Persiapan Materi Menulis menggunakan AI

Title: Cultivation and of wild strain *Chlorococcum sp.* and harvesting via flocculation

1. Introduction

- **Background**:
  - Microalgae have garnered recognition as a multifaceted resource: biofuels, bulk chemicals, and high-value biochemical constituents capitalizing on their superior photosynthetic efficacy.
  - Microalgae biomass is a feedstock for valuable components, drawing attention for their diverse applications.
  - Light intensity and color affect microalgae growth, with LEDs being more efficient than traditional lighting.
  - Chemical aided flocculation is key for cost-effective biomass harvesting.
- **Hypothesis**:
  - LED light colors differently affect *Chlorococcum aquaticum* growth, with red light expected to be the most optimum.
  - The efficiency of ferric chloride as a flocculant for harvesting varies with microalgae cell concentration and the medium pH.

- **Scope**: The study focuses on cultivating wild strain *Chlorococcom aquaticum* under different LED lights to find the optimal spectrum for growth, followed by optimization of biomass harvesting under various flocculant dose, cell concentration and medium pH.

3. Results and Discussion

3.1 Cultivation Parameters

3.1.1 Biomass growth

- The light spectrum's crucial role in optimizing *Chlorococcum aquaticum* growth (Figure 3).
- Red light resulted in the highest growth by enhancing photosynthesis; blue light promoted early growth.
- Light spectrum variations distinctly affect growth and morphology (Figure 4).

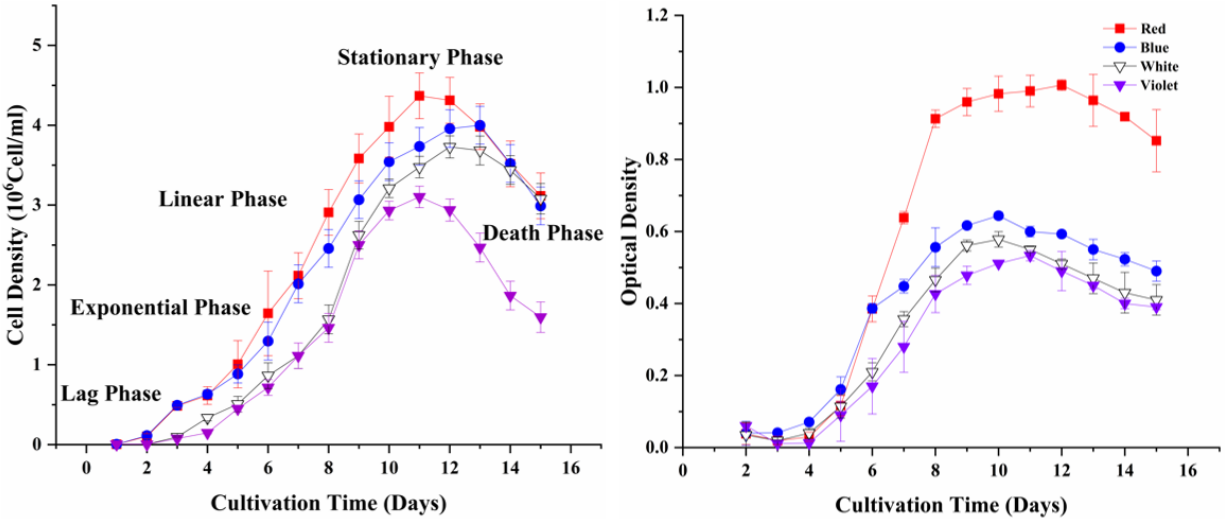

Figure 3. The growth of C*hlorococcum aquaticum* in batch-wise cultivation under varied light colors showing evolution of cell density (left) and optical density (right)

