JURNAL PERIKANAN DAN KELAUTAN
Volume 29 No. 3, October 2024: 343-349

e-issn : 2721-8902
p-issn : 0853-7607

Relationship of Total Oil Content and Planktonic Diatoms Abundance in the Coastal Waters of Lukit Kepulauan Meranti

Hubungan Kandungan Total Minyak dan Kelimpahan Diatom Planktonik di Perairan Desa Lukit Kepulauan Meranti

Riza Yuliani[1*], Sofyan Husein Siregar[1], Bintal Amin[1]
[1]Department of Marine Science, Faculty of Fisheries and Marine,
Universitas Riau, Pekanbaru 28293 Indonesia
**email: riza.yuliani4335@student.unri.ac.id*

Received
27 August 2024

Accepted
03 October 2024

Abstract

This research was conducted in January 2024 in the waters of Lukit, Merbau District, Meranti Islands. This study aimed to analyze the total oil content and abundance of planktonic diatoms and determine the relationship between total oil content and abundance of planktonic diatoms. This study used a purposive sampling method. The sampling location was divided into three stations with three sampling points. Station 1 is in the oil company jetty area, Station 2 is in the crossing port area, and station 3 is far away from residential areas. The results of the analysis of total oil content was 0,252 ppm. The highest oil content was found at station 2, which was 0,274 ppm, and the lowest oil content was found at station 3, which was 0,222 ppm. The results of the planktonic diatom abundance ranged from 75 – 187,5 ind/L. The highest abundance was found at station 3, which was 166,67 ind/L, and the lowest was found at station 2, which was 79,17 ind/L. The results of the simple linear regression test obtained the equation y= 177,77-225,55x with the value of R^2 = 0,1321 and the correlation coefficient r = -0,36, which shows that higher total oil content will cause a decrease in the abundance of planktonic diatoms.

Keywords: Kepulauan Meranti, Oil Content, Pollution

Abstrak

Penelitian ini dilakukan pada Januari 2024 di Perairan Desa Lukit, Kecamatan Merbau, Kepulauan Meranti. Tujuan dari penelitian ini adalah untuk menganalisa kandungan total minyak dan kelimpahan diatom planktonik serta mengetahui hubungan kandungan total minyak dan kelimpahan diatom planktonik. Penelitian ini menggunakan metode *purposive sampling*. Lokasi pengambilan sampel dibagi menjadi 3 stasiun yang terdiri dari 3 titik *sampling*. Stasiun 1 berada pada kawasan *jetty* perusahaan minyak, Stasiun 2 berada pada kawasan pelabuhan penyebrangan dan Stasiun 3 berada pada kawasan jauh dari pemukiman penduduk. Hasil analisis kandungan total minyak diperoleh rata-rata 0,252 ppm Kandungan minyak tertinggi terdapat pada stasiun 2 yaitu 0,274 ppm dan kandungan minyak terendah terdapat pada stasiun 3 yaitu 0,222 ppm. Hasil perhitungan kelimpahan diatom planktonik berkisar antara 75 – 187,5 ind/L. Kelimpahan tertinggi terdapat pada stasiun 3 yaitu 166,67 ind/L dan kelimpahan terendah pada stasiun 2 yaitu 79,17 ind/L. Hasil uji regresi linear sederhana didapatkan persamaan y= 177,77-225,55x dengan nilai R^2 = 0,1321 dan koefisien korelasi r = -0,36 yang menunjukkan hubungan kandungan total minyak yang tinggi akan menyebabkan penurunan pada kelimpahan diatom planktonik.

Kata kunci: Kepulauan Meranti, Kandungan Minyak, Pollution

1. Introduction

Lukit Village is one of the villages in Merbau District, Meranti Islands Regency, Riau Province. The waters of Lukit Village are an area used as a shipping route, where a crossing port is the source of the local community's economy. In addition, this area has many activities, such as oil drilling, fishing, and other activities that can affect aquatic ecosystems and are prone to oil pollution.

