biota in the water release CO2 as a result of respiration (Sriwahyuni & Afdal, 2021).

The color range in this study was between 76 PtCo-662 PtCo. The color of the water in the waters can be influenced by the substances contained in it such as the presence of plankton, decomposition of organic matter, suspended solutions or other substances dissolved in these waters. The dominance of plankton in a water can affect the color of the water and can indicate fertility in the waters (Rosarina & Laksanawati, 2018).

High total suspended solids (TSS) in waters can result in decreased productivity in these waters, because TSS greatly influences the respiration and photosynthesis processes of organisms in the waters (Winnarsih & Emiyarti, 2016). TSS is a solid material in the form of inorganic and organic materials suspended in waters (Jiyah, et al., 2017). Based on Table 1, the value of TSS at stations ranges from 5 – 73 ppm with a maximum quality standard of 100 ppm. So it is known that the TSS at each station still meets class III0 water quality standards.

Ammonia levels in the waters of the observation locations varied between 0.09 – 0.56 ppm. Ammonia quality standard required for aquaculture activities is a maximum of 0.5 ppm. This indicates that there are several observation stations that have slightly higher ammonia content than the required quality standard. Ammonia levels in this study are thought to be due to the presence of leftover feed, dead organisms and excreted organisms. In line with the research by Suresh & Lin

(1992) in Djokosetiyanto & Sunarma (2006) states that around 80% of the nitrogen consumed by fish will be discharged back into the waters in the form of solid or liquid waste. Spotte (1992) in Djokosetiyanto, et al. (2006) stated that about 50% of nitrogen excretion from fish is in the form of ammonia. Ammonia is not only toxic but also a product of the largest nitrogen metabolism produced by fish, besides that ammonia is also produced from the decomposition of dead organisms in the waters (Wahyuningsih & Gitarama, 2020).

Mustofa (2015) states that the phosphate content in waters can be used as an indicator to determine the fertility of these waters. Government Regulation Number 22 of 2021 stipulates that the quality standard for phosphate content for aquaculture activities is a maximum of 1 ppm. Table 1. shows that the phosphate content ranges from 0.02 ppm – 1.69 ppm, from this value there are stations where the phosphate content is slightly higher than the permitted quality standard. Naturally, the phosphate content comes from the waters themselves, which can be produced from the process of decomposition, weathering, decomposition, and the remains of organisms that die in the waters (Patty, 2015). Phosphate levels are very important to know in fish farming because it is a nutrient for phytoplankton which are primary producers and zooplankton as the first consumers who are natural food for fish (Ikhsan, et al., 2020; Raza'i, 2017). From the research conducted by Mustofa (2015) states that the elements N and P are the most needed nutrients by phytoplankton in the manufacture of fat and protein in the body. Phosphate levels in sewage channels are thought to be accumulated from aquaculture ponds and indicate that aquaculture waste that is discharged directly into the waters contains phosphate. Brahmana & Achmad (2012) stated that phosphate from aquaculture waste comes from inedible fish feed, which ranges from 10-15%, generally fish feed contains nitrogen and phosphate of 24-26% and 0.96 -1.2 respectively %. Apart from inedible feed, the metabolic activity of fish in the form of feces and urine which contains nitrogen and phosphate also increases phosphate levels in the waters (Brahmana & Achmad, 2012). High phosphate levels are feared to result in eutrophication, namely an explosion in the growth rate of algae (blooming), very fast algae growth can block sunlight from entering the waters, depletion of dissolved oxygen levels needed by fish and have a negative impact on aquaculture activities, namely the occurrence of mass mortality in fish (Tungka, et al., 2016).

Nitrate is the main form of nitrogen in waters from nitrification which is used by algae and phytoplankton for the growth process (Prosperous & Fahrur, 2011). Nitrification in waters is influenced by temperature, pH, dissolved oxygen, other organic matter in the waters, and bacterial activity. The nitrate content at the observation sites ranged from 0.01 - 0.3 ppm which indicated that the nitrate content at each observation station did not exceed the specified quality standard threshold. Appropriate nitrate levels in waters are needed by phytoplankton as nutrients for their growth and metabolism, the presence of phytoplankton in fish farming can affect the growth and reproduction of fish because phytoplankton is food for zooplankton which then becomes natural food for fish (Astuti & Supono, 2017).).

Based on the results of the pollution index analysis study, it can be seen that the receiving water bodies of aquaculture waste (station 5) are classified as lightly polluted water quality. The existence of parameters that are not in accordance with quality standards causes a high pollution index produced, these parameters are color, ammonia, and phosphate.

B. Phytoplankton Analysis

The types of phytoplankton obtained from the results of the study consisted of 20 species from 3 phytoplankton phyla, namely Cyanophyta (2 species), Chlorophyta (9 species), and Chrysophyta (9 species). The most dominant species is Microcystis while the lowest is Gyrosigma. Phytoplankton analysis was carried out as a basis for biologically determining water quality because it has a direct effect on water fertility (Uttah, et al., 2008); (Prosperous & Fahrur, 2011). The results of the analysis in the laboratory obtained data in Table 3 as follows.