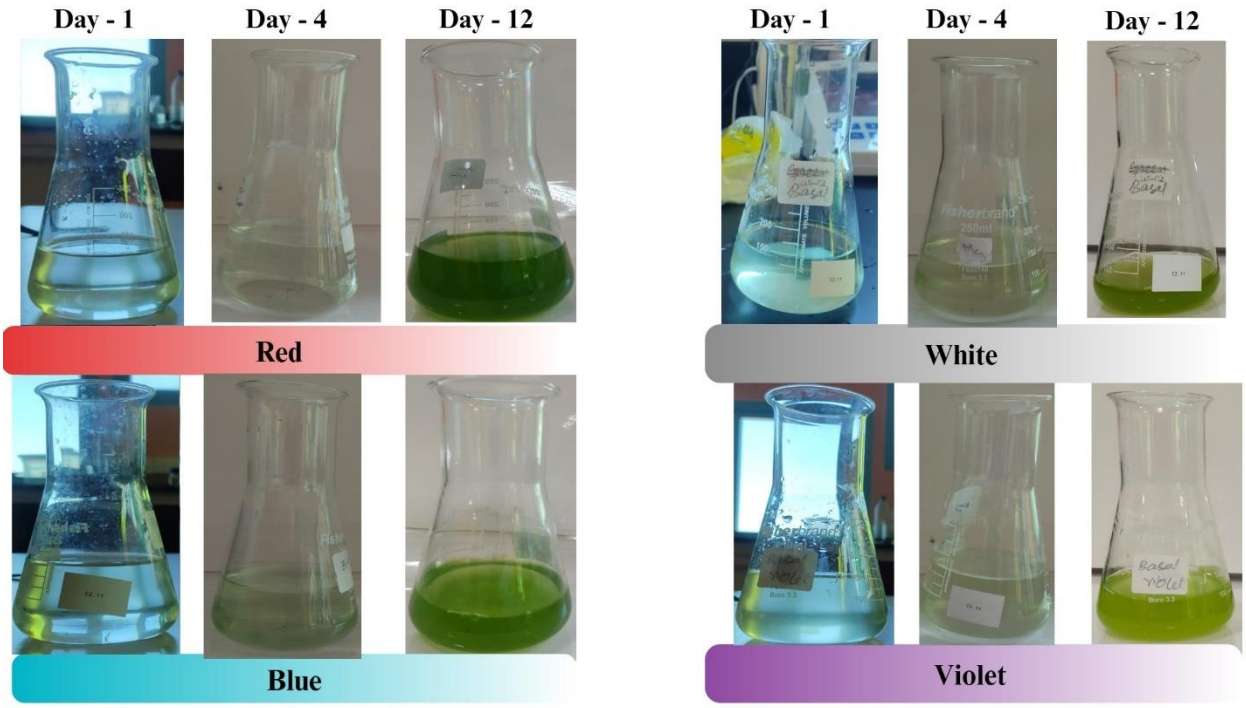

Figure 4: Image of batch-wise lab scale cultivated *chlorocuccum aquaticum* under varied LED light colors.

3.1.2 Cell Morphology

- The cell size is significantly affected by the light colors during the cultivation.
- The cell adapted to the light color by changing their morphology (Figure 5).

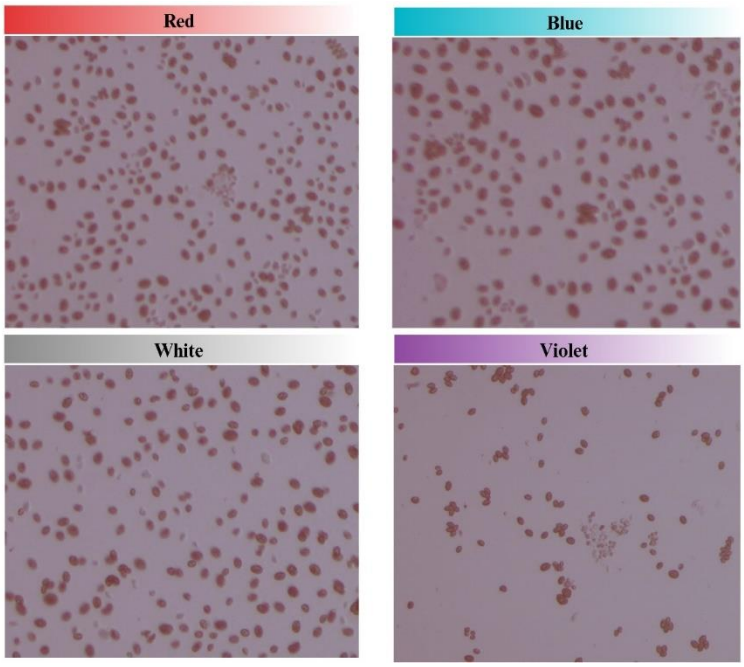

Figure 5. Microscopic pictures of *Chlorococcum aquaticum* cells cultivated under varied light colors.

