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EFFECT OF LIGHT FLUCTUATIONS ON GROWTH RATE OF *Thalassiosira sp.*

Pengaruh Fluktuasi Cahaya Terhadap Laju Pertumbuhan *Thalassiosira sp.*

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ABSTRACT

Thalassiosira sp. is a diatom and used as a natural feed source in shrimp farming. Apart form naturally, Thalassiosira sp. can also be grown or cultured artificially on a laboratory scale using light. The purpose of this study was to determine the growth rate of Thalassosira sp. cultured on a laboratory scale with different fluctuations or periods of exposure to light. The study was carried out by differentiating the light and dark time periods for Thalassiosira sp. cultures, 0 hours: 24 hours; 6 hours : 18 hours; 12 hours : 12 hours and 18 hours : 6 hours. Data analysis used the ANOVA test, followed by the Games-Howell test to determine the best exposure time periodization. The light-dark time period of 12 hours : 12 hours was gained the optimum average growth rate in this study (2.5875 x 10^5 cells/ml), which was obtained on the 6th day after the initial culture.

Keywords: Growth Rate, Light Fluctuation, Thalassiosira sp.

ABSTRAK

Thalassiosira sp. merupakan salah satu jenis diatom dan digunakan sebagai sumber pakan alami pada budidaya udang. Selain secara alami, *Thalassiosira* sp. juga dapat ditumbuhkan atau dikultur secara buatan pada skala laboratorium dengan menggunakan cahaya lampu. Tujuan dari penelitian ini adalah untuk mengetahui laju pertumbuhan *Thalassosira* sp. yang dikultur pada skala laboratorium dengan fluktuasi atau periodisasi waktu paparan cahaya lampu yang berbeda. Penelitian dilakukan dengan membedakan periode waktu gelap-terang pencahayaan lampu terhadap kultur *Thalassiosira* sp., yaitu 0 jam : 24 jam; 6 jam : 18 jam; 12 jam : 12 jam dan 18 jam : 6 jam. Analisa data menggunakan uji ANOVA, dilanjutkan dengan uji Games-Howell untuk menentukan periodisasi waktu paparan yang terbaik. Periode waktu gelap-terang 12 jam : 12 jam menunjukkan rata-rata laju pertumbuhan yang optimum pada penelitian ini yaitu 2,5875 x 10^5 sel/ml yang diperoleh pada hari ke-6 setelah pengkulturan.

Kata Kunci: Fluktuasi Cahaya, Laju Pertumbuhan, *Thalassiosira* sp.

INTRODUCTION

Natural food is a supporting factor in intensive cultivation. One example of natural food that is often found in nature and in abundant quantities is plankton. Various types of plankton, both phytoplankton and zooplankton, can grow well in waters. One of the phytoplankton in waters that is used as natural food is the diatom type, namely *Thalassiosira* sp. In the cultivation environment, especially shrimp cultivation, *Thalassiosira* sp. used as a natural food source because it has quite high nutritional content such as protein, carbohydrates and fat (Costard et al., 2012). Apart from being a natural food, *Thalassiosira* sp. It has also been used as biofuel (Nurachman et al., 2012), antibacterial (Anggraeni et al., 2019) and in the pharmaceutical industry (cosmetic ingredients) (Bhattacharjya et al., 2020).

Growth of Thalassosira sp. influenced by several external factors, including pH, temperature, nutrition and light or length of lighting time (Fadila et al., 2021). Light is needed by phytoplankton for the process of photosynthesis, photosynthetic pigments utilize light and use it to produce nutrients. Photosynthesis can occur without light, or in other words, this photosynthesis takes place following the reaction of light and dark (photoperiod) (Utami et al., 2012). Several studies have proven that the period of exposure and light intensity influence plankton growth (Arrico et al., 2020; Fischer et al., 2022; Ishak et al., 2022; Moeller et al., 2019; Padang et al., 2018).

