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Growth of *Nannochloropsis* sp. Cultured at Semi-Mass and Mass Scales at UPTD BPBALP Teluk Buo, Padang, West Sumatra

Pertumbuhan *Nannochloropsis* sp. yang Dikultur pada Skala Semi-Massal dan Massal Di UPTD BPBALP Teluk Buo, Padang, Sumatera Barat

Irvan Virnando[1], Ainun Rohmawati Bareta[1*], Lisna[1], Giri Pratama[1], Zawil Afkar[1], Hari Cahyono[2], Rahayu Dian Eka Putri [1]

[1]Fisheries Resource Utilization Study Program, Faculty of Animal Science, Universitas Jambi, Jl. Jambi–Muara Bulian KM15 Mendalo Darat, Jambi, 36361, Indonesia
[2]Fisheries Product Technology Study Program, Faculty of Animal Science, Universitas Jambi, Jl. Jambi–Muara Bulian KM15 Mendalo Darat, Jambi, 36361, Indonesia

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*Corresponding author: ainunrohmawati@unja.ac.id
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ABSTRACT

Natural feed plays a crucial role as a primary nutrient source that is easily digested and suitable for the physiological needs of larvae during early life stages. *Nannochloropsis sp.* is widely used as a main natural feed for larvae of various aquaculture commodities, making its stable and high-quality availability essential for hatchery success. This study aimed to evaluate *Nannochloropsis sp.* culture techniques at semi-mass and mass scales and to determine cell density as an indicator of feed quality. The study employed direct observation during the culture period and descriptive analysis of cell density and water quality. Culture procedures at both scales included tank preparation, seawater filling, inoculation, cell density measurement, and harvesting, with differences only in tank size and inoculum volume. Results showed that peak cell density on day five reached 42,326,000 cells/mL in the semi-mass scale and 39,400,000 cells/mL in the mass scale, followed by a decline on day six. The study concludes that the *Nannochloropsis sp.* culture technique applied at UPTD BPBALP Teluk Buo is effective in supporting phytoplankton supply for hatchery operations.

Keywords: density, *Nannochloropsis* sp., mass scale, semi-mass scale, culture technique

ABSTRAK

Pemberian pakan alami berperan penting sebagai sumber nutrisi utama yang mudah dicerna dan sesuai dengan kebutuhan fisiologis larva pada fase awal kehidupan. *Nannochloropsis sp.* merupakan salah satu pakan alami utama bagi larva berbagai komoditas perikanan, sehingga ketersediaannya yang stabil dan berkualitas sangat menentukan keberhasilan pembenihan. Penelitian ini bertujuan untuk mengetahui teknik kultur *Nannochloropsis sp.* pada dua skala produksi, yaitu semi-massal dan massal, serta menghitung kepadatan sel sebagai indikator kualitas pakan alami. Metode penelitian meliputi observasi langsung selama pemeliharaan dan analisis deskriptif terhadap kepadatan sel serta kualitas air. Proses kultur pada kedua skala dilakukan melalui tahapan persiapan wadah, pengisian air laut, penebaran bibit, penghitungan kepadatan sel, dan pemanenan, dengan perbedaan pada ukuran wadah dan jumLah bibit. Hasil penelitian menunjukkan bahwa pada hari ke-5 kepadatan sel tertinggi tercapai pada skala semi-massal sebesar 42.326.000 sel/mL, sedangkan pada skala massal sebesar 39.400.000 sel/mL. Pada hari ke-6, kepadatan sel mengalami penurunan pada kedua skala. Penelitian ini menyimpulkan bahwa teknik kultur *Nannochloropsis sp.* di UPTD BPBALP Teluk Buo telah berjalan efektif dalam mendukung penyediaan fitoplankton untuk kegiatan pembenihan.

Kata Kunci: kepadatan, *Nannochloropsis* sp., skala massal, skala semi-massal, teknik kultur

INTRODUCTION

The availability of natural feed is a key factor in determining success in aquaculture, especially during the early stages of organism development such as fish, shrimp, crab, and abalone larvae. Natural feed is a very important source of nutrients because it has a size suitable for larval mouths, complete nutritional content, is easy to digest, and can stimulate cultured organisms to consume it. One of the main natural feeds in aquaculture is rotifers, which are used as feed for fish larvae. Rotifers themselves require natural food in the form of microorganisms containing sufficient protein, fat, carbohydrates, minerals, and amino acids, such as phytoplankton.