Oil pollution can cause both short-term and long-term impacts on aquatic ecosystems. The entry of oil into the waters creates a film layer on the water's surface to affect and inhibit the photosynthesis process of marine organisms, one of which is diatoms (Hutagalung in Sinaga et al., 2022). Oil floating on the water's surface can reduce the intensity of sunlight used by planktonic diatoms to photosynthesize. If it occurs over a long period, it can disturb the ecosystem and reduce the rate of primary water productivity.

Planktonic diatoms are a parameter of aquatic environmental quality; planktonic diatoms are a food chain in marine ecosystems (Samudra et al., 2013). This is because the short life cycle of diatoms can reflect significant environmental changes in a short period, changing their diversity and density so that it is helpful as a bioindicator of water quality (Wang et al., 2019). Some of the species are sensitive to environmental changes. Hence, they respond quickly, can reflect changes in water quality in the short and long term, and are easy to samp, analyze, and identify. Therefore, this study was conducted to determine the relationship between the total oil content and the abundance of planktonic diatoms in the waters of Lukit Village so that the quality of the seas is maintained.

2. Material and Method

2.1. Time and Place

This research was conducted in January 2024 in Lukit Village, Merbau District, Merbau Islands, Riau Province (Figure 1). Total oil content was analyzed at the Chemical Oceanography Laboratory, and analysis of diatom abundance was carried out at the Marine Biology Laboratory, Faculty of Fisheries and Marine Sciences, Universitas Riau.

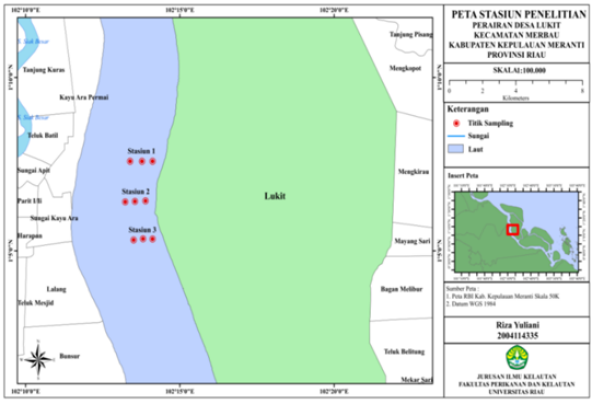

Figure 1. Location of research sampling points

2.2. Methods

Determination of sampling locations using purposive sampling technique based on the characteristics of oil pollutant sources. The sampling location was divided into three stations consisting of 3 sampling points. Station 1 was in the oil company jetty area, Station 2 was in the crossing port area, and Station 3 was in an area away from residential areas.

2.3. Procedures

2.3.1. Oil Sampling Procedure

Oil sampling is carried out on the water's surface with a depth of about 0-30 cm using an aluminium ladle. Oil samples that have been taken are put into a 1000 mL sample bottle. The sample bottle was added to two drops of concentrated H_2SO_4, labelled, and put into an ice box. Furthermore, the samples were brought to the laboratory for oil content analysis (Nasution et al., 2017).

2.3.2. Diatom Sampling Procedure

Diatom sampling was carried out during the day, between 11:00 am - 3:00 pm, because it was estimated that diatoms were on the surface to carry out photosynthesis (Nurrachmi et al., 2014). Diatom sampling was carried out on the surface of the water and taken using a 10 L plastic bucket with ten repetitions, then filtered using a plankton net no.25. The filtering results of 100 mL were put into a sample bottle, then given a 4% Lugol solution as much as 3-4 drops. Each sample was labelled, put into a box, and then taken to the laboratory for analysis.