Thalassosira sp. is one of the plankton whose growth can be done in the laboratory (Fadila et al., 2021). Isaac et al. (2022) stated that the optimum light intensity for the growth of Thalassosira sp. is 59 Lumen (393 Lux). Growth of Thalassosira sp. based on dark and light reactions with a time span that approaches natural conditions in nature has not been carried out, so this research was carried out to determine the growth of Thalassosira sp. using fluctuations or different light exposure times on a laboratory scale.

METHODS

This research was conducted in February 2024 for 23 days. Culture of Thalassosira sp. those obtained from the Brackish Water Aquaculture Fisheries Center (BPBAP) were subjected to initial identification microscopically, then cultured aseptically in a controlled room with the help of a 40 watt lamp and the room was maintained at a temperature of 25 0C. The laboratory scale culturing technique uses sea water with a salinity of 25 ‰ and added fertilizer (diatoms, silicates, trace metals and vitamins) as much as 1 ml/l in a clear glass bottle. Brown culture indicates that Thalassosira sp. has grown well and is ready to be used for the next process.

The research design was carried out using four treatments with different light-dark periods. Initial density of Thalassosira sp. The amount used was 4.25 x 104 cells/ml and each treatment was repeated three times. The four treatments are treatment A with a dark: light time period, namely 0 hours: 24 hours, treatment B with a dark: light time period, namely 6 hours: 18 hours, treatment C with a dark: light time period, namely 12 hours: 12 hours and treatment D with a dark : light time period of 18 hours : 6 hours (Utami *et al*., 2012). On the first day of culturing, 1 ml/l of fertilizer was added to all treatments and the growth rate was calculated every day. Calculation of growth rate is calculated based on the formula (Isnansetyo & Kurniastuti, 1995):

$$\text{Growth rate (cells/ml} = N \times 10^4)$$

Where:
N = Average number of cells
104 = Cell density per ml

Another supporting parameter measured is water quality including temperature, pH and DO (Dissolved Oxygen). Water quality measurements are only carried out at the beginning of treatment and at the end of treatment. Apart from descriptive analysis, statistical analysis was also carried out to determine the effect of light on the growth rate of Thalassosira sp. using One-Way ANOVA.

RESULT

The results of observations of water quality parameters, namely temperature, pH and DO, during the research showed that these 3 parameters were in the appropriate range for the growth of *Thalassiosira* sp. (Table 1)

Table 1. Water Quality Parameters for *Thalassiosira* sp Cultivation Culture Media

Measurement results	Parameter	Measurement results	Reference
Day 1 – 13	Temperatur	24 – 27 ^{0}C	21,7 – 29,6 ^{0}C (Baek et al., 2011)
	pH	7,3 – 8,3	8 – 8,5 (Wahyudi et al., 2022)
	DO	5 - 6	3 – 7 (Kadim et al., 2017)

The culture media temperature observed showed the optimal range for phytoplankton growth. In this study, the room temperature used for culture or growth was maintained at 25 0C. The pH and DO parameters show stable values and are in a suitable range for the growth of *Thalassiosira* sp.

Growth of *Thalassiosira* sp. characterized by an increase in the density of diatoms in the culture medium. Results of observations of the growth of *Thalassiosira* sp. using additional inorganic micronutrients at the start of culture showed different growth rate patterns (Figure 1).