Phytoplankton are microalgae that function as the primary producers in aquatic food chains and are very important in aquaculture because they serve as natural feed for the larvae of aquatic organisms (Aisyah et al., 2023). One of the microalgae widely used as natural feed in marine fish farming is *Nannochloropsis* sp. This microalga has high nutritional value and is suitable as feed for rotifers, which are then used as natural feed for fish larvae, containing high protein, namely 51.3%, with 24.03% of it being essential amino acids. In addition, this biomass contains 6% EPA, as well as vitamins at 0.368% and carotenoids at 0.528%. Its energy content is 1571 kJ per 100 g of algal powder (du Preez et al., 2021). *Nannochloropsis* sp. also contains high carbohydrates, namely 16.00%, and fats at 27.64% (Meria et al., 2021). These contents make *Nannochloropsis* sp. suitable to be used as natural feed in fish farming.

At the Teluk Buo Marine and Brackish Water Fisheries Center (BPBALP), *Nannochloropsis* sp. culture is carried out on two culture scales (semi-mass and mass scale) because each scale has different objectives, characteristics, and production challenges. The semi-mass scale aims to produce *Nannochloropsis* sp. in medium quantities as daily feed or culture starter, with the characteristic of smaller volumes making it easier to control water quality, light, and aeration, as well as having a lower risk of contamination. Meanwhile, the mass scale aims to meet the demand for natural feed in large quantities at the hatchery, thus requiring a more efficient, stable, and sustainable production system. However, large-scale operations pose more complex challenges, such as uneven light distribution, higher aeration requirements, increased risk of contamination, and greater operational costs. Therefore, this study aims to examine the differences in *Nannochloropsis* sp. culture techniques at both scales, allowing the research to determine the most effective and suitable production method to ensure the availability of high-quality natural feed for seed production.

RESEARCH METHOD

Time and Place

This observation was carried out at the UPTD Marine and Brackish Water Aquaculture Fisheries Center (BPBALP) Teluk Buo, West Sumatra Province. The observation was conducted from July 1 to September 1, 2025.

Tools and Materials

The equipment used includes concrete tanks, a refractometer, thermometer, dropper pipette, pH meter, hemocytometer, microscope, cover glass, test tubes, digital scale, aerator, aeration hose, aeration stones, filter bag, submersible pump, pump hose, bucket, broom, brush, jar, plug, scoop, calculator, mobile phone camera, and stationery. The materials used include *Nannochloropsis* sp., seawater, freshwater, fertilizers [Urea, ZA (Ammonium Sulfate), TSP (Triple Super Phosphate)], and calcium hypochlorite.

Methods

The methods used were direct observation and descriptive analysis. Direct observation was conducted by actively participating in all activities of *Nannochloropsis* sp. culture at the Marine and Brackish Water Aquaculture Development Center (BPBALP) Teluk Buo, from container preparation to harvesting, with the aim of observing the differences between semi-mass and mass scale culture techniques. Observed parameters included *Nannochloropsis* sp. density and water quality parameters such as temperature, salinity, and pH during the maintenance period. These parameters were observed daily for 6 days of observation from each maintenance tank.

The density of *Nannochloropsis* sp. was calculated using a haemocytometer by taking 2 drops of the culture media using a dropper. Then the water sample was placed on the haemocytometer and covered with a 20×20 mm cover glass, then placed under a microscope with a 4×10 magnification, and observed. After it was visible, the density of *Nannochloropsis* sp. was counted by moving the stage left and right. To calculate the abundance of the sample, 5 points were taken and then averaged, then the average result was multiplied by the 16 squares on the haemocytometer and then multiplied by 10^4. For a clearer understanding, the microalgae density calculation formula can be seen below.

$$N = n \times 16 \times 10^4$$

Descriptions:
N = Density of *Nannochloropsis* sp.
n = number of observation sample

Data Analysis

Descriptive analysis is a method of analysis used to describe, explain, and interpret data as it is without conducting hypothesis testing or in-depth generalization. In this study, descriptive analysis was used to present the culture process, changes in cell density of *Nannochloropsis* sp., as well as water quality conditions during the production of *Nannochloropsis* sp. at both culture scales based on direct observations.

