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The Relationship between Total Suspended Solids and Total Organic Matter and Phytoplankton Abundance in the Waters of Bayur Bay, Padang City, West Sumatra

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ABSTRACT

Phytoplankton, as primary producers in water, play an important role as food for various marine organisms. Primary. Primary producers are one of the factors that determine a body's fertility level. TSS contributes to turbidity by limiting light penetration for photosynthesis and visibility in waters. Organic material in marine waters is material derived from living organisms or the result of decomposition, such as food debris, organic waste, and microorganisms. Organic matter at certain levels is a pollutant that pollutes waters. This research aims to examine the total concentration of suspended solids, total organic matter, and abundance of phytoplankton in the waters of Teluk Bayur, Padang City, West Sumatra. Sampling was carried out in April 2025 through a survey method to determine research stations by purposive sampling. To see the relationship of total suspended solids and total organic matter to phytoplankton abundance, a multiple linear regression test was performed. The total concentration of suspended solids ranges from 10.6 to 15.67 mg/L. The total concentration of organic matter ranges from 27.808 - 33.917mg/L. There are 10 species of phytoplankton from the class Bacillariophyceae. Phytoplankton abundance ranges from 15,383.60 – 19,184.25 ind/L. The results of the linear regression test showed that the coefficient of determination for total suspended solids and total organic matter accounted for 55.88% of the variation in phytoplankton abundance. The relationship between total suspended solids, total organic matter, and phytoplankton abundance was 0.607, indicating a strong relationship (0.51-0.75).

Keywords: Total Suspended Solids, Total Organic Materials, Phytoplankton

1. INTRODUCTION

Teluk Bayur is one of the bays along West Sumatra's coast. The waters of Teluk Bayur directly face the Indian Ocean, which is the administrative area of Padang Selatan District – Lubuk Begalung, Padang City. Phytoplankton are unicellular organisms that live floating in water and play an important role as primary producers in aquatic ecosystems, as they contain chlorophyll and can photosynthesize.

Phytoplankton, as primary producers in waters, play an important role as food for various marine organisms. In addition to being a primary producer, phytoplankton is also a parameter of a body of water's fertility (Rahmah et al., 2022). Total suspended solids are the sum by weight of particles in mg/L present in the exhaust water after undergoing filtration. TSS contributes to turbidity by limiting light penetration for photosynthesis and visibility in waters. This is caused by the presence of finely decomposed organic substances, micro-organisms, mud, clay, and similar colloidal substances or floating objects that do not settle immediately.

Organic material in marine waters is material derived from living organisms or the result of decomposition, such as food debris, organic waste, and microorganisms. The increase in organic matter content in aquatic ecosystems is significantly influenced by various factors, including household waste, agricultural and industrial activities, and organic matter transported from land by rivers or estuaries as natural transportation routes (Hawari et al., 2013).

Aquatic organisms can serve as biological indicators of aquatic conditions. The use of bioindicators in evaluating water quality is considered more effective than that of physico-chemical parameters (Junshum & Traichaiyapor, 2007). At certain levels, organic matter is a pollutant in water. Input of organic

material starts in the upstream river, where dense residential areas are located. Urban and industrial activities are discharged into the river and carried by the current towards the estuary. Some organic material will undergo relaxation and form sediment, causing silting in the water.

2. RESEARCH METHOD

Time and Place

The location of this research is in the waters of Teluk Bayur. A sample performance time was conducted in April 2025. Sample processing is carried out at the Marine Chemistry Laboratory of the Faculty of Fisheries and Marine at the Universitas Riau.

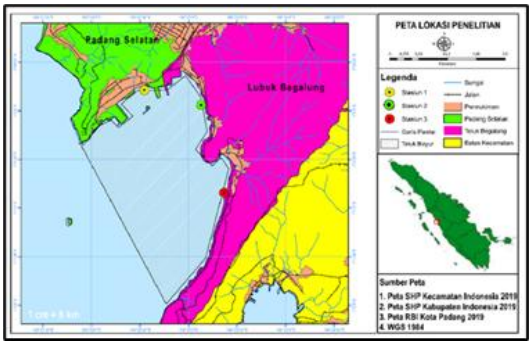

Figure 1. Research location

Method

The method used in this research is the survey method, with primary data collected. Primary data obtained through sample processing.

