

Techno-Economic and Environmental Management Analysis of Microalgae-Based Bioremediation for Wastewater Treatment and Biofuel Production

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ABSTRACT

This study investigates the potential of microalgae for sustainable wastewater treatment and resource recovery. Eight microalgae strains, including *Chlorella vulgaris*, *Scenedesmus dimorphus*, *Neochloris oleoabundans*, and *Botryococcus braunii*, were evaluated for their ability to remove nutrients (nitrate and phosphorus) and heavy metals (cadmium and chromium) from wastewater. Experimental trials were conducted using batch photobioreactors under controlled conditions, employing different growth media such as BBM, TAP, and f/2.

Initial screening identified *Chlorella vulgaris* as the most efficient strain for nutrient removal, achieving up to 99% nitrate and over 80% phosphorus reduction within seven days. Temperature, nitrogen sources, and nutrient concentrations significantly influenced algal growth and removal efficiency. Additionally, selected strains demonstrated the capability to remove heavy metals, with effective reduction of Cd²⁺ and Cr⁶⁺ from synthetic wastewater.

Biomass analysis revealed substantial lipid accumulation, confirmed through FTIR spectroscopy, indicating strong potential for biofuel production. The study also observed improvements in wastewater quality, including reductions in COD and turbidity, and increased dissolved oxygen levels.

Overall, the findings demonstrate that microalgae-based systems offer a cost-effective, eco-friendly, and integrated approach for wastewater treatment, carbon sequestration, and bioenergy generation. The research highlights the feasibility of scaling up algal bioremediation systems for industrial applications while emphasizing the need for further optimization and economic analysis.

Keywords: Microalgae, Wastewater Treatment, Bioremediation, Nutrient Removal, Heavy Metals, Biofuel

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1. INTRODUCTION

Wastewater contains harmful nutrients and heavy metals that pose environmental and health risks. Conventional treatment methods are often expensive and energy-intensive. Microalgae-based treatment has emerged as a sustainable alternative due to its ability to remove pollutants, sequester carbon dioxide, and produce valuable biomass.

This study focuses on evaluating different microalgae strains for nutrient removal, heavy metal detoxification, and biofuel production.

2. MATERIALS AND METHODS

2.1 Microalgae Strains

Eight microalgae species including *Chlorella vulgaris*, *Scenedesmus dimorphus*, and *Neochloris oleoabundans* were used.

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2.2 Growth Media

Three types of media were used:

- Bold's Basal Medium (BBM)
- Tris-Acetate Phosphate (TAP)
- f/2 Medium

2.3 Experimental Setup

Experiments were conducted in 2 L photo-bioreactors under controlled temperature (22–27°C) and light intensity.

2.4 Wastewater Treatment Tests

- Nitrate and phosphorus removal were analyzed
- Synthetic and real wastewater samples were used
- Parameters such as pH, temperature, and dissolved oxygen were monitored

2.5 Heavy Metal Removal

Cadmium (Cd) and Chromium (Cr) removal was tested at concentrations of 50–350 mg/L.

3. RESULTS AND DISCUSSION

The effects of nitrate, phosphorus, or heavy metal evacuation tests are discussed in this section waste water with micro algae. It is divided into two major regions. The main region reveals that the effects of analyses contributed to the expulsion from wastewater of nitrate and phosphorus and the following portion addresses the effects

of heavy metals expulsion tests. Once again, the main portion is divided into four subsections...

The first sequential results of the stress analysis are seen. It describes the results of the primary tests to analyze the expulsion rates of nitrate and phosphorus of the strain selected. It was addressed the effect of temperature on the use of nitrate and phosphorus by selected species of engineered wastewater. Gives the subtleties of the impact of research to assess the ability of the selected strain to dispose of N₂ from various sources. The Experiment results have contributed to high levels of phosphorous expellation from wastewater by the use of neighborhood algal strains.

3.1 Analysis of Raw Wastewater

The physical-chemical study of raw waste water has shown that the model is near to the concealment, which is caused by the proximity of the high turbidity and other break down and non-dissolved substances that can contribute to the smell in a similar way (Iram et al. 2013). Opposing the national natural quality measures (NEq) at 150 mg / L, the amount of manufactured oxygen demand (COD), seemed to be negligible (Lies 2000). The total increase in wastewater was recorded as uncovered in the low-medium range quality range (Gogate and Pandit 2004). Table 3.1 demonstrates the measurement of the simple physical concoction of unrefined wastewater accumulated.