RESULTS AND DISCUSSION

Semi-Mass Scale Culture Technique of *Nannochloropsis* sp.

The *Nannochloropsis* sp. culture technique on a semi-mass scale has several stages, which are described as follows.

a. Preparation of culture containers

The preparation of culture containers is a crucial step before breeding *Nannochloropsis* sp. On a semi-mass scale, the container used is a single concrete tank with a capacity of 2 tons (2,000 L). The preparation process begins by opening the outlet pipe to empty the tank. Once all the water has drained, the tank is rinsed with seawater to remove debris, then sprayed with a chlorinated lime solution at 500 g/L to ensure that any remaining parasites are eliminated. The tank with chlorinated lime is left for approximately 24 hours to sterilize the medium water used (Ningrum and Diniariwisan, 2024). After that, the tank is drained again, scrubbed, and rinsed with seawater until it is completely clean and free from debris. Next, the outlet pipe is reinstalled, and the tank is left to dry before use.

b. Seawater Filling

The total volume of water used in the process of culturing natural feed *Nannochloropsis* sp. in a semi-mass scale concrete tank measuring 1 × 2 × 1 m is 2,000 L. The seawater filling process is carried out by opening a tap connected to a reservoir tank as the water source. During filling, a bag filter is used to prevent dirt or large particles from entering the culture tank (Manan and Sari, 2012). The amount of seawater added to the tank is 1,500 L.

c. Spreading *Nannochloropsis* sp. Seedlings

The *Nannochloropsis* sp. seedlings used in semi-mass scale cultures come from cultures that have previously been grown on a laboratory or semi-mass scale. The seeding process is carried out by flowing the *Nannochloropsis* sp. suspension into the culture tanks using a submersible pump. Before use, the submersible pump is first soaked in freshwater for 5 minutes to ensure that the pump is clean and sterile. Next, the pump is placed in the seed culture container, positioned midway between the bottom and the water surface, so as not to disturb the bottom sediment. The seedlings are then channeled into the culture tank through a hose equipped with a filter bag to act as a strainer. The volume of *Nannochloropsis* sp. seedlings distributed in this activity amounts to 25% of the total water volume in the tank, which is 500 L. This aligns with the statement of Ayuzar et al. (2022) that the optimal inoculum discharged into the culture tank is 20-30%.

d. Fertilizer Addition

The addition of fertilizer to the culture tanks aims to accelerate the growth of *Nannochloropsis* sp. and increase the availability of nutrients in the culture medium. In this semi-mass culture scale, Urea, Ammonium Sulfate (ZA), and Triple Super Phosphate (TSP) are used (Sukardi et al., 2019). These three types of fertilizers are weighed at a ratio of 3:3:1, meaning that for a concrete tank with a capacity of 2 tons, 60 *g* of Urea, 60 *g* of ZA, and 20 *g* of TSP are required. After weighing, the fertilizers are dissolved in 500 mL of seawater in a separate container before being applied. The fertilizer solution is then evenly distributed to the middle part of the culture tank.

e. Maintenance of *Nannochloropsis* sp.

At this stage, it is necessary to monitor all semi-mass and mass culture tanks, and this observation is carried out daily in the morning at 08:00 WIB, in the afternoon at 14:00 WIB, and in the evening at 16:00 WIB until they are ready for harvesting on the fifth day. The observation can include checking the aeration hoses and monitoring the condition of *Nannochloropsis* sp. in all mass and semi-mass scale tanks. This needs to be done to support the success of *Nannochloropsis* sp. cultures. This is in accordance with the statement of Sari and Manan (2012), which states that for *Nannochloropsis* sp. cultures, the main aspects to consider are environmental conditions such as salinity, temperature, nutrients (macro & micro), media sterility to avoid contamination, sufficient aeration, and the harvest time when the population reaches its peak (stationary phase).

f. Harvesting *Nannochloropsis* sp.