3.1.3 Dissolved Oxygen

- DO reflected active photosynthesis, with notable increases during growth (Figure 6).
- Blue light promotes early growth; red promotes optimum growth.

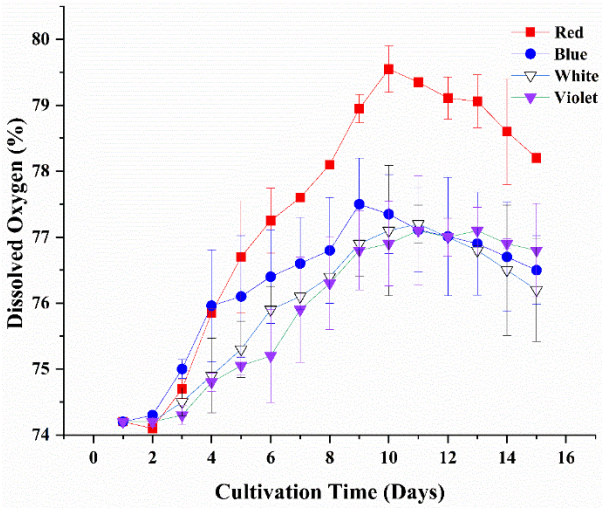

Figure 6. *The evolution of dissolved oxygen during the* batch-wise cultivation of *Chlorococcum aquaticum* under *v*arious *l*ight *c*olors.

3.1.4 Nitrogen and Phosphorus uptake

- The nutrients were completely assimilated suggesting effective wastewater treatment (Figure 7) irrespective of light color.
- Maximum removal efficiency is linked to active growth photosynthetic and nutrient uptake.

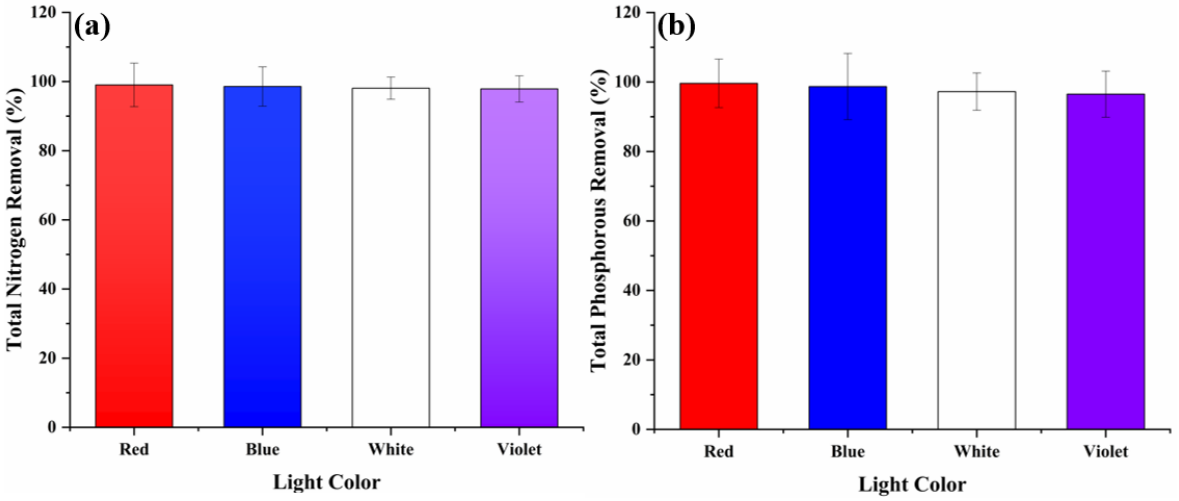

Figure 7. Total Nitrogen (a) and phosporous (b) uptakes during cultivation of *Chlorocuccum sp.*

3.1.5 Cultivation conditions: Conductivity, Total dissolved Solids and pH

- Conductivity and total dissolved solid (TDS) decrease across all light colors, reflecting nutrient uptake (Figure 8).

