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THE RELATIONSHIP BETWEEN NITRATE AND PHOSPHATE CONTENT AND DIATOM ABUNDANCE IN THE WATERS OF PANDAN ISLAND, WEST SUMATRA

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ABSTRACT

This research was conducted in the waters of Pandan Island, West Sumatra, to determine the content of nitrates, phosphates, and diatom abundance and the relationship between nitrate and phosphate concentrations and diatom abundance. The method used is the survey method. The sampling station is determined by purposive sampling based on cardinality. Define the relationship between nitrate and phosphate content content and diatom abundance using simple linear regression. The results showed that there were eight species of diatoms with the class Bacillariophyceae, including *Isthmia* sp, *Amphora* sp, *Closterium* sp, *Nitzschia* sp, *Hemiaulus* sp, *Asterionella formosa*, *Leptocylindrus* sp. The highest diatom abundance was at station IV, with an average abundance value of 14.092,09 ind/L, and the lowest abundance was at station I, with an average of 5.317,77 ind/L. The relationship between nitrate concentration and diatom productivity was obtained with the value of y = 31.184x-15.082 and the correlation coefficient (r) = 0.711. Meanwhile, the phosphate concentration on diatom productivity was obtained with a value of y = 51.543x-32.477 and a relational (r) coefficient value = 0.738. There is a strong relationship between nitrate and phosphate content and diatom abundance in the waters of Pandan Island, West Sumatra.

Keywords: Nitrate, Phosphate, Diatom Abundance, Pandan Island waters

1. INTRODUCTION

Nitrate is the main form of nitrogen in natural waters. Nitrate is one of the nutrients and compounds important in synthesizing animal and plant proteins. High nitrate concentrations in waters can stimulate the growth and development of aquatic organisms if supported by the availability of nutrients[1]. Naturally, the concentration of nitrate in seawater is only a few, and it is one of the compounds that stimulate the growth of marine biomass. Hence, it directly controls the development of primary production. It is closely related to the fertility of water[2].

Phosphate is one of the essential elements for protein metabolism and formation. Phosphate is one of the most important nutrient compounds in the ocean. Kadim et al.[3], phosphates being a crucial limiting factor in productive and unproductive waters, phosphorus plays a vital role in determining phytoplankton counts. In waters, phosphorus is not found in free form as an element but in the form of dissolved inorganic compounds (ortho-phosphate and polyphosphate) and organic compounds in particulates[4].

Diatoms are phytoplankton that belong to the class Bacillariophyceae. This class is widely found in waters because of its wide distribution. Diatoms contribute 40-45% of productivity in marine waters. Diatoms, apart from being the basis of the food chain, are also one of the parameters of the fertility rate of water. The growth of

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diatoms is influenced by nutrients, such as nitrate and phosphate content.

A body of water is said to be fertile if it contains many nutrients that can support organisms and accelerate the growth of diatoms. Several parameters, such as the concentration of nitrates and phosphate and the abundance of diatoms, can determine water fertility. Nitrates and phosphate are significant factors limiting phytoplankton productivity, and the primary nutrients phytoplankton needs to grow and develop.

Pandan Island is a conservation area located in the Pieh Island water area. The existence of garbage sent from the coast of Padang city that reaches the waters of Pandan Island and much organic waste in the form of dry leaves and tree branches coming from Pandan Island itself can affect the condition of the waters. However, there is no data on nitrate phosphate, diatom content, and water quality measurements in the Pandan Island Marine Conservation Area, West Sumatra.

2. RESEARCH METHOD

Time and Place

The research was carried out in August 2023 in Pandan Island, West Sumatra. Primary data was collected directly at the research location, namely the waters of Pandan Island, West Sumatra. Data analysis was conducted at the Marine Chemistry Laboratory, Department of Marine Sciences, Faculty of Fisheries and Marine, Universitas Riau.

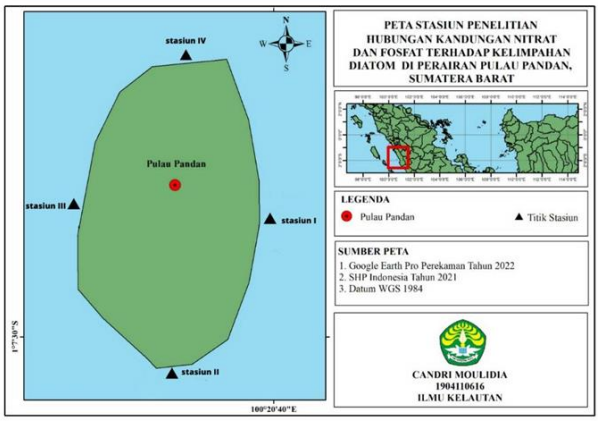

Figure 1. Research location

Method

The survey method is used in this study, where the waters of Pandan Island are used as observation and sampling locations. The samples were taken to the laboratory to analyze diatom abundance and nitrate and phosphate concentrations. The research location consists of four stations, with three sampling points at each station. The station I is located in the eastern part of Pandan Island. Station II is located in the southern part of Pandan Island. Station III is on the western part of Pandan Island, and Station IV is on the northern part of Pandan Island, West Padang District, Padang City.