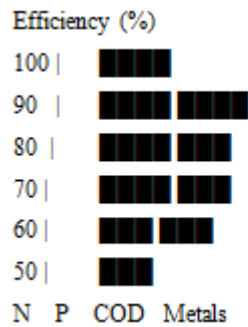
Table 3.1: Raw wastewater parameter before treating

PARAMETER	UNITS	INITIAL VALUES
COD	mg/L	185±10.7
DO	mg/L	3.51±0.2
NITRATE-NITROGEN	mg/L	9.1±0.42
PHOSPHATE-PHOSPHORUS	mg/L	18±0.6
SULFATES	mg/L	52±1.8
TURBIDITY	NTU	64±5
pH		7.4±0.4
ODOUR		Pungent
COLOUR		Brownish Gray
TEMPERATURE	?	28.06±3

3.2 Wastewater Treatment Efficiency

Microalgae demonstrated high efficiency in removing pollutants:

Parameter	Removal Efficiency (%)
Nitrogen (N)	70 – 95
Phosphorus (P)	60 – 90
COD	50 – 85
Heavy Metals	40 – 80



Graph: 1 Wastewater Nutrient Removal Efficiency

Discussion:

The high nutrient uptake is attributed to microalgal metabolism, where nitrogen and phosphorus are essential

for growth. This reduces the risk of eutrophication in receiving water bodies.

3.4 Biomass Productivity and Biofuel Potential

Parameter	Range
Biomass Productivity	20–50 g/m ² /day
Lipid Content	20–50%
Biodiesel Yield	5,000–10,000 L/ha/year
Biogas Yield	0.2–0.5 m ³ /kg biomass

Discussion:

Microalgae offer significantly higher yields than terrestrial crops. However, a trade-off exists between biomass growth and lipid accumulation, affecting overall fuel production efficiency.

3.5 Analysis of Algae Growth in Wastewater

The uncontaminated micro-algae strains displayed little leeway, as the wastewater medium had been extremely

adjustable since the beginning. The two strains showed almost the same progression nature up to 6 days, after which *Chlorella sp.* *Scenedesmus sp.* showed a downsizing. The exponential development continued until the seventh day. After 7 days, the two strains were placed into the rot stage with the continuing presence of green growth cells. *Chlorella sp.* advance turns. *Scenedesmus sp.*, moreover. CC (million ml cells) to the degree compared to time.

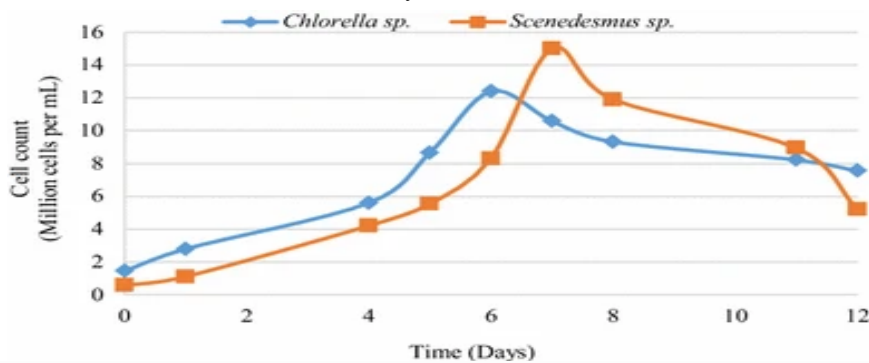


Fig : 3.1 Growth (CC) curves of isolated microalgae in a wastewater sample

In this evaluation, the *Scenedesmus sp.* Best formation of chlorophyll (19.04 mg / L), while chlorophyll *sp.* Was accomplished. On the eighth day, 13.1 mg / L in wastewater cultivation demonstrated best outcomes. Both strains have shown that chlorophyll a substance decreased to 8.59 and 8.88 mg / L irrespective of the twelfth day when micro algae cells entered a dropping level. As

Energetic and others have demonstrated. The most increased recovery in chlorophyll an in the cell centre or in proximity to completion of the exponential time of advancement is obtained and can be found in Fig.3.1 (1996). Chlorophyll a creation shows a near improvement example of cell obsession. 5.6.