- Red light shows the highest nutrients' uptake.
- TDS and conductivity removals follower order: red > blue > white > violet.
- pH increased during cultivation under all light color, with red causing the most rise.
- The effect of pH dynamics was in an order of red > blue > white > violet.

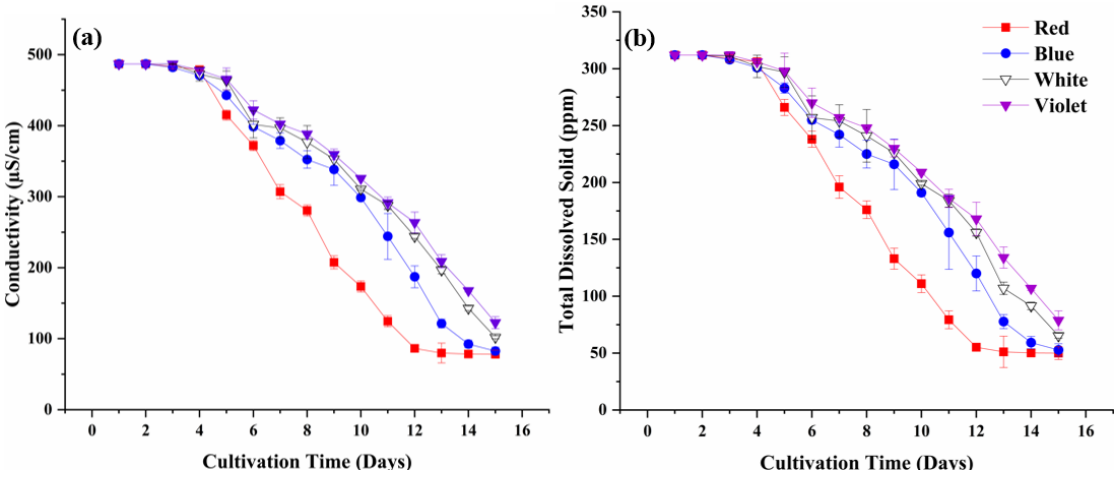

Figure 8. Conductivity (a) and total dissolved solid (b) profiles during the batch-wise cultivation of *Chlorococcum aquaticum*.

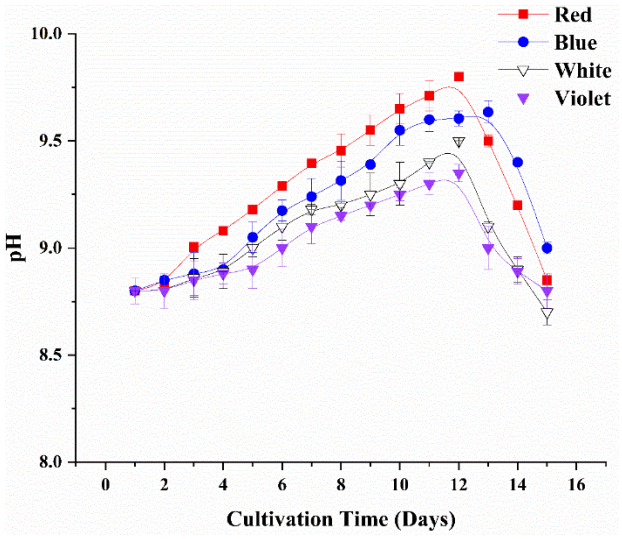

Figure 9: pH Fluctuation during the batch-wise lab scale cultivation of *chlorocuccum aquaticum*.

3.2 *Chlorocuccum aquaticum* harvesting

3.2.1 Dose optimization

Effect on HE (%) and CF

- Flocculant dose directly correlates with cell count for efficient harvesting irrespective of light colours (Figure 9).
- Higher flocculant dose enhanced harvesting efficiency by facilitating microalgae-flocculant collisions.
- Excessive flocculant doses slightly reduce efficiency due to destabilizing electrostatic charges.

