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(RESEARCH ARTICLE)

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Comparative analysis of algal strains for nutrient removal in household wastewater: A Sustainable Approach

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Abstract

Nutrient pollution, primarily caused by nitrates and phosphates in wastewater, poses severe environmental threats such as eutrophication and ecosystem disruption. This study investigates the potential of two microalgal strains, *Chlorella vulgaris* and *Spirulina platensis*, to remove these pollutants from household wastewater. A home-scale experiment was conducted, where wastewater samples were inoculated with the algae and monitored for two weeks. Nutrient levels were measured using standard water testing kits. Results showed that *Chlorella vulgaris* was more effective in nitrate removal, achieving a reduction of 62%, while *Spirulina platensis* excelled in phosphate removal with a 67% reduction. These findings highlight the practical potential of algae as eco-friendly, low-cost bioremediation agents, paving the way for sustainable wastewater treatment solutions.

Keywords: Algae; *Chlorella vulgaris*; *Spirulina platensis*; Wastewater Treatment; Nutrient Pollution; Bioremediation; Nitrate Reduction; Phosphate Uptake; Eutrophication; Sustainable Solutions.

1. Introduction

Nutrient pollution, caused by the excessive discharge of nitrates and phosphates into water bodies, is a growing environmental concern. Sources include agricultural runoff, industrial discharge, and untreated household wastewater. When nutrient-rich water enters natural ecosystems, it leads to phenomena like eutrophication, characterized by algal blooms, oxygen depletion, and harm to aquatic life.

Traditional wastewater treatment methods are expensive and energy-intensive, creating barriers to widespread adoption in small-scale or resource-limited settings. Algae offer a promising alternative due to their ability to assimilate nutrients during photosynthesis, thereby reducing pollutant levels in water. Additionally, algae are sustainable and cost-effective, requiring minimal inputs such as sunlight and CO_2. This study evaluates the nutrient removal efficiency of *Chlorella vulgaris* and *Spirulina platensis*, two algal strains known for their bioremediation potential. The research focuses on a practical, home-scale setup to demonstrate the feasibility of using algae for nutrient pollution control in household wastewater.

2. Materials and Methods

2.1. Materials

- Algal strains
    - *Chlorella vulgaris* (commonly available in powdered form or as live cultures).

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  - *Spirulina platensis* (available as food supplements or in live cultures).
- Household wastewater
  - Collected from kitchen sinks or laundry (pre-filtered to remove solid debris).
- Transparent containers (1-liter capacity) for algae cultivation.
- Water testing kits
  - Nitrate and phosphate test kits available online or from aquarium supply stores.
- Measuring tools
  - Ruler for visual growth assessment and a scale for biomass quantification.

2.2. Methodology

2.2.1. Preparation of Algal Cultures

- Algal cultures were rehydrated and grown in fresh tap water under natural sunlight for acclimatization. Cultures were aerated using manual stirring or a small air pump for optimal growth.

2.2.2. Experimental Setup

- Household wastewater was divided into three groups:
  - Control (no algae).
  - *Chlorella vulgaris*-inoculated.
  - *Spirulina platensis*-inoculated.
- Each group was set up in triplicate for reliability and placed in a sunny garden area.

2.2.3. Incubation and Monitoring:

- The containers were observed for two weeks, with daily stirring to ensure even exposure to light and nutrients.

2.2.4. Nutrient Analysis

- Nitrate and phosphate levels were measured on Day 0 and Day 14 using water testing kits. Nutrient reduction was calculated as:

$$\text{Reduction (\%)} = \frac{Initial\ Concentration - Final\ Concentration}{initial\ concentration}\ X\ 100$$

2.2.5. Biomass Measurement

- Algal growth was quantified by collecting and drying the biomass from the containers at the end of the experiment.

3. Results

Table 1 Comparison of Nitrate and Phosphate Removal and Biomass Yield of Chlorella vulgaris and Spirulina platensis

Parameter	Control	*Chlorella Vulgaris*	*Spirulina platensis*
Nitrate Reduction (%)	5	62	47
Phosphate Reduction (%)	3	54	67
Biomass Yield (g/L)	N/A	0.48	0.43

- **Nitrate Removal**: *Chlorella vulgaris* outperformed *Spirulina platensis* in nitrate reduction, likely due to its faster growth rate and higher nitrogen assimilation capacity.

- **Phosphate Removal**: *Spirulina platensis* demonstrated superior phosphate uptake, reflecting its preference for phosphorus-rich environments.
- **Biomass Yield**: Both algae showed comparable biomass production, indicating robust growth under wastewater conditions.

4. Discussion

The results confirm the potential of algae as effective agents for bioremediation. *Chlorella vulgaris* showed high nitrate removal, aligning with its established use in nutrient cycling studies. Its ability to grow rapidly and assimilate nitrogen makes it ideal for nitrogen-rich wastewater. Conversely, *Spirulina platensis* excelled in phosphate uptake, likely due to its metabolic adaptations favoring phosphorus utilization.

The control group exhibited negligible nutrient reduction, emphasizing the significant impact of algal inoculation. Additionally, both strains produced substantial biomass, which could be harvested for bioenergy, animal feed, or other applications, enhancing the economic viability of this approach.

This home-scale experiment demonstrates that algal bioremediation can be a practical and sustainable method for reducing nutrient pollution, particularly in decentralized or small-scale wastewater systems. Further research could explore combining *Chlorella* and *Spirulina* for optimized nutrient removal and assessing long-term scalability.

5. Conclusion

This study highlights the potential of *Chlorella vulgaris* and *Spirulina platensis* in removing nitrates and phosphates from household wastewater. *Chlorella* was more effective in nitrate removal, while *Spirulina* excelled in phosphate uptake. Together, these algae offer a low-cost, eco-friendly solution for nutrient pollution. Future research could focus on integrating this approach into community-scale wastewater treatment systems and exploring the additional benefits of algal biomass utilization.

References

[1] Wang, H., et al. (2016). Bioremediation of nutrient-rich wastewater using algae. Water Research, 92, 87-95.

[2] Kumar, K., et al. (2015). Wastewater treatment and bioremediation potential of microalgae. Applied Phycology, 27, 1245-1258.

[3] Richmond, A. (2004). Handbook of Microalgal Culture. Blackwell Science.