2.4. Data Analysis

2.4.1. Total Oil Content Analysis

Analysis of total oil content using gravimetric method (SNI 6989.10, 2011). Water samples that have been taken as much as 1000 mL are extracted with 25 mL of CCl4 until three repetitions, and each extraction result is accommodated in an Erlenmeyer, which has previously been filtered using glass wool. The results of the filtration measured the volume (C mL), and the extraction results were separated into a flask first known by weight (washed, rinsed with distilled water and heated in an oven for 1 hour at 105ºC and cooled in a desiccator for 30 minutes - 1 hour, then weighed (B g). After weighing, the extract was heated in an oven at 90 ºC until the CCl_4 evaporated. After evaporating, the extract was cooled in a desiccator for 30 - 1 hour, then weighed (A g) at four decimal accuracy. Calculation of oil content:

$$\text{Oil content} = \frac{(A-B)g\ X\ 75\ mL}{(C\ mL\ X\ 1000)} = \cdots ppm$$

Description:
A = Weight of flask after evaporation (g)
B = Weight of empty flask (g)
C = Volume of CCl4 after extraction (mL)

2.4.2. Planktonic Diatom Abundance Analysis

Diatom samples were taken using a drop pipette of as much as 0.05 mL, placed in an object glass, covered with cover glass, and observed under a microscope. Diatom observations were made using the 12 field of view method by observing all columns on the object glass with a magnification of 10 x 10 for three repetitions on each sample. Calculation of diatom abundance using the APHA (1995) formula, namely:

$$N = \frac{X}{Y} x\ \frac{1}{V} x\ Z$$

Description:
N = abundance of planktonic diatoms (ind/L)
X = volume of filtered water (125 mL)
Y = volume of sample water under the cover glass (0.08 mL)
V = volume of filtered sample water (50 L)
Z = Number of individuals found

3. Result and Discussion

3.1. General Condition of the Study Location

Fixed Lukit Village is one of the villages in the administrative area of Merbau District, Meranti Islands Regency, Riau Province. Astronomically, Lukit Village is located at 102° 14' 10.102" - 102° 23' 51.942" East Longitude (BT) and 01° 17' 17.062" - 00° 56'19.641" North latitude (LU). The waters of Lukit Village are generally murky and brownish in color. The Lukit Village water area is a shipping lane with a crossing port that is a source of the local community's economy. This is because the geographical position of Lukit Village is on Padang Island, consisting of strait waters and dynamic shipping lanes. In addition, the level of activity in the waters of Lukit Village is relatively high, including oil mining, community activities around the seas, fishing activities, and other activities.

3.2. Water Quality Parameters

The measured water quality parameters include physical parameters and chemical parameters. Physical parameters consisted of temperature, current speed, and brightness. At the same time, chemical parameters consist of acidity (pH), salinity, and dissolved oxygen (Table 1 and Table 2).

Based on the measurement of physical and chemical parameters, it is known that the average water temperature ranges from 28.03 - 28.90ºC, the current speed ranges from 0.08 - 0.38 m/s, salinity ranges from 19.97 - 21.30, the average pH in these waters ranges from 6.2 - 6.8, the range of dissolved oxygen (DO) is 5.54 - 5.95 ppm and nitrate concentration is 0.75 - 0.92 mg/L, where the range of temperature, salinity, pH, dissolved oxygen (DO) and nitrate is suitable for diatom life in waters. Based on PP RI No. 22 of 2021 Class II, the temperature and pH of the water are also in the optimal range for diatoms (Bacillariophyceae), namely in the temperature range of 20-30ºC and pH 6.5-8.5 and dissolved oxygen levels (≥4 mg/L). According to Effendi (2003), the optimum temperature range for phytoplankton growth in waters is 20-30 ºC. According to Davis in Hidayanni et al. (2013), a water body can support abundant organisms if the dissolved oxygen is more significant than 4.2 mg/L. According to Patty (2015), the Ministry of Environment 2004 set the quality standard for nitrate compounds ranging from 0.3-0.9 mg/l sufficient for organism growth. Water brightness ranges from 61.67 - 69.55 cm, and phosphate concentration is 0.16 - 0.22 mg/L, with fewer phosphate levels following the tolerance limit for diatom life in waters. According to the Government Regulation of the Republic of Indonesia Number 22 of 2021, if the phosphate concentration exceeds 0.015 mg/L, this condition can be dangerous for marine biota and cause eutrophication.