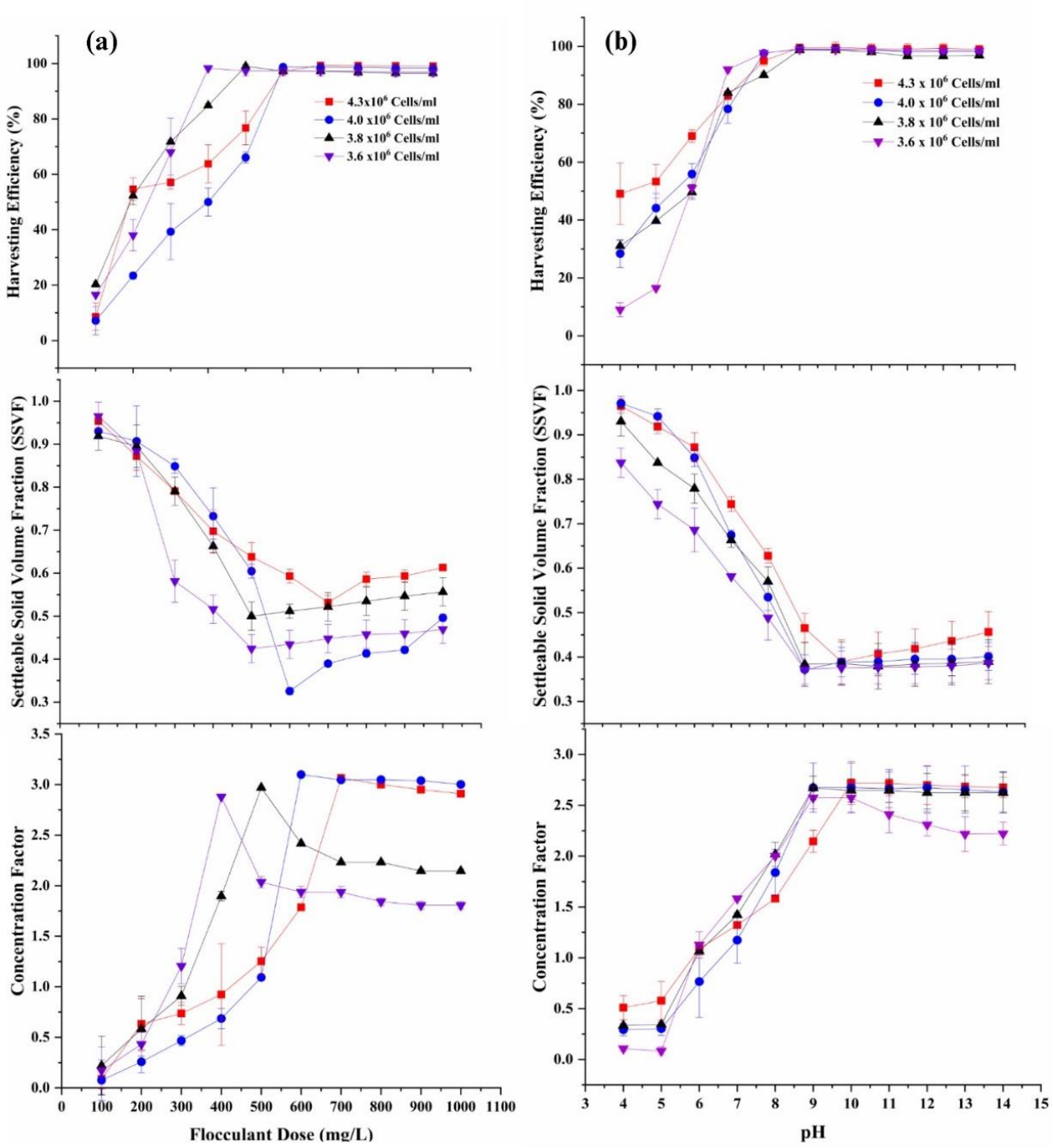

Figure 10: (a) Influence of flocculant dosage on HE, CF and SSVF at the actual pH ($4.3 \times 10^6 \pm 1627$ cells/ml at pH 8.8, $4.0 \times 10^6 \pm 1957$ cells/ml and pH 9.0, $3.8 \times 10^6 \pm 1657$ cells/ml at pH 8.7, $3.6 \times 10^6 \pm 1359$ cells/ml at pH 8.5), **(b)** Influence of pH on HE, SSVF, and CF at the optimal dose of flocculant (700 mg/L for $4.3 \times 10^6 \pm 1627$ cells/ml, 600 mg/L for $4.0 \times 10^6 \pm 1957$ cells/ml, 500 mg/L for $3.8 \times 10^6 \pm 1657$ cells/ml, and 400 mg/L for $3.6 \times 10^6 \pm 1359$ cells/ml) harvesting of *chlorocuccum aquaticum* broth cultivated under varied light conditions.

Effect on Settleable Solid Volume Fraction (SSVF)

- Optimal flocculant dosage of xx mg/L yields efficient biomass separation (Figure 10).
- High SSVF values indicate effective flocculation.
- There was an inverse relationship between SSVF and harvesting efficiency.
- Balancing flocculant dosage and microalgae concentration is crucial for optimizing microalgae separation.

3.2.2 Flocculation pH optimization

Effect on HE (%) and CF

- Higher pH levels enhance harvesting efficiencies by facilitating cell bridging (Figure 11).
- Maximum harvesting efficiency observed at a certain pH.
- Beyond optimal pH, HE slightly declined due to saturation of flocculation sites.
- Efficient floc formation occurs when flocculant balance with cell charges at optimal pH.

Effect on HE and SSVF

- HE% increased with pH levels reaching an optimum value (Figure 12) and decreased beyond an optimum value.
- Increased HE% corresponds with a decline in SSVF.

- The findings align with literature highlighting differences in flocculant efficacy (Table 2).
- The HE peaked and declined beyond optimal showed the balance of flocculant concentration, pH, and algal response.
