Role of Algae in Bioremediation of Waste water: Current Research

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Abstract—**The commercial use of these plants for wastewater treatment has been minimal, despite the diversity of algae and the low cost of algae biomass. These days, bioremediation is a cheap and effective decontamination technique that is gaining popularity to lessen environmental pollution. Sewage disposal in urban and semi-urban colonies has turned into an ecological issue.One of the main causes of water contamination is the wastewater discharge from homes and businesses. For the removal of such contaminated materials, several techniques, including ion exchange, evaporation, and precipitation, has been devised. Algae are utilized in wastewater treatment already and are significant bioremediation agents. However, compared to its current role, algae have far larger potential in wastewater cleanup. This publication outlines the region where research gives to the globe a "Algal Based Bioremediation" for cleaning the water bodies. We examined the efficacy of algae in wastewater bioremediation in this review research.**

Index Terms—**Bioremediation, Biosorption, Heavy Metals, Microalgae, Waste water**

I. INTRODUCTION

Ecosystem restoration and soil, surface water, and ground water sediment cleanup have been effectively accomplished through the use of bioremediation. Algae on sewage have two functions: they produce important protein and clean up possible environmental pollutants. Cultivating of *Spirulina platensis* in wastewater systems is useful in densely populated nations like India where waste generation is substantial and presents environmental challenges.

One of the main issues facing the country's expanding urban areas is the removal of waste, which exposes humans to direct exposure in rivers. These rivers' water is then consumed by aquatic life, directly affecting human health when humans drink it and contract diseases like diarrhea, typhoid, and chlorella, which are frequently caused by contaminated water.

According to Oluduro and Adewoye (2007), the availability of high-quality water is essential for both preventing such diseases and enhancing life quality. Thus, various novel technologies are being put forth to address waste water treatment.

Lead, cadmium, mercury, nickel, zinc, aluminum, arsenic, copper, and iron are examples of heavy metals that are listed as environmental hazards that can result in serious poisoning. Biological systems are used in bioremediation, a pollution control technique, to catalyze the breakdown or conversion of certain chemicals into less hazardous forms. (Derek, 1999; Dias *et al,* 2002; Ballantyne *et al*, 1999).Creating biologically based treatment systems is thought to be more environmentally friendly and economically more affordable (Valderrama, 2002).

Algal bioremediation is being employed in waste water treatment because it has far greater potential for waste water remediation than it does now. This review article provides an overview of the usage of microalgae in water body bioremediation (Volesky, 1990; Wase and Foster, 1997).

Reports of Certain Algae Consuming Heavy Metals

The term "bioaccumulation process" refers to a method of active metal accumulation by live cells that is dependent on the cells' metabolic activity (Volesky 1990; Wase and Foster, 1997). Oswald and Gootas first suggested the theory that microalgae aid in the bioaccumulation of heavy metals in 1957, however Oswald 1988 and Doshi et al., 2007 are the most recent studies to address this issue. In many

affluent nations throughout the world, heavy metal poisoning of agricultural soils has become a major problem for crop productivity and human health. There are now several methods for removing heavy metals from contaminated water, such as chemical precipitation, phycoremediation, ion-exchange, reverse osmosis, electro dialysis, and ultra filtration.

Table 1 indicates the one-established capacity of algae to absorb various organic and inorganic contaminants from water, including heavy metals, sewage, waste, oil, and industrial effluents.

Table 1. Algae Participate in Wastewater's Bioremediation of Various Pollutants

Pollutant	Algae use bioremediation	Summary of Result	Reference
Acidity, Alkalinity, Hardness, TDS, TSS, TS, Dissolved Oxygen (DO), Chemical Oxygen Demand (COD) and Biological Oxygen Demand (BOD).	Spirulina maxima	BOD and COD levels were reduced. pH of the water in both the cases is slightly shifted from acidic to alkaline or from alkaline to little more alkaline by addition of Spirulina maxima.	Prabha Y et al, 2016
Zinc, Nickel Biological oxygen demand (BOD), and Chemical Oxygen Demand (COD)	Anabaena variabilis, Lyngbya majuscule, Nostoc muscorum, and Oscillatoria Salinas	Cyanobacteria are being extensively used in bioremediation because of its capability to degrade Pollutants in industrial effluents, waste water, andthey can also degrade hydrocarbons such as crude oiland its components from oil spills in ocean and soil.	Pawan k N B et al, 2016
BOD COD Phosphate EC TDS TSS	Spirulina platensis	The present study that the Spirulina platensis was cultivated on different concentration of dairy effluent yield better growth than control set and very efficient in COD/Phosphate/EC removal in all concentration.	Kulkarni et al, 2016
Al, Ni and Cu	Spirulina platensis and Chlorella vulgar	The present study proposes and optimizes a process for the removal of toxic metals (Ni, Al and Cu) from industrial wastewater	Almomani F, Bhosale R, 2021

pH, TDS, TSS, Phosphate, Nitrate, Chloride, Sulphate, BOD and COD	Spirulina platensis and Chlorella vulgar	metals using Spirulina platensis and Chlorella vulgaris algae strains.	Radwa T M 2021
Chromium (CR)	Chlorella vulgaris	Several analysis were conducted and results showed that parameters analyzed including pH, TDS, TSS, phosphate, nitrate, chloride, sulphate, BOD and COD had considerable reduction in their concentrations.	Dabai A I et al, 2024
Dissolved O2 Dissolved CO2 Nitrate, Sulphate, Phosphorus and COD	Synechococcus Sp, Cyanothece Sp, Nodularia Sp, Oscillatoria Sp	This study exploited the capability of Chlorella vulgaris for chromium bioremediation in synthetic tannery wastewater using a hybrid microalgae-activated sludge system.	Sheela T et al, 2022
Lead (Pb)	Phormidium sp. Monoraphidium sp. Uronema sp. Chlorella sp. Anacystis sp.	The results of bioremediation by Cyanobacteria Species, used to degrade or removing the contaminants from the water source, which are industrial effluents (Sugar mill wastewater).	Madusha Lakmali W.G.et al,2022
Chromium Lead(Pb)	Nostoclinkia	Chlorella sp. Monoraphidium sp., Phormidium sp. and Uronema sp. were further screened against 20-mg/L Pb(II) solutions for bioremediationPhormidium, Monoraphidium, and Uronema showed significantly higher Pb(II) removal abilities and survival levels than Chlorella and	Cepoi L et al, 2022

Mercury (Hg) Cadmium (Cd) Nickel (Ni)	Spirulina platensis	Anacystis	Diaconu M et al, 2023
		The ability to bioaccumulate Cr(VI) from the contaminated medium by cyanobacterium Nostoc linkia	
		The damage interaction between S.platensis and the studies metals was the highest in the case of Cd, moderate for nickel and the lowest for lead.	

II. CONCLUSION

These evaluations highlight the potential of algae to remove a variety of pollutants from wastewater, including organic and inorganic pollutants, oil effluents, and industrial waste. Algae are a promising source material with low cost and no secondary contamination for purifying waste water that contains heavy metals.

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