The harvesting method used is the daily harvesting method. *Nannochloropsis* sp. culture media is considered ready for harvest when its density reaches the peak phase, indicated by the water turning dark green. The harvesting process is carried out by transferring the culture using a submersible pump and hose from the semi-massive tank to the mass tank (Sari and Manan, 2012). Before the transfer process is carried out, the mass tank is first cleaned and prepared, including the installation of the aeration hose that will be used for the next culture. Once all the equipment is properly installed, the *Nannochloropsis* sp. culture is flowed from the semi-massive tank to the mass tank using a pump connected to the hose until the entire required volume is successfully transferred.

Mass Scale Culture Techniques of *Nannochloropsis* sp.

The mass-scale culture technique of *Nannochloropsis* sp. has several stages which are described as follows.

a. Preparation of Culture Vessels

At the stage of mass-scale *Nannochloropsis* sp. culture, the vessels used are concrete tanks with a capacity of 8 tons (8,000 L). The preparation process begins by opening the water taps and drainage to empty the tank. Next, the tank is cleaned by scrubbing all surfaces until free from any remaining algae or moss. After that, a sterilization process is carried out by evenly pouring a suitable amount of calcium hypochlorite solution over the entire tank, then leaving it for 24 hours. This stage aims to eliminate parasites and other potential contaminants. After the soaking period, the tank is drained and scrubbed again until completely clean, then rinsed with seawater to ensure no residue remains. The final step is to reinstall the drainage pipes, making the tank ready to be filled with culture media consisting of seawater.

b. Filling with Seawater

After the tank is confirmed to be clean and free from debris, the next stage is filling it with seawater. The volume of seawater used in the culture of *Nannochloropsis* sp. is adjusted according to the capacity of the container. In large-scale culture, a concrete tank measuring 2 × 4 × 1 m with a capacity of 8,000 L is used. The water is filled by opening a faucet directly connected to a reservoir tank as the water source. During the filling process, a bag filter is used to prevent dirt or large particles from entering the culture medium. At this stage, 6,000 L of seawater are added to the tank. The seawater used comes from the waters around BPBALP Teluk Buo. The water is pumped using a pump machine and first stored in reservoir I. Then, the water is directed to reservoir II through a sand filter containing layers of sand and charcoal, each 60 cm thick. Water from reservoir II is then passed through a UV filter which functions to reduce the presence of bacteria and viruses. After that, the water is distributed to the semi-mass scale culture aquariums using a bag filter so that the media entering the culture tanks is more sterile.

c. Spreading *Nannochloropsis* sp. Seedlings

The *Nannochloropsis* sp. seedlings used in mass-scale cultures come from cultures that have previously been grown on a semi-mass or mass scale. The seedlings are spread by pumping the *Nannochloropsis* sp. suspension into the culture tanks using a submersible pump. Before use, the pump is soaked in fresh water for 5 minutes to ensure it is clean and sterile. After that, the pump is placed in the middle position between the surface and the bottom of the tank to prevent sediment from being sucked in. The seedlings are then delivered to the culture tank through a hose equipped with a filter bag to strain unwanted particles. The amount of seedlings spread in this mass-scale culture is 2,000 L, which is 25% of the total water volume in the tank.

d. Fertilizer Addition

The application of fertilizer in culture tanks aims to accelerate the growth of *Nannochloropsis* sp. while also increasing nutrient content in the medium. In both semi-mass and mass-scale cultures, the fertilizers used are the same: Urea, ZA, and TSP, with a ratio of 10:30:30. For an 8-ton concrete tank, 240 *g* of Urea, 240 *g* of ZA, and 80 *g* of TSP are used. After being weighed, the fertilizers are dissolved in 500 mL of seawater before being evenly distributed throughout the tank, particularly in the central area. Additionally, aeration is installed to maintain oxygen supply and support optimal algal growth.

e. Maintenance of *Nannochloropsis* sp.