Table 1. Measurement results of physical parameters

Station	Sampling point	temperature (ºC)	Current speed (m/det)	Brightness (cm)
1	1.1	28,00	0,57	53,66
	1.2	27,80	0,23	82,50
	1.3	28,30	0,34	72,50
Average		28,03	0,38	69,55
2	2.1	28,30	0,25	65,83
	2.2	29,20	0,26	70,67
	2.3	28,80	0,37	48,50
Average		28,77	0,29	61,67
3	3.1	28,80	0,06	41,50
	3.2	28,70	0,07	78,67
	3.3	29,30	0,11	81.33
Average		28,90	0,08	67,17

Table 2. Measurement results of chemical parameters

Station	Sampling point	Salinity (ppt)	pH	Dissolved oxygen (ppm)	Nitrate (mg/L)	Phosphate (mg/L)
1	1.1	21,30	6,5	5,81	0,77	0,23
	1.2	21,60	5,9	5,74	0,96	0,25
	1.3	21,00	6,3	5,93	0,73	0,11
Average		21,30	6,2	5,83	0,82	0,20
2	2.1	21,30	6,8	5,55	0,69	0,25
	2.2	21,30	6,8	5,49	0,71	0,09
	2.3	19,30	6,5	5,58	0,85	0,32
Average		20,63	6,7	5,54	0,75	0,22
3	3.1	17,60	6,7	5,90	0,87	0,15
	3.2	22,00	6,9	6,12	0,75	0,09
	3.3	20,30	6,8	5,83	1,14	0,23
Average		19,97	6,8	5,95	0,92	0,16

3.3. Total Oil Content in Lukit Village Waters

The average oil content in Lukit Village Waters is 0.252 ppm. The average oil content in the dock area (station 1) is 0.262 ppm. In the ferry port area (station 2), the average value of oil content is 0.274 ppm. While in the area away from residential areas (station 3), the average value of oil content is 0.222 ppm. The highest oil content is found at station 2, with a value of 0.274 ppm. The high oil content in the area is thought to be due to the large number of ship activities at the ferry port, loading and unloading activities, and other oil sources, namely, carried by currents from areas that have oil spread due to the activities of ships passing by in these waters. A comparison of the total oil content in the waters of Lukit Village can be seen in Figure 2.

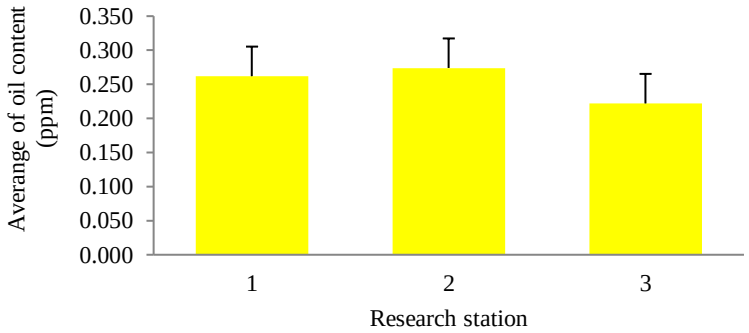

Figure 2. Total oil content at each station

Pulungan & Badrun (2023), in their research, stated that the results of the analysis of oil content in coastal Dumai City had oil levels ranging from 0.2428 - 0.3406 ppm. The highest oil content of 0.3406 ppm is found in the area around the harbour. Ship activities such as loading and unloading and ships anchored near the port that carry out ship engine washing activities impact the waters. Namely, there is a layer of oil on the surface of the seas; the oil layer can interfere with phytoplankton's ability to carry out photosynthesis due to the obstruction of sunlight entering the waters. Based on research by Nurrachmi et al. (2021), the value of total oil concentration varies; the highest total oil concentration is in the industrial area with an average value of 0.3245 ppm, while the lowest total oil concentration is in the region away from community activities which is a mangrove forest area with an average value of 0.0738 ppm. This area has several industries: Crude Palm Oil (CPO), sugar, paint, and

fertilizer. In addition, there is also an export ship dock that can load three tankers once docked, so there are many tanker activities at this station.