Table 3: Results of plankton analysis.

Phyllum	**Genera**	**Sampling Station**								
		ST-1	**ST-2A**	**ST-2B**	**ST-2C**	**ST-3A**	**ST-3B**	**ST-3C**	**ST-4**	**ST-5**
Phytoplankton										
Cyanophyta	Oscillatoria	-	-	30	20	30	90	-	-	30
	Microcystis	-	6680	20	-	290	20	-	-	-
Chloropyta	*Pediastrum*	-	310	40	60	-	-	60	-	-
	Hormidium	-	-	-	-	-	-	30	-	-
	Scenedesmus	980	390	-	520	-	-	-	60	-
	Spirogyra	20	-	-	-	120	-	-	40	-
	Roya	10	320	70	250	10	190	130	70	160
	Moegeotiopsis	-	-	10	70	230	-	-	70	-
	Gonatozygon	1790	830	40	-	40	520	270	160	100
	Closterium	-	-	-	580	-	-	-	-	-

	Staurastrum	270	410	-	-	-	-	-	-	-
Chrysophyta	*Surirella*	-	-	50	-	10	90	30	-	100
	Synedra	1040	1380	30	30	40	20	-	50	-
	Diatoma	160	90	10	-	10	40	30	-	30
	Corethron hystrix	-	-	10	-	10	-	-	-	-
	Melosira	230	-	10	-	-	10	-	-	10
	Amphora	50	-	-	20	30	-	30	10	-
	Fragillaria	2450	-	-	-	40	460	100	280	90
	Eunotia	10	-	-	10	-	40	-	-	-
	Gyrosigma	-	-	-	-	-	10	-	-	-
Abundance (Cells/liter)		7010	10410	320	1560	860	1490	680	740	520
Diversity Index (Shannon-Wiener)		1,6686	1,2574	2,1927	1,5121	1,8635	1,7091	1,7299	1,7466	1,7055

Source: Results of data processing (2022)

• Plankton abundance

Based on Table 3. the abundance of individual plankton at the stations ranged from 320 cells/L – 10,410 cells/L. The highest abundance of plankton is the phylum Cyanophyta, namely Microcystis of 7,010 cells/L, Cyanophyta are easy to find in waters because they are able to live in extreme conditions such as heat resistance in waters, besides that they can easily breed in waters containing organic matter (nitrogen and phosphate) is high. Cyanophyta are phytoplankton that play a role in producing food (producers) as well as nitrogen compounds in waters, but Cyanophyta in certain types can produce toxins that are harmful to aquatic ecosystems (Cahyani, 2017).

Satino & Setyaningsi (2012) stated that Chlorophyta and Crysophyta are phytoplankton that can live well in unpolluted waters, while Cyanophyta can be found abundantly and dominate in waters that tend to be polluted so that they can be used as indicators of pollution by organic materials. The difference in the abundance of phytoplankton at each station is influenced by the difference in light intensity for the photosynthesis process at each station (Burhanuddin, 2015; Khaqiqoh, et al., 2014).

• Shannon-Winner diversity index value (H')

Table 4: Shannon & Wiener Index Pollution Criteria.

Degree of Pollution	Diversity Index
Unstable biota community (water quality heavily polluted)	H'<1
Moderate biota community stability (moderately polluted water quality)	1<H'<3
Biota community stability in prime or stable condition (clean water quality)	H'>3

Source: Basmi, 1999 in Prasiwi & Wardhani, 2018.

The diversity index value indicates the stability level of the biota community in a waters (Fahrur et al., 2011). Based on the results of the analysis it is known that the diversity index value at all stations ranges from 1.2574 - 2.1927, according to the Shannon-Winner category if the diversity index value is 1<H'<3, it can be stated that the stability of the biota community is in the medium category and the water quality at Stations 1, 2A, 2B, 2C, 3A, 3B, 3C, 4, and 5 are said to be moderately polluted but these conditions are still relatively supportive for the development of plankton (Utojo, et al., 2016). The polluted conditions are thought to be influenced by the presence of organic matter which has exceeded the quality standard and is used as a nutrient by phytoplankton for growth and metabolism. The diversity of phytoplankton is also influenced by the ratio of organic matter phosphate, nitrate and ammonia contained in a waters (Prosperous, et al., 2013).

The diversity index can describe the amount of plankton that is able to adapt to these waters, with a high value of the diversity index it is concluded that more and more species can survive in these waters (Burhanuddin, 2015). From the results of the analysis of the diversity index of phytoplankton it is known that the water body receiving aquaculture waste is included in the moderately polluted category.

CONCLUSION

Physically and chemically through the pollution index, water bodies for disposal of aquaculture waste are included in the slightly polluted category, with water quality parameters that exceed quality standards, namely color, ammonia and phosphate. Based on the diversity index (H') of phytoplankton, water bodies are included in the moderately polluted category.

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