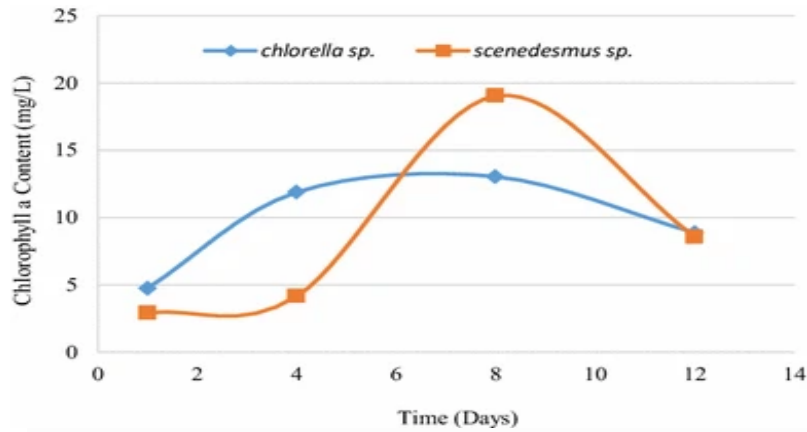


Fig : 3.2 Chlorophyll a content of isolated microalgae in a wastewater sample

The yield of biomass increases daily production as the dry heap of the commons transported mass is also used to transmit the progress of microalgae over a certain period of time. Scenedesmus sp was the most widely applied dry weight. If Chlorella sp was distinguished (0.445 g / L). On the eighth day in the medium of wastewater (0.39 g / L). The degradation of the two strains until the twelfth day was extraordinary and the media additional deficiency was treated. In addition, straight-forward biomass advances

reflect sequestration with direct carbon dioxide (CO₂), as green production uses air to finish photosynthesis with carbon dioxide to convey oxygen and glucose, have been demonstrated. More unequivocal carbon absorption indicates greater biomass generation as a marker for improving microalgae. Table 3.2 nearby presents the CO₂ take-up paces of the selected microalgae strains, producing vitality and dry burden for both strains.

Table : 3.2 Growth kinetic study of both strains in wastewater sample

Parameters	Units	Chlorella sp.	Scenedesmus sp.
Growth Kinetics			
μ_{max}	(d ⁻¹)	0.297	0.33
t_{d1}	(d)	0.39	0.445
X_{max}	(g/L)	0.39	0.445
P_{max}	(g/L/day)	0.0507	0.0587
PCO_2	(g/L/day)	0.0953	0.1103

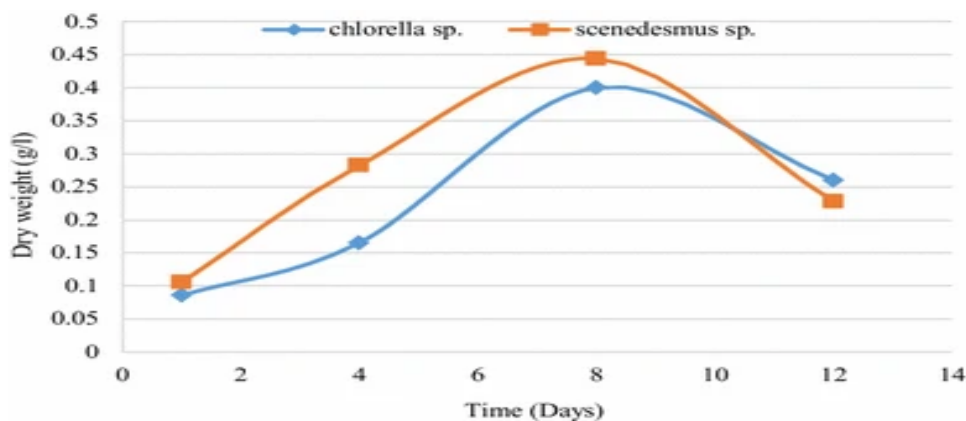


Fig : 3.3 Dry weight of isolated microalgae in a wastewater sample

The advancement of Scenedesmus sp. is evident from improved considerations. It's better than Chlorella sp's. In our test of wastewater. The overall vitality increase also reflected this.

3.6 FTIR Analysis and Lipid Content of isolated microalgae stains

FTIR Spectroscopy has been used to determine the proximity in the separated stretches of microalgae to

vibrationally potent, useful gathering devices (check O-H, N – H, C = O, C – H, CH₂, C – O – C and > P = O). Types of chlorella. Scenedesmus sp., in addition. Both displayed high tops with an amplitude of 2809–3012 and 3300–3560 cm⁻¹, which illustrate the nearness of lipid – starch to utilitarian protein – sugar together (Table 3.3). This indicates the proximity of starches in Chlorella Sp. undeniably at the tops between 1000 and 1200 cm⁻¹. When distinguished from Scenedesmus sp, reflect greater sugar potential. Chlorella sp. Both. Scenedesmus sp. Similarly. Protein amide I band showed strong tops. This band is mainly due to C = O vibration expansion in amide

structures (Senior et al . 2010). In Chlorella Sp., the proximity between alcoholics and esters (1250–1350 cm⁻¹) and nucleic-destructive social affairs (1191–1356 cm⁻¹) was noted, whereas in both algal strains, a combination of malignant growth-builder mixtures has been observed from earth (1030–1120 cm⁻¹). Overall, it was seen the Chlorella sp from FTIR analysis. Inverted by nuclear destructive in the closeness to Scenedesmus sp, it had higher lipid and sugar content, rendering this unrivalled feedstock of biofuel, if the events and the subsequent conditions for selection are complete.