3.4. Planktonic Diatom Abundance in Lukit Village Waters

The abundance of diatoms in the waters of Lukit Village ranged from 75.0 - 187.5 ind/L. The highest abundance was found in the area away from residential areas (station 3), with an average abundance of 166.67 ind/L, while the lowest abundance value was in the crossing port area (station 2), with an average abundance value of 79.17 ind/L. The highest abundance of planktonic diatoms is found at station 3, which is 166.67 ind/L. A comparison of planktonic diatom abundance results at each station can be seen in Figure 3.

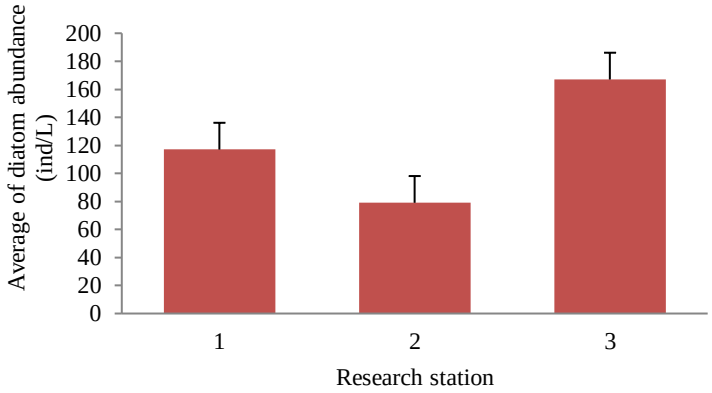

Figure 3. Diatom abundance at each station

The abundance of diatoms at station 3 is thought to be because it is far from residential areas and around mangrove ecosystems. This mangrove ecosystem produces organic matter in nutrients, as stated by Septriono et al. (2019), which states that the waters around mangroves are rich in organic and inorganic nutrients. These nutrients are beneficial not only for mangroves but also for diatom growth. This is also in line with the statement of Nugraheni et al. (2014), which states that mangrove vegetation is a nutrient trap, and deposition makes the concentration of diatoms and nutrients on the surface and supports the process of photosynthesis. The lowest abundance of planktonic diatoms was found at station 2, 79.17 ind/L. This is proven by Aryawati et al. (2023) in their research, which states that one of the factors of phytoplankton growth is caused by the presence of nutrients in the form of nitrates and phosphates and a stable improvement in water quality.

The difference in abundance of planktonic diatoms is found in station 3, with the highest abundance, and station 2, with the lowest abundance. The high and low abundance of planktonic diatoms in a body of water can be influenced by nutrients, one of which is nitrate. The highest nitrate concentration was found at station 3, which was 0.92 mg/L and the lowest at station 2, which was 0.75 mg/L. According to Asriyana & Yuliana (2012), the primary inorganic nutrients needed by phytoplankton to reproduce are nitrogen (nitrate/NO_3) and phosphorus (phosphate/PO_4). Other inorganic and organic nutrients may be required in minimal amounts, but their effect on productivity is not as significant as nitrogen and phosphorus.

3.5. Relationship between Oil Content and Planktonic Diatom Abundance

Based on the analysis results, the simple linear regression value obtained the equation y = 177.77-225.55x with R^2 = 0.1321 and the correlation coefficient r = -0.36 (Figure 4). According to Tanjung (2014), a negative linear indicates a form of relationship where the higher the value of the independent variable (X), the lower the dependent variable (Y). This shows that the higher the oil content in a water body, the lower the abundance of planktonic diatoms.