Procedures

Sampling Location

The research location was determined through direct field surveys in Teluk Bayur. Station I is located in waters near the port (Teluk Bayur Harbor, PELINDO); station 2 is located in waters near residential areas; and station 3 is located in tourist areas (Taman Nirwana).

Water Quality Reinforcement

Water quality measurements were carried out at all three stations. The water quality parameters measured during the sampling process (in situ) are temperature, salinity, pH, current speed, brightness, and dissolved oxygen (DO).

Sampling

TSS sampling is carried out at high tide (around 13.00) at each sampling point. A water sample was taken from a surface of 200 mL and labeled. The sample is then inserted into the ice box.

Sampling of total organic matter is carried out from tide to ebb (around 13.00) at each sampling point. Water samples were taken at the water surface, measuring ± 1 liter each, wrapped in aluminum foil, and labeled. The sample is then put into an ice box.

Phytoplankton sampling is carried out at the tide to ebb (around 13.00) along with TSS sampling at each sampling point and in a tidal state to ebb. Phytoplankton sampling using a 10-liter bucket with 10 repetitions, then filtered with a plankton net number 25 with a mesh eye size (*mesh*) 55 µm to a volume of 125 mL, then transferred to a sample bottle that has been prepared and labeled, then given 3-4 drops of 4% lugol.

Total Suspended Solids

TSS data processing is analyzed using a gravimetric method. by separating the large particles floating on the sample first, shaking the sample bottles so that the particles are stirred evenly, filter paper is weighed with an analytical scale before the filtering process as the initial weight, filter paper is placed on a measuring cup, previously, filter paper is wetted with aquades to mineralize the paper. Then slowly pour 1-2 liters of water. After the suspended solids are filtered on Whatman paper, place the filter in the oven at 103-105ºC for 1 hour, then place it in a desiccator, and weigh the paper using an analytical scale. To calculate TSS, use the formula according to (SNI 06-6989-3, 2004) as follows:

$$\text{TSS (mg/L)} = \frac{(A-B)\ x1000}{V}$$

Description:

A = Filter paper weight + residue dry (mg)
B = Filter paper weight (mg)
V = Test sample volume (mL)

Total Organic Materials

Total Organic Material (BOT) in water was measured using the titrimetric method (SNI 06-6989.22-2004). A sample of 100 ml of water was placed in a 250 ml Erlenmeyer flask, and a few drops of $KMnO_4$ were added until the solution turned slightly bluish. After that, 10 mL of 4N H_2SO_4 solution was added. Next, the mixed solution was heated on a hot plate until boiling, then 10 mL of 0.01 N $KMnO_4$ solution was added. The solution is then boiled for 10

minutes at 105 ºC, then 10 ml of $H_2C_2O_4$ 0.01 N oxalic acid solution is added and boiled again. To calculate total organic matter, use the formula according to SNI 06-6989.22-2004 as follows:

$$TOM = \frac{(X-Y) \times 32 \times 0{,}01 \times 1000}{V}$$

Description:

X = Volume of Sodium Oxalate 0,01 N to no colored
Y = Volume of Potassium Permanganate until becomes pink
V = Volume of samples in titration

Phytoplankton Abundance

Phytoplankton abundance was calculated using the visual field method, Lackey Drop Macrotransect Counting from APHA (1992), as follows:

$$N = \frac{Oi}{Op} \times \frac{Vr}{Vo} \times \frac{1}{Vs} \times \frac{n}{12}$$

Description

N = Phytoplankton Abundance (Ind/L)
Oi = Preparation cover area (324 mm²)
Op = One viewing area (1,036mm²)
Vr = Volume of water filtered (125 mL)
Vo = Volume of water observed (0.06 mL)
Vs = Volume of water filtered (100L)
n = The number of phytoplankton observed

Data Analysis

To examine differences in TSS content, organic matter, and phytoplankton abundance among the stations, an ANOVA was performed. The relationship between TSS content and phytoplankton abundance was assessed using a simple linear regression. According to Sugiyono (2007), the multiple linear regression equation can be seen from mathematical equations, namely:

$$Y = a + bx1 + bx2$$

Description:

Y = Phytoplankton abundance (ind/L)
a and b = Constant
x1 = TSS content (mg/L)
x2 = Organic matter content (mg/L)

3. RESULT AND DISCUSSION

Water Quality

Measuring aquatic quality is one way to assess the good and bad of an aquatic environment. Aquatic quality is also a limiting factor that can affect phytoplankton abundance. The results of the research on water quality parameters in Teluk Bayur are shown in Table 1.