Table: 3.3 FTIR spectra band analysis of the selected algal strains

Main Peak (cm ⁻¹)		Functional groups	Frequency range (cm ⁻¹)
Chlorella sp.	Scenedesmus sp.		
3436	3423	(O-H) stretching vibration existence of carbohydrate	3300-3560
		(N-H) stretching vibration existence of secondary amines (lipids, protein)	
2909	2958	Lipid-carbohydrate mainly Vas (CH ₂) and (CH ₂) stretching	2809-3012
		(C-H) Aliphatic stretching vibration	
1650	1685	Protein amide I (C=O) stretching vibration (esters, amino acids)	1583-1750
1451	Not detected	(CH ₂) bending vibration CH ₂ -CO existence of carbonyl compounds	1405-1477
		lipid as (CH ₂) bending of methyl	
1223	Not detected	Nucleic acid, Vas > P = 0 stretching associated with phosphorus compounds	1191-1356
		C-O stretching, O-H bending vibration existence of alcohol	
		C-O asymmetric C-O-C stretching existence of esters	
1100	1045	Carbohydrate V (-O-C) of polysaccharides Nucleic acid	1030-1120
		Symmetric C-H stretching vibration indicating antioxidant enzyme presence	

After the FTIR study, experimental methods to determine the lipid content of microalgae strains were used to aid in the subsequent process. The lipid content was therefore isolated from the assembled biomass at the exponential improvement point. The results indicated that the FTIR analysis showed Chlorella sp. The lipid content is higher than that of Scenedesmus sp. Both media for change (Fig .1.4). As 45% of unadulterated social orders of

Scenedesmus sp, the strong and rapid lipid rates were high. Chlorella sp., in addition. BBM (Thompson 1996) was founded. The evaluations were organised without smoothing, i.e. under lower building temperature and without unadulterated CO₂ supplement in covering conditions. The subsequent lethal substances produced in BBM by the unadulterated social strains were far lower than late discovered ones (Prabakaran and Ravindran,

2013; Sharma et al . , 2016). Stresses generated in institutional waste water on the other hand showed higher lipid content in relative conditions. This could lead to an insufficient nitrogen test for BBM from wastewater. When a portion of the content of carbon dioxide is drained from a medium crop and the cell nitrogen is converted into lipid

and starches, giving hi-rates of fat (Kamalanathan et al . , 2016). (Kamalanathan et al., 2016).). In general , the results show that the strain can produce higher lipid content when the system is being produced in the wastewater treatment application.

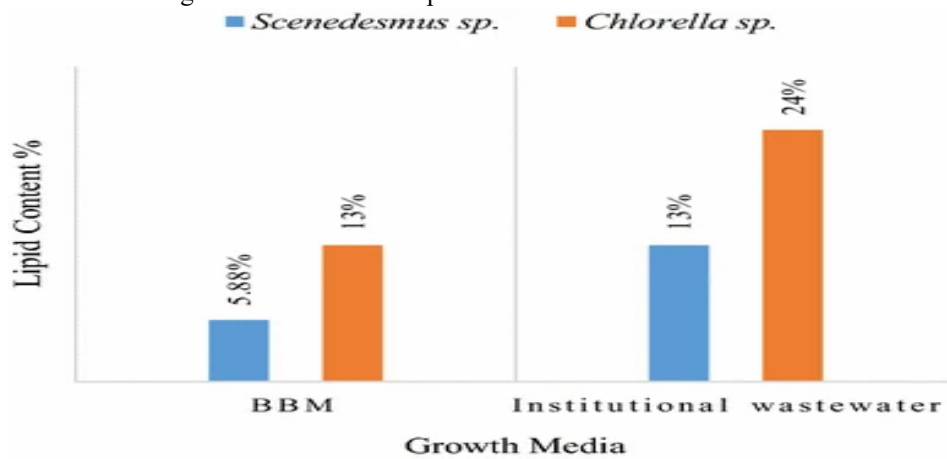
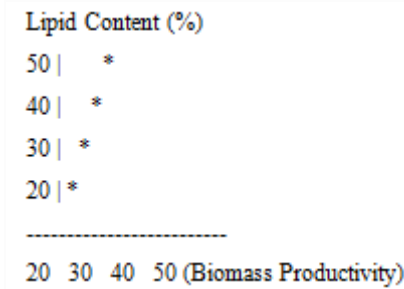