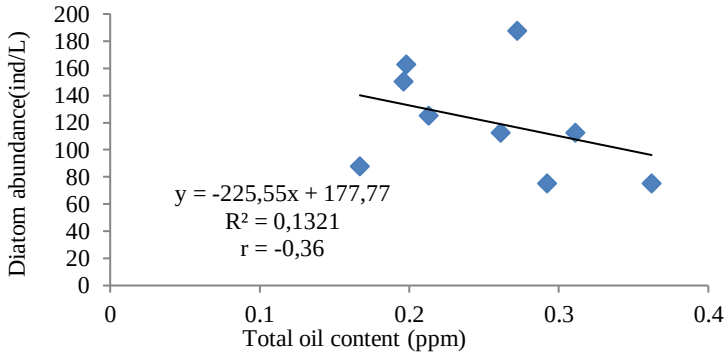

Figure 4. Relationship between oil content and abundance of planktonic

Based on the research of Nurrachmi et al. (2021), the results of the regression test of total oil concentration and phytoplankton abundance obtained the mathematical equation y = 157.01 + (-22.042x) with the coefficient of determination R^2 = 0.0104 and coefficient r = 0.10. The r value indicates a very weak relationship between total oil concentration and phytoplankton abundance in Pelintung waters. The negative correlation value illustrates that high oil content will cause a decrease in phytoplankton abundance in the seas.

In another study conducted by Puspita et al. (2021), the results of the regression test of total oil content and abundance of epiphytic diatoms obtained a mathematical equation y = 183.26 - 42.921x with the coefficient of determination R^2 = 0.001 and the relationship coefficient r = 0.03. The value of r indicates a very weak relationship. Following the oil content with the abundance of epiphytic diatoms can have a very weak relationship if the correlation coefficient (r) value is 0.00-0.20. This is thought to be the condition of very active water activities so that shipping activities affect the spread of oil and other water quality parameters such as nitrate, phosphate, salinity, temperature, waves, currents, wind, and tides. Based on the equation, it is known that the effect of oil content on diatom epiphytes is 3%. This shows that the total oil content does not affect the abundance of diatoms in the waters of Pandaratan Beach. With this, it can be concluded that the oil content in the waters of Lukit Village does not affect the abundance of planktonic diatoms.

4. Conclusions

The total oil content in Lukit Village Waters ranged from 0.167 - 0.362 ppm, where the total oil content at each station had no difference ($p>0.05$). The abundance of planktonic diatoms ranged from 75.0 - 187.5 ind/L, where the abundance of planktonic diatoms at each station differed ($p<0.05$). The simple linear regression analysis results obtained a value of r = (-0.36), which indicates that a high total oil content will cause a decrease in the abundance of planktonic diatoms. However, the relationship between total oil content and planktonic diatomic abundance is still relatively weak.

5. Suggestions

Further research related to the total oil content with the abundance of epiphytic, epipelic and other diatoms is needed by adding observation areas and different seasons. In addition, measurements of other parameters that have not been measured need to be done to provide a complete picture of the water conditions regarding oil content and diatom abundance.

6. References

[SNI] Standar Nasional Indonesia. 6989.10. (2011). *Cara Uji Minyak Nabati dan Minyak Mineral Secara Gravimetri.* Departemen Perindustrian dan Perdagangan Republik Indonesia. Jakarta.

APHA. (1995). *Standard Methods for the Examination of Water and Wastewater*. Washington DC. 769.

Aryawati, R., Melki, M., Azhara, I., Ulqodry, T.Z., & Hendri, M. (2023). Keragaman Fitoplankton dan Potensi Harmfull Algal Blooms (HABs) di Perairan Sungai Musi Bagian Hilir Provinsi Sumatera Selatan. *Buletin Oseanografi Marina*, 12(1): 27–35.

Asriyana, A., & Yuliana, Y. (2014). *Produktivitas Perairan.* PT Bumi Aksara. Jakarta.