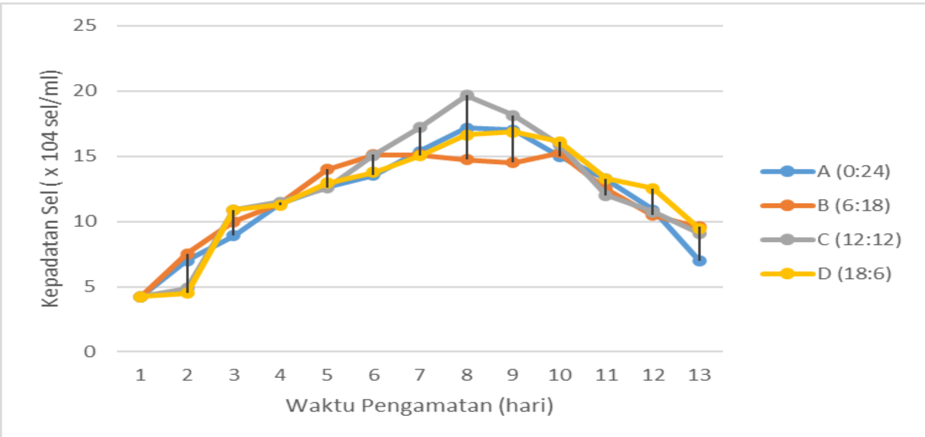

Figure 1. Growth graph of *Thalassiosira* sp.

Growth and density of *Thalassiosira* sp. can be known from the first day of culture until the end of the research based on changes in the color of the water in the maintenance medium. Figure 1 shows the growth results of *Thalassiosira* sp. during the 13 day observation period, where there was an increase in cells from the first day to the 13th day for all photoperiod treatments (dark-light).

DISCUSSION

The plankton growth phase consists of the adaptation phase, exponential phase, stationary phase and death phase. The phases mentioned above are influenced by several factors, one of which is light, where light is the energy source for *Thalassiosira* sp. to carry out photosynthesis. Another factor that influences the survival of Thalassiosira sp. is the condition of water quality. Water quality influences the growth rate of *Thalassiosira* sp. Temperature has a direct effect on the metabolic processes of aquatic organisms. Diatoms grow optimally at a temperature of 25 0C because at this temperature productivity and metabolic processes take place at optimal conditions. However, *Thalassiosira* sp. can still live in the temperature range of 21.7 – 29.6 0C in waters (Baek et al., 2011). Diatom productivity is also influenced by pH, if it is too low or even high, diatom productivity and growth will also slow down or die. The pH value shown during the research still meets the requirements for the survival and growth of *Thalassiosira* sp. The ideal pH for phytoplankton life in waters is 8.0 – 8.5 (Wahyudi et al., 2022).

Dissolved oxygen is the result of the photosynthesis process carried out by microalgae and other aquatic plants. The oxygen produced from this process is then dissolved in the water to support aquatic life such as fish and other aquatic organisms. The solubility of oxygen in water is influenced by temperature and salinity, if the water temperature is higher, the solubility of oxygen in the water will also be lower (Manullang et al., 2023). This is because warmer water molecules have the capacity to store less oxygen. Low oxygen levels in water can have serious impacts on the organisms that live in it. In fact, at extreme levels, low oxygen levels can cause the death of aquatic organisms. During photosynthesis, plants and some types of plankton use the light energy emitted by sunlight, carbon dioxide, and water to produce glucose which is used for growth and also emit oxygen as a byproduct. Manipulation of sunlight energy using lamp light has been utilized in several fields, such as agriculture (Sanoubar et al., 2018), fisheries (Cheng et al., 2022; Marzetz et al., 2020; Tagliafico et al., 2022), animal husbandry (Alattar et al., 2019; Gharahveysi et al., 2020) and others.

Growth of *Thalassiosira* sp. varies between treatments depending on the period of light exposure and the inorganic micronutrients added at the beginning of the culture. Light variability and light intensity influence the increase in reactions in the phytoplankton photosynthesis process (Marzetz et al., 2020). The most optimal results were shown in the 12 hour: 12 hour light dark treatment, this may be due to the light intensity obtained by *Thalassiosira* sp. for optimal photosynthesis. These results were also supported by the results of statistical analysis using the ANOVA test, followed by the Games-Howell test which showed that optimal results were found in the 12 hour: 12 hour photoperiod treatment (data not shown). The light-dark time period of 12 hours: 12 hours is almost close to the actual conditions in nature, because it is based on the earth's rotation which takes about 24 hours. Nearly half of this rotation, the side of the planet facing the sun experiences daytime, which means it is exposed to sunlight, while the opposite side experiences nighttime or not exposed to sunlight.