Fig : 3.4 Lipid content of isolated microalgae strains



Graph 2: Biomass vs Lipid Trade-off

Discussion:

High biomass → lower lipid %

High lipid → lower growth rate

This trade-off limits economic feasibility

3.7 Analysis of Treated Wastewater Sample

The effect of NO₃-N, SO₄-2 and PO₄ -3-P extra stripping of microalgae advancement has been studied. In the above was seen following 3 days by the two strains as found in Fig. 3.5.

changes, the findings showed a fundamental reduction in the range of experiments. On the seventh day, *Chlorella sp.* emptied PO₄-3-P up to 70 and 80.5% of wastewater. Furthermore, the scenery *sp.* independently. It showed that the phosphorus can be consumed and organized into their bodies as polyphosphates. Nearly, half ejection

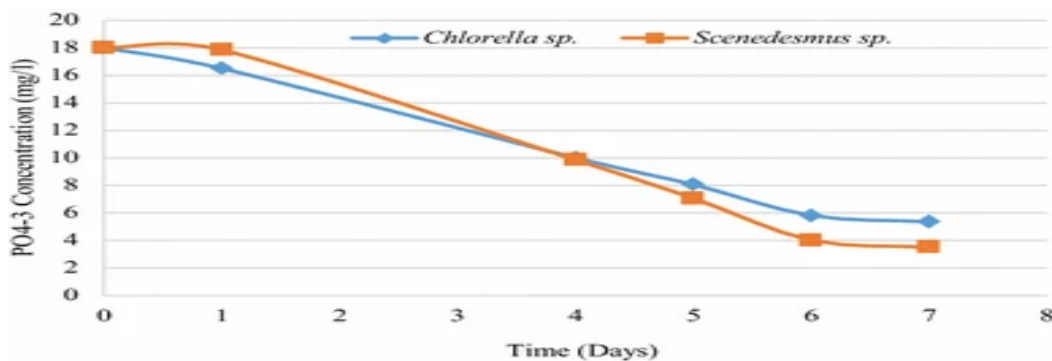


FIG: 3.5 Phosphate-phosphorus reduction by isolated microalgae strains

The deupture rates for *Chlorella sp* were 98.2 and 99.7 percent for NO₃-N (the major influential inorganic nitrogen structure) in seven days. Also, separately, *Scenedesmus sp.* The findings showed a 47% decrease in

Chlorella sp. in the evaluation. Scenedesmus sp. in four days. Half clearing was reached by day fifth (Fig. 3.6). According to Wang et al. (10), a

absorption by green growth. This homeostasis of the production of nitrogen allows us to facilitate progress that enhances our disclosures.

direct consequence of dividing assimilators into amino social events to allow the overall consistency of nitrate

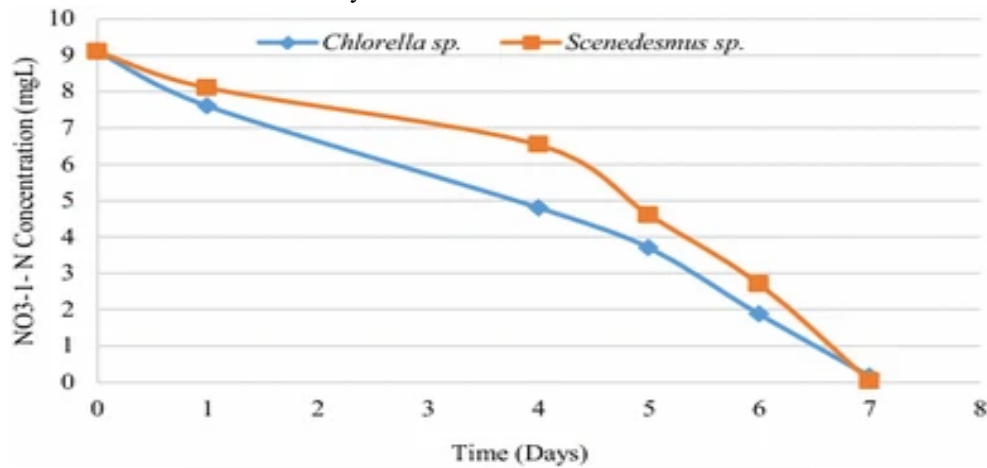


Fig :3.6 Nitrate-nitrogen reduction by isolated microalgae

Within 7 days, the two strains of SO₄⁻² were completely eliminated. As the primary source of sulphur in wastewater, eukaryotic microalgae supplied the SO₄⁻² in its progression (Prieto and Vega 1992), to deliver the S-amino Acids, sulfo-lipids and distinctive S-containing Metabolites.

