Microalgae as an Environmentally-friendly Bio-feedstock: Microbial Characterization to Augment Photosynthesis

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Mass microalgae cultures, desirable for a number of environmentally-friendly applications, remain constrained by cost. A new paradigm posits the construction of artificial consortia to confer external dependencies (e.g. nitrogen fixing) into biological functions. Light availability is a universal limiting factor to biomass productivity, uniquely well-suited for a biological framework. Engineering native microalgae-attached microbes to carry bioluminescence can eradicate self-shading cost-effectively if an optimal method of introduction is elucidated. This study characterized microalgae-adhered bacteria for 1) overlapping bacterial taxa; 2) ease of isolation; and 3) high-density microenvironments in diverse, alkaline algal strains. Microalgae-associated bacteria, isolated with sequential centrifugation, was analyzed by next-generation sequencing to identify adhered community makeup in commercial control Chlorella vulgaris and environmental isolate C. sorokiniana sp. Phylogenetic characterization identified taxa of the Proteobacteria phylum in both adhered bacterial communities. Bacteria-correlated aggregation was then analyzed over time in alkaline media as proof of concept of progressive, spatially-structured environments. High aggregate size and frequency was correlated to mixotrophy. Thus, broad-host range plasmids have promise for engineering heterologous bioluminescence expression in algal microbiomes, based on favorable association of Proteobacteria and characteristics for maintenance by transfer in the spatially structured microenvironment of microalgae-bacteria aggregates. This study identified BHR plasmids, previously only studied as antibiotic resistance-spreading vectors, as promising approaches for bioengineering in native microbial communities.

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