Effendi, H. (2003). *Telaah Kualitas Air. Pengelolaan Sumberdaya dan Lingkungan Perairan*. Yogyakarta.

Hidayanni, G., Mulyadi, A., & Siregar, S.H. (2013). Study of Diatoms Epiphytic as Indicators Water Environment Kampar River Around Buluh Cina Village Siak Hulu district of Kampar Regency in Riau Province. *Jurnal Kajian Lingkungan*, *1*(2): 123-133.

Kementerian Negara Lingkungan Hidup. (2004). Keputusan Menteri Negara Lingkungan Hidup No. 51 Tahun 2004 tentang Baku Mutu Air Laut. KLH, Jakarta.

Nasution, N.A., Siregar, Y.I., & Nurachmi, I. (2017). Hubungan Kandungan Minyak dengan Kelimpahan Diatom pada Strata Kedalaman di Perairan Tanjung Buton Kabupaten Siak. *Jurnal Online Mahasiswa*, 3(2): 1-11.

Nugraheni, D., Zainuri, M., & Afiati, R.N. (2014). Studi tentang Variabilitas Klorofil-a dan Net Primay Productivity di Perairan Morosari, Kecamatan Sayung Demak. *Jurnal Oseanografi*, 3(4): 519-527.

Nurrachmi, I., Nedi, S., & Khaironisa, R. (2021). Analysis of Total Oil Concentration and Phytoplankton Community Structure in the Waters of Pelintung Industrial Area. *Journal of Coastal and Ocean Sciences*, 2(1): 7-14.

Patty, S.I. (2015). Karakteristik Fosfat, Nitrat dan Oksigen Terlarut di Perairan Selat Lembeh, Sulawesi Utara. *Jurnal Pesisir dan Laut Tropis*, 2(1): 1-7.

Peraturan Pemerintah Republik Indonesia (PP RI) Nomor 22 Tahun 2021 Kelas II tentang Penyelenggaraan Perlindungan dan Pengelolaan Lingkungan Hidup.

Pulungan, I.W., & Badrun, Y. (2023). Hubungan Produktivitas Primer Fitoplankton dengan Kandungan Minyak di Perairan Pesisir Kota Dumai. *Jurnal Multidisiplin Indonesia*, *2*(7): 1477-1484.

Puspita, S., Siregar, S.H., & Nedi, S. (2021). Total Oil Content and Epiphytic Diatom Density in Seagrasses Leaves *Enhalus acoroides* at Pandaratan Beach Tapanuli Tengah Regency North Sumatera Province. *Asian Journal of Aquatic Sciences*, *4*(1): 21-28.

Samudra, S.R., Soeprobowati, T.R., & Izzati, M. (2013). *Komposisi, Kelimpahan dan Keanekaragaman Fitoplankton Danau Rawa Pening Kabupaten Semarang*. Berkala Ilmiah Biologi : Semarang.

Septriono, H.N. (2019). Karakteristik Umum Diatom dan Aplikasinya pada Bidang Geosains. *Oseana*, 44(1): 70–87.

Sinaga, O.L.B., Siregar, S.H., & Nedi, S. (2022). Analisis of Total Oil Content and Planktonik Diatom (Bacillariophyceae) in the Waters of Lalang Strait, Mengkapan Village Siak Regency. *Jurnal Perikanan dan Kelautan*, *27*(2): 129-135

Tanjung, A. (2014). *Rancangan Percobaan* (Edisi Revisi 3). Tantaramesra. Bandung.

Wang, X.W., Huang, L., Ji, P.Y., Chen, C.P., Li, X.S., Gao, Y.H., & Liang, J.R. (2019). Using a Mixture of Wastewater and Seawater as the Growth Medium for Wastewater Treatment and Lipid Production by the Marine Diatom *Phaeodactylum tricornutum*. *Bioresource Technology*, 289: 121681