At this stage, all culture tanks, whether semi-mass or mass scale, need to be monitored routinely every day, namely in the morning at 8:00 AM, in the afternoon at 2:00 PM, and in the evening at 4:00 PM, until the culture is ready for harvest, indicated by the water changing to a dark green color. Observations include checking the condition of the aeration hoses as well as the condition of *Nannochloropsis* sp. in each tank. This activity aims to ensure the smooth running of the culture process and support the successful growth of the algae.

f. Harvesting *Nannochloropsis sp.*

The harvesting method at the mass stage uses a daily harvesting method. The basic principle that must be carried out during harvesting is to observe the *Nannochloropsis* sp. culture medium, which is ready to be harvested when its density has reached its peak, indicated by a change in the water color to a deep green. Harvesting of *Nannochloropsis* sp. is carried out using a submersible pump and hose that is directed from the mass tank to the Rotifera tank or the hatchery tank..

Growth of *Nannochloropsis* sp.

The results of the calculations of *Nannochloropsis* sp. density in semi-mass and mass-scale tanks are presented in Table 1. Light is an important factor in the growth of *Nannochloropsis* sp., directly affecting the photosynthesis process and indirectly influencing cell growth and development. In addition to nutrients, light intensity and duration of illumination are key factors in the culture of this algae. Photosynthesis consists of two stages, namely the light reaction and the dark reaction (photoperiod). Under light conditions, cells divide asexually, so the daughter cells are smaller than the parent cells, whereas under dark conditions, cells develop to reach their normal size (Nurdiana et al., 2017). Light intensity determines the amount of energy received by the phytoplankton during culture, and this amount of energy affects population growth (Dewi et al., 2023). If the light energy received exceeds the utilization capacity or is too low, the reproduction process or cell division process of phytoplankton can be inhibited (Utami et al., 2012).

According to Pelczar et al. (1986), the normal growth pattern of microalgae is divided into five growth phases: the lag phase, the exponential phase, the deceleration phase, the stationary phase, and the death phase. The population growth of *Nannochloropsis* sp. in each treatment initially increased slowly, which was due to the number of dividing cells not being very high. This stage is called the lag phase, which is the adaptation phase to environmental conditions where microalgal cells are adapting to their growth medium. The lag phase in all treatments occurred very briefly. The density graph of *Nannochloropsis* sp. can be seen in Figure 1.

Based on observations over six days, the growth of *Nannochloropsis* sp. on a semi-mass and mass scale showed a similar pattern, but with different density levels. On the first day, the initial culture density on a semi-mass scale reached 7,200,000 cells/mL with a sample size of 45, while on a mass scale it was 6,880,000 cells/mL with a sample size of 43. At this early phase, the cells were adapting to the environment, so nutrient utilization was not yet optimal. As a result, the division process occurred slowly and the cells mostly experienced size enlargement (Selvika et al., 2016; Putra et al., 2015). By the third day, both culture scales began to show a significant increase in density, reaching their peak on the fifth day. On the semi-mass scale, the highest density reached 43,240,000 cells/mL, while on the mass scale it reached 39,200,000 cells/mL. After that, on the sixth day, the density began to decrease to 38,720,000 cells/mL each for semi-mass scale and 32,128,000 cells/mL for mass scale.

Table 1. Density of *Nannochloropsis sp*. During the Observation Period

DAY	Density (cell/mL) Semi-Mass Scale		Mass Scale	
	Number of sampels	cell/mL	Number of sampels	cell/mL
1	45	7,200,000	43	6,880,000
2	115	18,400,000	85	13,600,000
3	149	23,840,000	122	19,520,000
4	198	33,660,000	182	29,120,000
5	246	43,240,000	245	39,200,000
6	242	38,720,000	206	32,128,000

Source: Data Processing

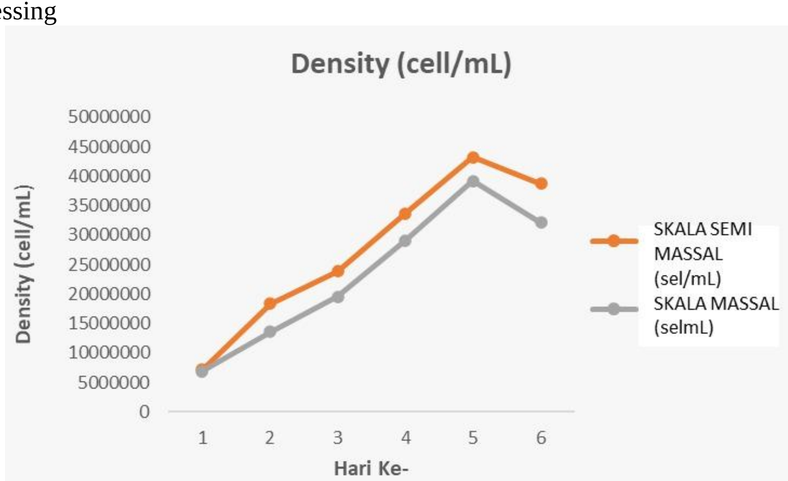

Figure 1. Density of *Nannochloropsis* sp. During the Observation Period
Source: Data Processing