- Flocculant charge density, like cellulose nanofibers, affects dynamics and efficiency.
- A range of flocculants, from physical to bio-based, shows varied success in algal harvesting.

4. Conclusions

- Finding demonstrated the significant impact of LED light color, flocculant dosage, and pH on microalgae cultivation and harvesting efficiencies.
- Red light maximizes growth, achieving the highest biomass concentration.
- Optimal ferric chloride dosage correlated directly with cell count, while optimum pH was critical for HE.
- Findings contribute to optimizing microalgae biomass production, indicating potential for industrial application.

Abstract

Keywords

2. Methodology

2.1 Materials

- The Chlorococcum aquaticum strain is a wild species obtained locally.
- The light sources for cultivation were using four types of LED lights
- Material: like Ferric chloride and Bold's Basal Medium [Sigma Aldrich]

2.2 Cultivation setup and process

- The experiment aimed to determine the most effective light color for cultivating Chlorococcum aquaticum by analyzing its impact on growth parameters.
- The study examined Chlorococcum sp.aquaticum's growth under different LED light colors using a setup depicted in Figure 1.
- Four separate containers, each with a specific LED light color, ensured controlled cultivation environments.
- Two 250 ml Pyrex glass conical flasks per container were filled with 50 times diluted Bold's Basal Medium.
- An initial inoculum of 10.0 ml Chlorococcum aquaticum was added to each flask, starting the cultivation process.
- Inorganic carbon was supplied through passive CO2 diffusion from air, with flasks kept open throughout the process.
- The cultivations were performed in duplicate to ensure replicable results.
- Red, blue, white, and violet LED lights, each with 50 LEDs on a 5-meter strip, served as light sources.