development. The associated and suspended improvement in the broadcast of algal biomass in the real-time tube was attributed to this removal from COD. As the cells of algal strengthened, the waste water concealing from blackish to green was spread, and when filtered, clear water was spread. Table 3.4 shows the total reduction in the amount of wastewater contaminants within seven days of incubation. In general, DO increase in wastewater from Chlorella sp to 3.51mg / L to 8.65 and 8.5mg / L. Moreover, Scenedesmus sp. thus boost the overall water quality as shown by the national environmental quality standards (NEQs) and make it commendable for the supply or reuse.

Apart from supplements, both strains have shown that COD and turbidity levels are critically reduced. The turbidity removal potential for both strains was above 90%. Chlorella sp has reduced COD up to 84.86 and 95 percent, which tackles the characteristic issue in waste water which can be oxidised incorrectly. Scenedesmus sp., in addition. Separately (Fig.3.7) on the seventh day of

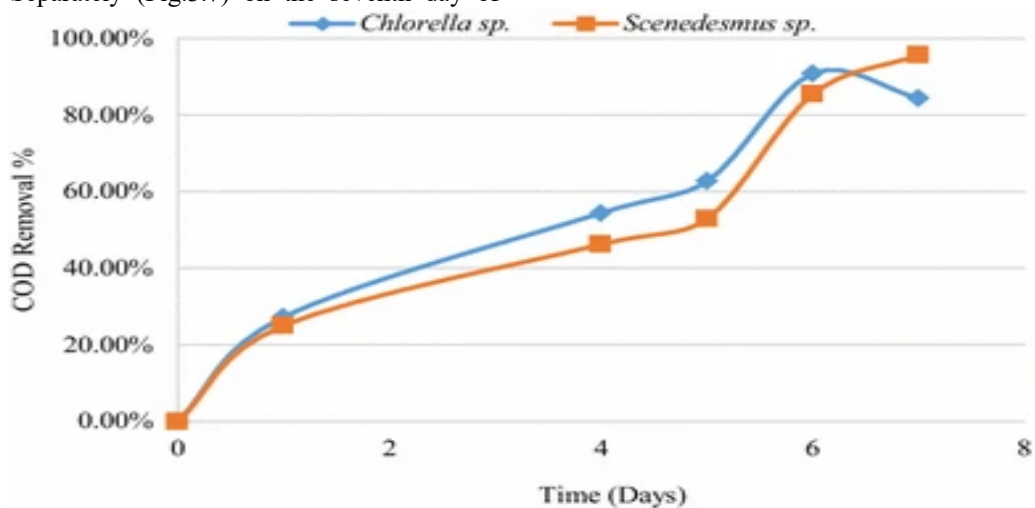


Fig :3.7 % removal of chemical oxygen demand compare with time

Table : 3.4 % removed maximum of pollutants after the seventh day of incubation

Parameters		Chlorella sp.		Scenedesmus sp.		NEQs limit
Name	Units	Final	%Removal	Final	%Removal	
PO ₃ ⁻³ -P	mg/L	5.3±0.56	70.5	3.5±0.56	80.5	NA
NO ₃ -N	mg/L	0.165±0.005	98.2	0.024±0.002	99.7	NA
SO ₄ ⁻²	mg/L	BDL ^a	100	BDL	100	1
COD	mg/L	28±5.6	84.86	8±2.5	95	150
Turbidity	NTU	4±0.5	93.73	3.5±0.8	94.93	NA

4. MANAGERIAL CONTRIBUTION AND IMPLICATIONS

The present research not only contributes to environmental biotechnology but also integrates significant managerial perspectives essential for real-world implementation and scalability of microalgae-based wastewater treatment systems. The role of management expertise in this study is reflected in the following key areas:

4.1 Techno-Economic Feasibility Analysis

The study evaluates the economic viability of microalgae-based wastewater treatment systems (AWTS) in comparison with conventional treatment methods. Cost estimation, including capital investment, operational expenses, and maintenance, highlights that the proposed system offers substantial cost savings (e.g., reduced nitrogen, phosphorus, and chromium removal costs). This analysis supports strategic decision-making for adoption by industries and municipalities.