Procedures

Nitrate and phosphate water sampling was taken simultaneously at each sampling point, and diatom sampling was taken during the day when the water was at high tide. A water sample is taken and put into a 100 mL sample bottle. Nitrate samples were added with sulfuric acid (H_2SO_4) and phosphate; no sulfuric acid solution was added. The results of the diatom sample are put into a sample bottle of 125 mL and then given 4% Lugol for 3-4 drops. Then, the samples are labelled and stored in an ice box.

Diatom Abundance Analysis

The diatom samples that have been obtained from each station are then calculated by the Lakey drop Macrotransec counting (LDMC) method from APHA[5] as follows:

$$\text{Number of ind/L} = \frac{T}{L} \text{ x } \frac{V0}{V1} \text{ x } \frac{1}{p} \text{ x } \frac{1}{w} \text{ x } N$$

L = area of view of the microscope (1.306 mm^2)
N = The number of diatom individuals found per preparation
p = number of fields of view observed (12 fields of view)
T = area cover glass (25 x 25 mm^2)
V1 = The volume of water below the cover glass (0.06 mL)
V0 = the sample volume of water in a sample bottle (125 mL)
W = volume of filtered water (100 L)

Relationship between Nitrate, Phosphate Concentration and Diatom Abundance

A simple linear regression test is used to see whether there is a relationship, how the relationship is directed, and how strong the relationship between nitrates, phosphate, and diatoms is. The equations used are:

$$y = a+bx$$

Information:
x = Nitrates and Phosphate
y = Diatom abundance
a = Constant (value y' if x = 0)
b = Regression coefficient (value of increase or decrease)

Furthermore, to determine the strength of the relationship between Nitrate and Phosphate with diatoms quantitatively divided into four[6], namely: 0.01-0.25 (weak relationship); 0.26-0.50 (medium); 0.51-0.75 (strong); 0.76-1.00 (very strong).

3. RESULT AND DISCUSSION

Conditions of Research Locations

The Pieh Island Tourism Aquatic Park area and the surrounding sea is a national marine conservation area covering an area of 39,900 ha, consisting of five island clusters, namely Pieh Island, Water Island, Bando Island, Toran Island, and Pandan Island. Geographically, the islands in the TWP area of Pieh Island and the surrounding sea are included in the administrative areas of Padang Pariaman Regency, Pariaman City, and Padang City, West Sumatra. Pandan Island is an island that is administratively included in the sub-district of West Padang, Padang City, West Sumatra; geographically, the island is located at the coordinates 00°56'58"S and 100°08'23"E and has an area of 16.64 ha, with circumference of Pandan Island is 1,601 m.

Nitrate and Phosphate Content

Each station is different based on the nitrate and phosphate content analysis in the waters of Pandan Island, West Sumatra. The average nitrate and phosphate can be seen in Table 1.

Table 1. Average nitrate and phosphate concentrations

Station	Concentration	
	Nitrate (mg/L)	phosphate (mg/L)
I	0,73	0,76
II	1,35	0,90
III	0,87	0,83
IV	0,85	0,88

It can be seen from the results of nitrate and phosphate analysis that the range is between 0.73–1.35 mg/L. station I had a nitrate concentration of 0.73 mg/L and phosphate of 0.76 mg/L. Station II has a nitrate concentration of 1.35 mg/L and phosphate of 0.90 mg/L. Station III nitrate concentration is 0.87 mg/L and phosphate 0.83 mg/L. Station IV has a nitrate concentration of 0.85 mg/L and phosphate of 0.88 mg/L.

The average nitrate concentration in the Pandan Island area is relatively high in the 0.73–1.35 mg/L. High concentration in the Pandan Island area is feared to result in eutrophication and endanger marine life. Because it is almost close to the nitrate concentration value, eutrophication is more than 0.2 mg/L. Nitrate concentration at the station on Pandan Island has exceeded 0.1. Effendi[1] stated that nitrate concentrations of more than 0.2 mg/L can result in the eutrophication of waters and subsequently stimulate the rapid growth of algae and aquatic plants (blooming). The highest nitrate concentration in the waters of Pandan Island is found in Southern Station II, with an average of 1.35 mg/L can be caused by

sediment suspension; this is evidenced by the high current in Station II, as well as the high influx of organic matter from land activities which can be in the form of land erosion, weathering of rocks and weathering of coral reefs in the waters of Pandan Island, as well as the large amount of leaf and tree branch waste that comes from the island itself. Dzialowski et al.[7] state that resuspension in sediment is one of the processes that can potentially contribute important nutrients such as nitrates to the water column. The lowest concentration was found at station I in the eastern part of Pandan Island due to higher salinity at station I compared to stations III and IV, which was 27.72 ppt. Utami et al.[8] stated that nitrate concentrations will decrease as salinity increases.