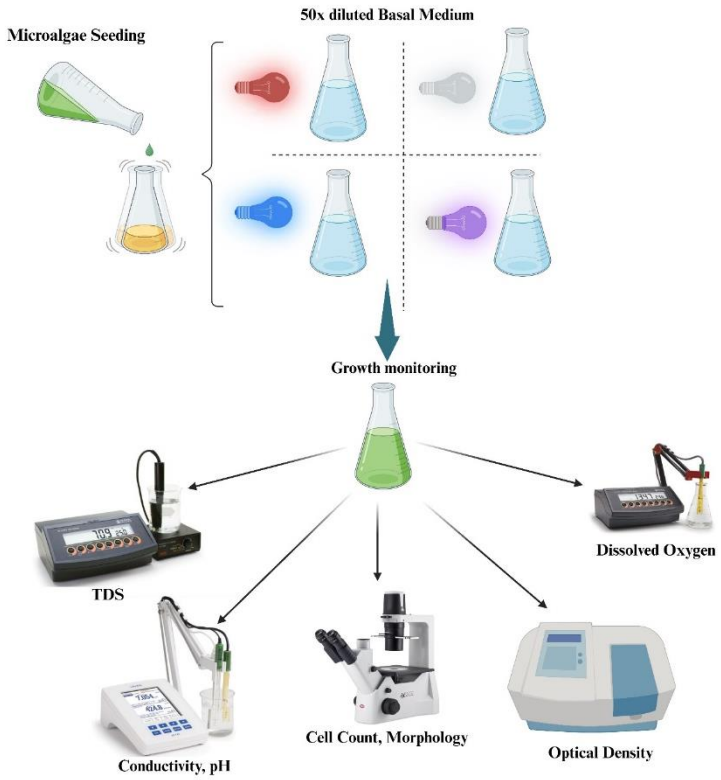

Figure 1. Illustration of batch-wise cultivation of wild strain *Chlorococcum aquaticum* under variable light colors.

2.2 Cultivation parameters

- Daily monitoring of *Chlorococcum aquaticum* involved key parameters, namely DO, conductivity, TDS, temperature, and pH.
- DO levels were measured with a HI2300 sensor; other parameters used a HI5521 sensor.
- Microalgae population and cell counts were analyzed with an AE31 ELITE Microscope.
- The broth's optical density (OD) was determined using a HI83341 photometer.
- Total phosphorous and nitrogen levels were assessed using Hach-Lange kits (Methods 8190, 8048, and M281).

2.3 Microalgae Harvesting

- The *Chlorococcum aquaticum* broth was first diluted using distilled water (refer to Figure 2).
- The diluted broths were distributed into 10 and 12 beakers for ferric chloride (0.1 to 1 g/L) dose and pH (4 to14).
- The pH of medium was adjusted using 0.1 M HCl and NaOH.
- Flocculation process: vigorous mixing with flocculant for 5 minutes, followed by 30 minutes of gentle mixing, followed by 60-minute settling phase.
- The OD was measured at 610 nm using a spectrophotometer.
- Harvesting efficiency, concentration factor, and settleable solid volume fraction were calculated using specific equations.

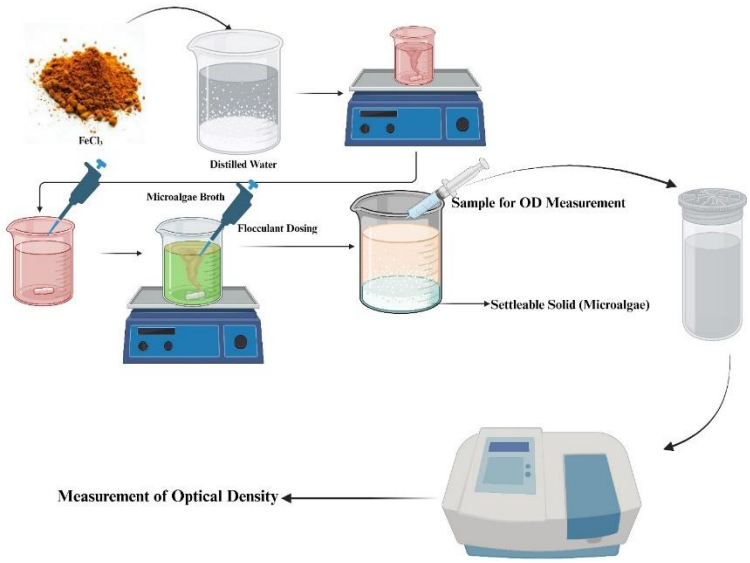

Figure 2. Illustration of C*hlorococcum aquaticum* harvesting process using Ferric chloride as flocculant under varying conditions.