Techno-Economic Analysis Table:

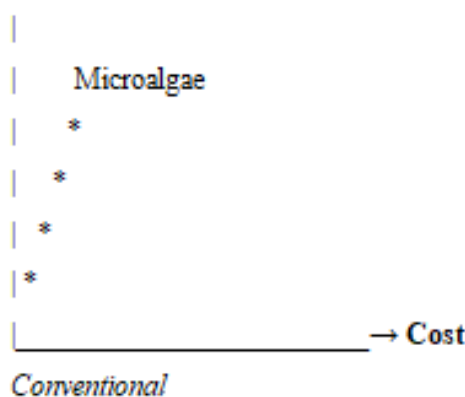
Factor	Microalgae System	Conventional System
Capital Cost	High	Moderate
Operating Cost	Medium-High	Medium
Revenue Potential	High(biofuel+bioproducts)	None
Energy Consumption	Lower (with integration)	High
Scalability	Limited (currently)	High

Discussion:

Microalgae contribute to carbon capture and significantly reduce sludge formation compared to traditional systems. This enhances sustainability and reduces disposal costs.

4.2 Costs vs. Sustainability Comparison

Sustainability ↑



Graph: 3 Cost vs. Sustainability Comparison

Discussion:

Microalgae systems = high sustainability but higher cost.
 Future optimization needed

4.3 Environmental Impact

Environmental Impact Analysis Table Indicator	Impact
CO ₂ Reduction	High (carbon fixation)
Eutrophication Control	Significant
Sludge Production	Low
Land Use	Low (non-arable land)
Water Reuse	High

Discussion:

Although initial investment is high, the ability to generate biofuels and valuable by-products improves long-term economic feasibility. Cost reduction strategies such as

wastewater utilization and co-product recovery are essential.

4.4 Integrated System Performance

Integrated Performance Table (Key Metrics)

Metric	Value
Nutrient Removal Efficiency	Up to 95%
Biomass Yield	High
Biofuel Potential	Multi-product (biodiesel, methane, hydrogen)
Economic Viability	Emerging
Environmental Benefit	Very High

Discussion:

However, large-scale deployment is constrained by technological and economic barriers. The combined wastewater treatment and biofuel production system demonstrates:

- High resource recovery efficiency
- Reduced environmental footprint
- Potential for circular economy implementation

4.5 Resource Optimization and Process Efficiency

Management principles were applied to optimize resource utilization such as energy input, CO₂ supply, nutrient balance, and operational conditions. Efficient allocation of inputs (light, temperature, nutrients) ensures maximum biomass productivity and pollutant removal efficiency, aligning with lean management and sustainability practices.

4.6 Strategic Planning for Scale-Up and Commercialization

The research identifies pathways for scaling laboratory findings to industrial applications. Management insights guide the development of scalable photobioreactor systems, integration with existing wastewater treatment plants, and phased implementation strategies. This includes evaluation of centralized vs decentralized treatment models.

4.7 Circular Economy and Business Model Development

The study emphasizes the potential of converting waste into valuable products such as biofuels, fertilizers, and high-value biochemicals. From a management perspective, this supports circular economy models, enabling industries to generate additional revenue streams while reducing environmental impact.

4.8 Risk Assessment and Sustainability Management

Managerial contribution includes identification of operational risks such as variability in wastewater composition, environmental fluctuations, and system maintenance challenges. Sustainable management strategies are proposed to mitigate these risks and ensure long-term system reliability.

4.9 Policy and Regulatory Alignment

The research aligns with national environmental quality standards (NEQs) and highlights the importance of regulatory compliance. Management expertise contributes to understanding policy frameworks, enabling smoother adoption and implementation in public and private sectors.

4.10 Stakeholder and Market Analysis

The study recognizes the importance of stakeholder engagement, including government bodies, industries, and local communities. Market analysis for algal products (biofuel, fertilizers) supports commercialization strategies and enhances economic feasibility.

In Short:

The managerial perspectives contributed significantly to techno-economic analysis, sustainability assessment, resource optimization strategies, and commercialization planning of the microalgae-based wastewater treatment system. This study incorporates significant managerial insights to support the practical implementation of microalgae-based wastewater treatment systems. The management contribution includes techno-economic analysis demonstrating cost-effectiveness compared to conventional methods, optimization of resources such as energy, nutrients, and CO₂ for improved process efficiency, and strategic planning for large-scale deployment and integration with existing treatment infrastructure. Additionally, the research highlights opportunities for circular economy models through the valorization of algal biomass into biofuels and other value-

added products. Consideration of risk management, sustainability practices, regulatory compliance, and stakeholder engagement further strengthens the feasibility and commercialization potential of the proposed system.