Meanwhile, the average phosphate concentration in the Pandan Island area ranges from 0.73-0.95 mg/L. The Station II area has the highest phosphate concentration, with an average of 0.90 mg/L, and the lowest concentration is found in Station I, with an average of 0.76 mg/L. The presence of phosphate in the waters is very important, especially in forming proteins and metabolism for organisms. However, high phosphates are feared to cause eutrophication in the form of an explosion in the number of algae (blooming), which has a bad effect on aquatic ecosystems. Sources of phosphate in waters come from livestock waste, human waste, especially detergents, agriculture, mainly inorganic fertilizers such as TSP (Triple Super Phosphate), industrial waste, and natural processes in the environment itself[9].

The high phosphate concentration on Pandan Island is suspected to be due to many factors that make the high phosphate value in the Pandan Island area. The high concentration of phosphate at station II is also related to current. High currents can lead to a resuspension process. The resuspension process can cause sediment on the seafloor to rise into the water column and cause chemical elements, including phosphates, to be lifted into the water column. According to Utami et al.[8], sediment is one of the processes that can potentially contribute to the input of nutrients such as nitrates and phosphates derived from sediment into the water column.

Diatom Abundance in Pandan Island Waters

Based on the data processing results, the value of the abundance of diatoms in the waters of Pandan Island, West Sumatra, can be seen in Table 2.

Table 2. The average value of diatom abundance

Class	Species	Average diatom abundance (ind/L)			
		I	II	III	IV
Bacillariophyceae	*Isthmia* sp	797,67	797,67	0	2.127,11
	Closterium sp	1595,33	3.456,55	2.924,77	2.393,00
	Amphora sp	1.063,55	0	21.063,55	2.924,77
	Nitzschia sp	797,67	0	1.595,33	1.063,55
	Hemiaulus sp	1.063,55	2.393,00	2.127,11	0
	Asterionella formosa	0	2.127,11	0	3.722,44
	Leptocylindrus sp	0	2.924,77	3.190,66	0
	Climacosphenia sp	0	2.127,11	0	1.861,22

Based on Table 2, the average abundance of diatoms in the waters of Pandan Island, West Sumatra, can be seen. The factors that affect the abundance of diatoms are temperature, current, pH and nutrients. The highest diatom abundance was found in Station IV, with an average abundance value of around 14.092,09 ind/L. In contrast, the lowest average abundance was found in the Station I area, with an average value of 5.317,77 ind/L. The high abundance of diatom at station IV compared

to other locations is supported by good water quality conditions. This is suspected because of the high level of brightness that supports the photosynthesis process for diatoms. In photosynthesis, sunlight is needed, so sunlight is the main factor in the reproduction of diatoms. In addition, water concentration is highly dependent on several physic-chemical parameters, such as light intensity and nutrients, which also affect the abundance of diatoms[10]. The low abundance of diatoms at Station I is suspected to be due to the lack of nitrate and phosphate content and low concentration. This is evidenced by Aryawati et al.[11], who states that one of the growth factors of phytoplankton is caused by the presence of nutrients in the form of nitrates and phosphate and the improvement of stable water quality.

Water Quality

Water quality parameters measured in the field for each station are temperature, salinity, pH, current velocity, and brightness. The results of measuring water quality parameters in the waters of Pandan Island, West Sumatra, can be seen in Table 3.

Table 3. Water quality parameters

Station	Suhu (^{0}C)	Salinity (ppt)	pH	Current velocity (m/s)	Brightness (m)
I	25.3	27.72	8.17	0.37	8.2
II	25.0	28.00	8.10	0.49	8.8
III	26.0	27.06	7.9	0.38	9.0
IV	26.4	26.45	7.0	0.46	9.0

Based on Table 3, the highest temperature is found at station IV, which is 26.4^{o}C, and the lowest at station II is 25^{o}C. The highest salinity was found at station II, 28.00 ppt, and the lowest at station IV, was 26.45 ppt. The highest acidity (pH) at station I was 8.17, and the lowest at station IV was 7. The highest current velocity is found at station II, which is 0.49 m/s and the lowest at station I, which is 0.37 m/s. The highest brightness is at stations III and IV, with a value of 9 m and the lowest is found at station I, which is 8.2 m.