Development of density of *Thalassiosira* sp. It is closely related to photoperiod because the photosynthesis process is influenced by sunlight, where in this study the function of sunlight was replaced with lamp light. Changes in cell number of *Thalassiosira* sp. observed in this study included the adaptation phase, logarithmic or rapid growth phase, growth stabilization phase (stationary phase), and the end of life phase. In the adaptation phase, *Thalassiosira* sp. adjust to changes in photoperiod. The adaptation strategy used by an organism to carry out photosynthesis depends on the type of light and the length of the photoperiod (Gajdošik et al., 2022). Short photoperiods can reduce the time available for photosynthesis, while long photoperiods provide more time for that process. During the adaptation phase, *Thalassiosira* sp. may undergo changes in metabolic activity and physiological responses to adapt to changes in photoperiod.

In the logarithmic phase, the density of *Thalassiosira* sp. increased significantly. This increase occurs due to environmental conditions that support plankton growth, including long exposure to light for optimal photosynthesis. A long photoperiod provides sufficient time for plankton to carry out metabolic processes and growth. In general, the amount of biomass increases significantly when there is an increase in light intensity and nutrient supply (Marzetz et al., 2020). However, the data obtained shows that the photoperiod of 6 hours: 18 hours is lower than the photoperiod of 12 hours: 12 hours. This is because there are other factors that also play an important role in the growth and development of plankton. One factor that may limit the increase in plankton biomass despite high light intensity is nutrient availability. Although sufficient light supports photosynthesis, plankton also needs nutrients to grow properly. If the supply of nutrients is limited, plankton growth can be hampered even though there is sufficient light.

Apart from that, competition factors between individual plankton can also influence the growth of the plankton itself (Sourisseau et al., 2017; Wilda, 2020). If nutrient sources are limited or increasingly depleted and fought over by many individual plankton, it is likely that not all plankton will get enough nutrients to reproduce quickly, even if the light intensity is sufficient. This is what causes a decrease in the growth rate (stationary phase). During this phase, the plankton density of *Thalassiosira* sp. reaches its maximum point and its growth begins to slow down. Unfavorable environmental conditions also play a role in the amount and growth rate of plankton (Dewanti et al., 2018; Hamzah et al., 2015). If there are large numbers of *Thalassiosira* sp. If they die, the decomposition process will occur, which will indirectly reduce water quality. The concentration of dissolved oxygen in the water can decrease and have a negative impact on plankton life. Apart from that, the decomposition process can also reduce water quality (Yuningsih et al., 2014)because this process produces compounds that increase the acidity of the water or cause an increase in the concentration of potentially toxic substances, which can damage water quality.

The final phase experienced by *Thalassiosira* sp. is the death phase. The death phase is a natural phenomenon in the plankton life cycle, in this phase the growth rate begins to decrease significantly. The overall treatment showed the same trend, namely on the 10th day onwards there was a decrease in the growth rate. The decrease in water quality caused by the decomposition of dead plankton results in an increase in pH and a decrease in DO. Hansen (2002) stated that increasing pH will have a negative impact on plankton growth. In addition, the greatly reduced nutrient availability can no longer support *Thalassiosira* sp. for growth caused by providing nutrients only at the start of culture and not adding any more until the research is complete.

CONCLUSION

The aim of culturing Thalassiosira sp. artificially on a laboratory scale using constant light with different photoperiod variations to determine the growth rate of Thalassosira sp. The results of this research show that a photoperiod of 12 hours: 12 hours on the 8th day is the most optimal result for the growth of Thalassiosira sp.. The trend of decreasing growth rate is relatively the same for all photoperiod treatments.

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