Table 1. Average quality parameter values for Bayur Bay waters

Station	Water Quality Parameters					
	Temperature (°C)	Salinity (‰)	pH	Current speed (m/s)	Brightness (cm)	DO (mg/L)
1	28,2	28	6,8	0.26	550	8
2	30,4	27	7	0.09	640	11
3	31,3	24	8	0.08	600	10

Table 2. TSS concentration

Station	Sample Point	Concentration (mg/L)	Concentration (mg/L)
1	1	14,4	15,67
	2	17,0	
	3	15,6	
2	1	12,0	10,6
	2	09,4	
	3	10,4	
3	1	13,2	12,67
	2	10,2	
	3	15,2	

Based on sample processing results, the highest TSS concentration was observed at the station, averaging 15.67 mg/L. The lowest TSS concentration is at station 2, with a mean of 10.6

mg/L. The highest TSS concentration is at station 1, namely 15.67 mg/L in the port area. This is caused by activities in the port, such as ship ballast water disposal, port trench water disposal, coal loading and unloading, and cement and logistics.

The lowest TSS concentration is at station 2, 10.60 mg/L, in a water area near residential areas. Various factors, including conditions near settlements, small river markets, and water movement itself, influence TSS concentration at station 2. The beach at Station 2 is rocky, with a base composed mainly of coral rock. This is also in line with the highest brightness value at station 2. The TSS content is still below the Ministry of the Environment's quality standard for total suspended solids in coral waters, namely 20 mg/L. Suspended solids in waters consist of inorganic materials, usually terrestrial sediments carried through fluvial (river) or aeolian (carried by wind) processes and/or suspended seabed sediments, as well as dissolved and particulate organic materials, such as phytoplankton, zooplankton, and bacteria (Soaudy et al., 2023).

Total Organic Materials

Based on the processing of organic material samples, data on the total organic material content are obtained, which vary. The highest total organic matter concentration was at station 1, with a value of 33.917 mg/L, and the lowest was at station 2, with a value of 27.808 mg/L, as shown in Table 3.

Table 3. Concentration of organic materials

Station	Sampling Point	Concentration (mg/L)	Average(mg/L)
	1	34,760	
1	2	36,024	33,917
	3	30,968	
	1	26,544	
2	2	27,176	27,808
	3	29,704	
	1	32,864	
3	2	30,968	31,389
	3	30,336	

At station 1, which is a port area. High BOT content can lead to low dissolved oxygen levels in water. It turns out that the high TOM value is also consistent with the reduced pH, as indicated by the oxidation reaction results (Supriyantini et al., 2017). The high organic matter content is also thought to be influenced by the high rainfall that occurs before sampling. High rainfall will carry solids from land, namely organic and inorganic particles that dissolve or are suspended in seawater (Jamaludin et al., 2021).

Phytoplankton Abundance

Based on the identification of phytoplankton, 10 types of phytoplankton have been obtained. The phytoplankton obtained were all from the class Bacillariophyceae. The species obtained are: *Isthmia* sp.; *Synedra* sp.; *Melosira* sp.; *Navicula* sp.; *Pinnularia* sp.; *Pleurosigma* sp.; *Bacilaria* sp.; *Nitzschia* sp.; *Coscinodiscus* sp.; *Amphora* sp.

At each station, differences in phytoplankton species were observed, such as *Pleurosigma* sp. and *Navicula* sp. Only found at station 3, *Coscinodiscus* sp. Only found at station 2 as well, *Amphora* sp. Only found at stations 1 and 2.

10 types of phytoplankton were identified. The composition of phytoplankton in Bayur waters consists entirely of the class Bacillariophyceae, with the most common being *Synedra* sp. This is because the class Bacillariophyceae, or diatoms, is the most common phytoplankton found in marine waters. The Bacillariophyceae class is dominant because the phytoplankton of the Bacillariophyceae class can adapt to the environment and reproduce quickly (Juadi et al., 2018).