Relationship of Nitrate and Phosphate Concentrations with Diatom Abundance

To determine the relationship between nitrate and phosphate concentrations and diatom abundance, a simple linear regression test using SPSS can be carried out and the regression equation results are obtained, namely the value of y = 31.184x-15.082 and the value of the correlation coefficient (r) = 0.711 which means that the nitrate content and diatom abundance have a strong relationship. Meanwhile, the phosphate concentration on diatom susceptibility was obtained with a value of y=51.543x-32.477 and a coefficient value of correlation (r)=0.738, meaning that the phosphate content and diatom abundance have a strong relationship.

The results of the study, it can be seen that the high abundance of diatoms is caused by the high content of nitrates and phosphate at the research site, which is caused by the environment or topography of the region as well as from currents and waves of seawater. Sampling is also influenced by environmental factors such as substrate characteristics, depth, and salinity, which often have more influence on the presence of diatoms.

4. CONCLUSION

The concentration of nitrates in the waters of Pandan Island ranges from 0.73 to 1.35 mg/L. The Station II area has the highest nitrate concentration, with an average of 1.35 mg/L, and the lowest concentration in Station I, with an average of 0.73 mg/L. Phosphate concentrations in the Pandan Island area ranged from 0.73-0.95 mg/L. The Station II area has the highest phosphate concentration, with an average of 0.90 mg/L, and the lowest concentration is

found in Station I, with an average of 0.76 mg/L. On Pandan Island, it was found that the composition of diatom species found in the waters of Pandan Island consisting of 4 stations and 12 side points was obtained diatoms, namely from the Bacillariophyceae *class*. The class Bacillariophyceae has 8 species, namely *Isthmia* sp, *Amphora* sp, *Closterium* sp, *Nitzschia* sp, *Hemiaulus* sp, *A.formosa*, and *Leptocylindrus* sp. The highest diatom abundance is found at station IV with an average abundance value of around 14.092,09 ind/L.

REFERENCES

1. Effendi, H. *Water Quality Study, for the Management of Aquatic Resources and Environment*. Fifth Printing. Yogyakarta. Kanisius, 2003.
2. Murtiono, L.H., Yunianto, D., Nuraini, W. Analysis of the Suitability of Grouper Cultivation Land with Floating Net Cage System with the Application of Geographic Information System in the Waters of Ambon Dalam Bay. *Journal of Marine Aquaculture Technology*, 2016; 6:1-16.
3. Kadim, M.K., Pasisingi, N., Paramata, A.R. 2017. Study of the Water Quality of Gorontalo Bay using the Storet. *DEPIK*, 2017; 6(3):235-241.
4. Purnamaningtyas, S.E. 2014. Distribution of Oxygen, Nitrogen and Phosphate Concentrations in Saguling Reservoir, West Java. *LIMNOTEK*, 2014; 21(2): 125-134.
5. [APHA] American Public Health Association. *Standard Methods for the Examination of Water and Wastewater*. Port City Press. Washington DC, 1992.
6. Tanjung, A. *Revised Edition Experimental Design*. Tantaramesta. Bandung, 2014.
7. Dzialowski, A.R., Shih-Hsien, W., Niangchoo, L., Beury, J.H. Huggins, D.G. Effect of Sediment Resuspensions on Nutrient Concentration and Algal Biomass in Reservoirs of the Central Plains. *Lake and Reservoirs Management*, 2008; 24: 313-320.
8. Utami, T.M.R., Maslukah, L., Yusuf, M. Distribution of Nitrate (NO_3) and Phosphate (PO_4) in the Waters of Karangsong, Indramayu Regency. *Marina Oceanography Bulletin*, 2016; 5(1): 31-37.
9. Ramadhan, R., Yusanti, I.A. Study on Nitrate and Phosphate Levels in Floodplain Waters of Medium Village, Suak Tapeh District, Banyuasin Regency. *Journal of Fisheries Sciences and Aquaculture*, 2020; 15(1): 37-41
10. Ridhawani, F., Ghalib, M., Nurrachmi, I. Water Fertility Level Based on the Abundance of Phytoplankton and Nitrate-Phosphate to the Turbidity Level of the Rokan River Estuary, Rokan Hilir Regency. *Jurnal Perikanan dan Kelautan*, 2017; 22(2): 10-17.
11. Aryawati, R., Melki, M., Azhara, I., Ulqodry, T. Z., Hendri, M. Phytoplankton Diversity and Potential of Harmfull Algal Blooms (HABs) in the Waters of the Musi River downstream of South Sumatra Province. *Marina Oceanography Bulletin*, 2023; 12(1): 27–35.