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Bioremediation of reactive blue textile dye using a filamentous cyanobacterial strain

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The continuous discharge of synthetic textile dyes into aquatic ecosystems presents significant environmental and public health challenges, necessitating the development of sustainable remediation approaches. This study investigated the dye-degradation capability of a filamentous cyanobacterium, strain P1, isolated from a freshwater environment in Sri Lanka. The organism's performance was evaluated under oligotrophic conditions using 10 ppm reactive blue dye solution, without supplemental nutrients. Over a 28-day incubation period at room temperature with 2000-3000 lux illumination, the 75.19% decolorization efficiency was observed, as measured by UV-Vis spectrophotometry at the λmax (616 nm) of the dye. Remarkably, this degradation occurred alongside, throughout substantial cyanobacterial growth, achieving 94.91% of maximum growth potential (OD680) and yielding an average biomass production of 50 mg/day. Phytotoxicity assessment using *Vigna radiata* (green gram) demonstrated significant detoxification, statistically analysed by one-way ANOVA, with treated samples showing mean root and shoot lengths of 8.47 cm and 7.10 cm respectively, comparable to control treatments. These findings suggest that P1 may possess robust metabolic pathways capable of simultaneously degrading complex dye molecules and sustaining growth under nutrient-limited conditions. The organism's ability to utilize the dye as a potential nutrient source while achieving effective decolorization highlights its potential for practical bioremediation applications. Notably, the absence of nutrient requirements simplifies potential scale-up processes and reduces treatment costs. The results indicate that P1 could serve as an efficient, eco-friendly solution for textile dye wastewater treatment, particularly in resource-limited settings. Its performance may be further enhanced in real wastewater conditions containing additional organic and inorganic compounds that could serve as supplementary nutrients. Future research should focus on optimizing degradation kinetics, examining enzyme systems involved, and testing the strain's efficacy against higher dye concentrations and mixed dye effluents to fully assess its practical applicability in industrial wastewater treatment systems.

Keywords: *Decolorization, detoxification, eco-friendly, phycoremediation, reactive dye.*