The peak density on the fifth day indicates that the culture has entered the stationary phase, which is the ideal time for harvesting. In this phase, the population reaches its maximum point before nutrients start to deplete and waste products accumulate, which can interfere with the organisms that will later utilize the culture results (Isnansetyo & Kurniastuti, 1995). After this phase, logarithmic growth ceases and is followed by the stationary phase leading to the onset of the death phase on the sixth day. This decline in density is triggered by the reduction of nutrients in the medium, so the growth rate can no longer keep up with the cell death rate.

On the sixth day, the culture entered the death phase, characterized by a cell death rate that was faster than the growth rate. This condition occurs because the nutrients in the medium are very limited, so many cells are unable to maintain their metabolism and eventually die (Ru'yatin et al., 2015). The declining water quality, nutrient depletion, and reduced metabolic capacity also accelerate cell death (Pelczar et al., 1986; Kawaroe et al., 2010).

When compared, cultures on a semi-mass scale show cell densities that are consistently higher than on a mass scale. This difference is suspected to be caused by the volume of the medium. On a semi-mass scale, the medium volume is smaller, so the distribution of nutrients (such as fertilizers or culture medium) tends to be more even and easily absorbed by phytoplankton cells. On a mass scale, the large water volume often causes nutrient gradients, where some areas may lack nutrients, resulting in uneven cell growth. In semi-mass containers, illumination is also more evenly distributed throughout the water column. Meanwhile, on a mass scale, light only penetrates the surface layer, so the lower parts of the container receive less light intensity, hindering cell growth. When compared, cultures on a semi-mass scale show cell densities that are consistently higher than on a mass scale. This difference is suspected to be caused by the volume of the medium. On a semi-mass scale, the medium volume is smaller, so the distribution of nutrients (such as fertilizers or culture medium) tends to be more even and easily absorbed by phytoplankton cells. On a mass scale, the large water volume often causes nutrient gradients, where some areas may lack nutrients, resulting in uneven cell growth. In semi-mass containers, illumination is also more evenly distributed throughout the water column. Meanwhile, on a mass scale, light only penetrates the surface layer, so the lower parts of the container receive less light intensity, hindering cell growth.

As population density increases, competition among cells for nutrients also becomes greater, while the availability of nutrients in the medium continues to decrease daily. This condition necessitates a culture rejuvenation process, either by transferring the inoculum to a new medium in another vessel or by continuing the culture in a vessel with a larger volume. According to Buwono and Nurhasanah (2018), the decline in algal population growth in a limited medium is mainly caused by competition and the decreasing nutrient content.

Overall, the growth pattern of *Nannochloropsis* sp. from the first day to the sixth day shows dynamics influenced by a combination of physicochemical factors of the water, the cells' adaptive capabilities, as well as the availability of light and nutrients (Rahmah et al., 2022). This explains why the cell density continued to increase until the fifth day before eventually declining on the sixth day.

Water Quality Measurement

The measurement of water quality in the culture of *Nannochloropsis* sp. aims to determine the physical, chemical, and biological parameters that are suitable for the growth of *Nannochloropsis* sp. The water quality parameters measured include physical parameters such as temperature, and chemical parameters such as pH and salinity. Water quality measurements are conducted twice daily, in the morning at 08:00 AM and in the evening at 05:00 PM. Water quality has a significant impact on the *Nannochloropsis* sp. culture because it can directly or indirectly affect the growth of *Nannochloropsis* sp. (Dismayanti and Hasibuan, 2024). In the *Nannochloropsis* sp. culture process, water quality tends to remain stable with no significant changes, except during cloudy midday and rainy nights, as these conditions can affect the measurements. Overall, the measured water quality parameters still meet the requirements for the sustainability of the culture *Nannochloropsis* sp. Water quality measurements can be seen in Table 2 below. It shows dynamics influenced by a combination of physicochemical factors of the water, cell adaptation capabilities, as well as the availability of light and nutrients (Rahmah et al., 2022). This explains why cell density continued to increase until the fifth day before eventually decreasing on the sixth day.

