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Role of Aquatic Macrophytes in Water Quality Improvement

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Abstract: *Water pollution is one of the major environmental challenges affecting freshwater ecosystems worldwide. Aquatic macrophytes, which include submerged, floating, and emergent aquatic plants, play a vital role in maintaining water quality through nutrient uptake, pollutant removal, and habitat enhancement. The present study evaluates the effectiveness of selected aquatic macrophytes in improving water quality parameters in freshwater systems. Common macrophytes such as Eichhornia crassipes, Lemna minor, and Typha latifolia were assessed for their capacity to reduce nutrient loads and organic pollutants. The findings indicate that aquatic macrophytes significantly improve water quality by reducing nitrate, phosphate, and biological oxygen demand while increasing dissolved oxygen levels. These results highlight the importance of aquatic vegetation in sustainable water resource management and ecological restoration.*

Keywords: - *Aquatic macrophytes, water quality, phytoremediation, freshwater ecosystem, nutrient removal.*

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Introduction

Freshwater ecosystems are essential for sustaining biodiversity, agriculture, fisheries, and human livelihoods. However, increasing urbanization, industrialization, and agricultural activities have led to the deterioration of water quality in many aquatic environments. Excessive discharge of nutrients, organic matter, and pollutants into water bodies often results in eutrophication, oxygen depletion, and loss of aquatic biodiversity. Consequently, there is a growing need for environmentally friendly and cost-effective methods for water purification and ecosystem restoration. Aquatic macrophytes are large plants that grow partially or completely in aquatic environments. They are generally classified into floating, submerged, and emergent forms. These plants perform important ecological functions, including nutrient cycling, sediment stabilization, oxygen production, and provision of habitat for aquatic organisms. In recent years, aquatic macrophytes have gained considerable attention as natural agents for water quality improvement due to their ability to absorb excess nutrients and contaminants from water.

The process by which plants remove pollutants from the environment is known as phytoremediation. Aquatic macrophytes are particularly effective in phytoremediation because of their rapid growth rates, extensive root systems, and adaptability to diverse environmental conditions. Species such as *Eichhornia crassipes* (water hyacinth), *Lemna minor* (duckweed), and *Typha latifolia* (cattail) have been widely used in wastewater treatment systems and constructed wetlands for the removal of nutrients and heavy metals. The present study aims to evaluate the role of selected aquatic macrophytes in improving water quality and to assess their potential application in sustainable freshwater management.

Materials and Methods

Study Site

The study was conducted using water collected from a freshwater pond receiving domestic runoff and organic waste inputs. The pond exhibited moderate levels of nutrient enrichment and organic pollution.

Selection of Aquatic Macrophytes

Three commonly occurring aquatic macrophytes were selected:

1. *Eichhornia crassipes* (Water Hyacinth)
2. *Lemna minor* (Duckweed)
3. *Typha latifolia* (Cattail)

These species were selected because of their widespread distribution and documented phytoremediation potential.

Experimental Design

Table 1. Average Changes in Water Quality Parameters After 30 Days

Parameter	Initial Value	Final Value
Dissolved Oxygen (mg/L)	4.2	6.8
Biological Oxygen Demand (mg/L)	12.5	7.1
Nitrate (mg/L)	8.4	3.2
Phosphate (mg/L)	2.6	0.9
pH	7.3	7.1

Plastic containers of equal size were filled with pond water. Each container was assigned one macrophyte species, while an additional container without plants served as the control. The experiment was maintained for 30 days under natural environmental conditions.

Water Quality Analysis

Water samples were collected before and after the experimental period. The following parameters were analyzed:

- pH
- Dissolved Oxygen (DO)
- Biological Oxygen Demand (BOD)
- Nitrate concentration
- Phosphate concentration

Standard methods recommended for limnological and water quality studies were employed for analysis. APHA. (2017).

Results and Discussion

The aquatic macrophytes demonstrated considerable effectiveness in improving water quality during the experimental period.

A substantial reduction in nitrate and phosphate concentrations was observed in containers containing macrophytes. Dissolved oxygen levels increased significantly, indicating enhanced water quality and ecological health. Biological oxygen demand decreased considerably, reflecting reduced organic pollution. Among the tested species, *Eichhornia crassipes* showed the highest nutrient removal efficiency, followed by *Lemna minor* and *Typha latifolia*. Water transparency also improved due to the settling of suspended particles and filtration effects provided by plant roots.

The findings of the present study demonstrate the significant role of aquatic macrophytes in improving water quality. The reduction in nitrate and phosphate concentrations can be attributed to direct nutrient uptake by plant tissues. Aquatic plants require these nutrients for growth and development, thereby removing excess nutrients from the water column.

The increase in dissolved oxygen may be associated with photosynthetic activity and improved ecological conditions within the experimental system. Higher oxygen concentrations promote aerobic microbial processes that facilitate the decomposition of organic matter and reduce pollution levels. The observed decline in biological oxygen demand

indicates that macrophytes contribute to the reduction of organic pollutants. Their root systems provide favorable surfaces for microbial colonization, enhancing biological degradation processes. Similar findings have been reported in numerous studies where aquatic plants effectively removed nutrients and contaminants from wastewater and eutrophic water bodies.

Water hyacinth exhibited superior nutrient removal efficiency due to its rapid growth rate and extensive root system. However, uncontrolled proliferation of this species may cause ecological problems such as obstruction of waterways and reduction of native biodiversity. Therefore, periodic harvesting and proper management are necessary when using this species for phytoremediation. Duckweed and cattail also showed considerable potential for water purification. These species are easier to manage and can be integrated into constructed wetlands and wastewater treatment systems. The combined use of multiple macrophyte species may further enhance pollutant removal efficiency and ecosystem stability. Overall, aquatic macrophytes serve as natural biological filters that improve water quality through nutrient absorption, sediment trapping, microbial interactions, and oxygen production. Their utilization offers a sustainable and cost-effective approach to freshwater conservation.

Conclusion

Aquatic macrophytes play a crucial role in maintaining and improving water quality in freshwater ecosystems. The present study demonstrated that selected macrophytes significantly reduced nitrate, phosphate, and biological oxygen demand while increasing dissolved oxygen levels. These improvements contribute to the restoration of ecological balance and the prevention of eutrophication. The use of aquatic macrophytes in phytoremediation and wetland management represents an environmentally sustainable strategy for water pollution control. Further research should focus on long-term field studies and the evaluation of species combinations for enhanced remediation efficiency.

References

APHA. (2017). Standard Methods for the Examination of Water and Wastewater. 23rd Edition. American Public Health Association, Washington, DC.

Kadlec, R. H., & Wallace, S. D. (2009). Treatment Wetlands. CRC Press, Boca Raton.

Mitsch, W. J., & Gosselink, J. G. (2015). Wetlands. 5th Edition. Wiley, New York.

Reddy, K. R., & DeBusk, W. F. (1985). Nutrient removal potential of selected aquatic macrophytes. *Journal of Environmental Quality*, 14(4), 459–462.

Vymazal, J. (2013). Emergent plants used in free water surface constructed wetlands: A review. *Ecological Engineering*, 61, 582–592.

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