The Bacillariophyceae class has a high level of adaptation and tolerance, enabling it to survive better. Light intensity is the main factor for phytoplankton in carrying out the photosynthesis process, so light intensity is a limiting factor for phytoplankton reproduction.

Other factors that can influence abundance include environmental parameters, such as physical, chemical, and biological factors, as well as interaction factors with other biota. Aquatic temperature influences phytoplankton growth. The optimal temperature for phytoplankton ranges from 25–30 °C. *Synedra* sp. is also known to withstand unfavorable environmental conditions. This is possible because *Synedra* sp. is a diatom with layered, wrapping cells. Besides that, *Synedra* sp. can survive in environments low in nutrients (oligotrophic) with low nitrogen and phosphate concentrations. This is because *Synedra* sp. can accumulate nutrients and store them as food reserves in the form of undissolved polymers (Isti'anah et al., 2015).

Table 4. Phytoplankton abundance (ind/L)

Station	Sampling Point	Abundance (ind/L)	Average (ind/L)
1	1	15,745.57	17,012.45
	2	16,831.47	
	3	18,460.32	
2	1	20,632.12	19,184.25
	2	18,460.32	
	3	18,460.32	
3	1	15,202.61	15,383.60
	2	16,831.47	
	3	14,116.71	

The high class of Bacillariophyceae found in the waters of the Bayur Bay is thought to be because this type of phytoplankton is positively phototactic, so the high intensity of sunlight causes phytoplankton from the Bacillariophyceae type to be abundant. Some phytoplankton species may prefer certain conditions provided by certain types of sediment. In many aquatic ecosystems, sediments and phytoplankton abundance can fluctuate seasonally. For example, during the rainy season, soil erosion can increase sediment in water, while phytoplankton abundance can increase during the summer when temperatures and sunlight increase (Effendi et al., 2025).

Relationship between TSS and Total Organic Materials and Phytoplankton Abundance

To determine the relationships between TSS, total organic matter, and phytoplankton abundance, multiple linear regression can be used. Based on the test results, the regression equation was obtained: Y = 29,046,855 + (-35,640) X1 + (366,867)X2. From the results of this test, the determination coefficient (R2) is 0.468, indicating that the concentrations of TSS and total organic matter explain 55.88% of the variation in phytoplankton abundance. This suggests a moderate relationship between these variables.

Value multiple R obtained based on the regression of 0.607. According to Sugiyono (2007), the relationship between TSS and total organic matter with a phytoplankton abundance of 0.607 is considered a strong relationship (0.51-0.75). This is also consistent with the significance level (F = 0.025) and is smaller than alpha (0.05), indicating a significant effect of TSS and total organic matter on phytoplankton abundance.

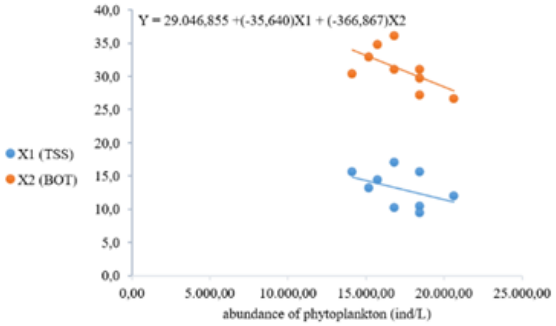

Figure 2. Relationship between Abundance of Phytoplankton, TSS, and BOT

4. CONCLUSION

Based Based on research in Teluk Bayur waters, it can be concluded that: The total concentration of suspended solids (TSS) is between 10.60 and 15.67 mg/L, total concentration of organic matter ranged from 27.808 to 33.917 mg/L. The phytoplankton species found are: *Isthmia* sp.; *Synedra* sp.; *Melosira* sp.; *Navicula* sp.; *Pinnularia* sp.;

Pleurosigma sp.; *Bacilaria* sp.; *Nitzschia* sp.; *Coscinodiscus* sp.; *Amphora* sp. Phytoplankton abundance ranges from 188.89-235.56 ind/L.

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