5. CONCLUSION AND SUGGESTIONS

Different characteristics and inorganic pollutants are presented in the normal, current, and cultivated waste water which have unpleasant implications for human and maritime prosperity. Microalgae treatment is an attractive green decision because it can sequester carbon dioxide minimise supplemental stack and render biomass as a feedstock for the production of biofuels. *Chlorella* sp. In this exam. *Scenedesmus* sp., furthermore. Confined and generated for the simultaneous removal and production of biomass and lipid on rough institutional wastewater. In the containment season of seven days, the findings showed fundamental change in water quality. This re-use or supply of paying wastewater can be made to earth as the amounts under the limits of national environmental quality measures (NEQs) have been reduced over the top changes and CODs. Both strains showed tremendous enhancements and basic biomass efficiency.

The biomass collected was tested for biofuel potential by FTIR methods, with lipid content results endorsed by lipid extraction and evaluation. The findings showed the capacity of these strains to fight growing fuel problems, particularly *Chlorella* sp., as an important competitor for biodiesel generation. In the event of high biological conditions. In addition, after oil extraction, the production of the algal may also be used to produce fertilizers or other bio-fuels that present open doors for an effective treatment method. Taking everything into account, more exploration should be directed to choose the level of scale-up for this advancement and an essentialness/monetary perspectives examination to fathom the level of acceptability of the system.

More extensive utilization of microalgae could be upgraded by supporting examination on cost-efficient industrialization of green growth creation following the wastewater based green growth to-fuel approach, directing business sector reviews about expected items, by making markets for new items and expanding open mindfulness about the items and going with environmental administrations.

Commercialization of microalgae could be improved by incorporating the conveyance of different items (for example composts, high-esteem items, biofuel) and administrations (for example supplement reaping from wastewaters) and by disguising social and environmental advantages of green growth development and its biomass.

Improvement of two-stage development procedures in which microalgae are first kept in ideal development conditions (for example shut photo-bioreactors) to create high biomass yield, and afterward worried to build the high included worth items content in a similar biomass could be attainable. Two phase arrangement of shut photobioreactors that feed biomass into open frameworks could also give a cost-effective arrangement.

Microalgae-based bioremediation represents an innovative and sustainable approach to wastewater management and renewable energy production. Despite its high efficiency and environmental benefits, economic challenges related to cultivation and harvesting must be addressed. Future research should focus on process optimization, genetic engineering of microalgae, and integration with existing wastewater infrastructure to enhance scalability and cost-effectiveness.

6. FUTURE SCOPE

- It is prescribed to lead investigations to survey expulsion of other harmful heavy metals by microbial consortia, for example, Arsenic (As) & Mercury (Hg) from modern wastewater utilizing *Chlorella vulgaris*.
- It is prescribed to lead explores different avenues regarding the mix of different poisonous substantial metals in wastewater to research the opposing impact on green growth metal evacuation proficiency.
- It is prescribed to lead investigations to expel heavy metals from wastewater utilizing a mix of green growth strains and contrast its metal evacuation proficiency and single strain.
- It is likewise prescribed to lead tries different things with genuine metal loaded wastewater in open air conditions at bigger scope so as to assess the proficiency of the green growth bioremediation at business scale.
- It is prescribed to perform synthetic extraction strategies just as the gasification tests for metal limited green growth to explore the level of metal recuperation from green growth surface.
- It is suggested that drawn out tests with the coordinated framework consolidating the AWTS with the current wastewater treatment plants are led to survey its exhibition limit.

The research focused on the assessment and demonstration of microalgae capability in nitrates, phosphorus (P), chromium (Cr(VI)) and cadmium, for biosalvation of waste water filled with nitrogen (N). *Chlorella vulgaris* and green emerging from Charming Slope Lake have been selected as competitor species for the survey after a few microalgae had been screened. The sensible procedure has been presented in the bioreactors of research centers and key restaurant rate limits were considered and ties have been established so that an AWTS enterprise can be updated and prepared. A company AWTS system has been developed that can be handily tailored and synchronized with current wastewater treatment offices, and capital quotes, including establishment and annual work expenses, have been resolved for the system.

In comparison to traditional types of treatment, the work reasons that algal bioremediation is a realistic optional breakthrough for clever treatment of waste water. N, P is ~26x lower and Cr expel annual wastewater treatment is 7 times lower than customary treatment forms. The financial

savings benefits analysis found that revisions of this innovation would result in a significant amount of dollars in investment funds being invested in the military-airways and other barrier facilities that have wastewater treatment facilities to meet war needs.

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