a. Temperature

Based on Table 8 above, the water quality in the semi-massive *Nannochloropsis* sp. tanks shows a temperature range of 24-32°C. Meanwhile, in the mass culture tanks, the temperature range obtained is 31-24°C. This temperature range is optimal for the growth of *Nannochloropsis* sp. This range is consistent with the statement by (Taw., 1990) that, in general, the optimal temperature for phytoplankton culture ranges from 20-24°C. Temperatures below 16°C can slow growth rates, while temperatures above 36°C can cause death. According to research by (Daulay, 2014), the ideal temperature for culture media ranges from 25-35°C.

b. Salinity

The water salinity in semi-mass culture tanks of *Nannochloropsis* sp. ranges from 30-34 ppt, while in mass culture tanks it ranges from 31-34 ppt. The water salinity in both semi-mass and mass culture tanks of *Nannochloropsis* sp is in optimal conditions, with *Nannochloropsis* sp thriving at a salinity range of 32-36 ppt; however, the most optimal salinity for *Nannochloropsis* sp. growth is 33-35 ppt (Agustiawati, 2013). This is also supported by (Zumaritha, 2011), who stated that *Nannochloropsis* sp can grow well at a salinity of 31 ppt and can continue to grow within a salinity range of 22-49 ppt.

c. pH

Meanwhile, the pH range of water in semi-mass culture tanks of

Nannochloropsis sp. is around 7-8. In mass culture tanks, it is also around 7-8. The pH range in both semi-mass and mass culture tanks of *Nannochloropsis* sp represents the optimum pH range. This is in accordance with Effendi (2003), who stated that the general optimum pH range for *Nannochloropsis* sp culture is between 7-9.

Table 2. Water Quality Measurement During the Observation Period

Parameters	**Time**	**Semi-Mass Production Bucket**					**Mass Production Bucket**				
		Day					**Day**				
		1	2	3	4	5	1	2	3	4	5
Temperature (^oC)	Morning	28	25	27	28	25	27	28	26	25	26
	Afternoon	29	29	28	30	31	29	30	28	29	30
Salinity (ppm)	Morning	30	29	31	30	29	30	30	31	32	30
	Afternoon	32	31	32	33	31	31	31	32	33	32
pH	Morning	7	7	8	7	7	8	7	7	7	7
	Afternoon	7	8	7	7	7	7	8	8	7	8

Source: Data Processing

pH or acidity levels can affect the metabolism and growth of microalgae cultures as well as alter nutrient availability and influence cell physiology. This pH or acidity level can indicate the number of hydrogen ions in a culture medium (Omairah, Diansyah, & Agustriani, 2019).

CONCLUSION

The semi-mass and mass scale culture techniques of *Nannochloropsis* sp. at the Marine and Brackish Water Aquaculture Center (BPBALP) Teluk Buo, Padang, West Sumatra, were carried out in open spaces in 2-ton and 8-ton concrete tanks, respectively. On the 5th day, in the semi-mass scale culture tanks, cell density increased to an average of 42,326,000 cells/mL, while in the mass scale it reached 39,400,000 cells/mL. This increase indicates a transition from the adaptation phase to the exponential phase, during which cell division occurs at its maximum. On the 6th day, cell density in the semi-mass culture tanks decreased to 38,235,000 cells/mL, and in the mass scale, it decreased to 32,300,000 cells/mL. This indicates that the culture has entered the death phase due to a decline in nutrients.

RECOMMENDATIONS

Based on the results of research on the culture of *Nannochloropsis* sp. on a semi-mass and mass scale, it is recommended that future studies test more specific environmental factors such as light intensity, nutrient concentration, and aeration levels to determine their effects on growth rate and biomass quality. In addition, a production cost analysis at each scale should be conducted to determine the most efficient and economical culture techniques for seed production needs.

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