An algal-bacterial symbiotic system of carbon fixation using formate as a carbon source

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April 6, 2021

Abstract

Algae are an attractive option for CO2 sequestration due to their natural ability to simultaneously fix CO2 and accumulate algal biomass for value-added products. However, the commercial implementation of such technology for efficient capture of CO2 from fossil-derived flue gases is not a reality yet due to several major challenges, such as low gas-liquid mass transport efficiency and relatively high light irradiance demand of algal growth. This study explored an algal-bacterial symbiotic system to utilize formate, a potential intermediate liquid compound of CO2, as carbon source to support microbial growth. The algal-bacterial assemblage, after an adaptive evolution using the formate medium, demonstrated a new route to assimilate CO2 without using high pH cultivations and promote biomass production under low light irradiance condition. The formate based culture system not only resolves CO2 mass transfer limitation, but also expels algae grazers in non-sterilized cultivation conditions. Continuous cultivation of the assemblage on formate led to a carbon capture efficiency of 90% with biomass concentration of 0.92 g/L and biomass productivity of 0.31 g/L/day, which is significantly better than the control cultivation on saturated CO2. In addition, isotope tracing and microbial community analysis offer new insights into formate metabolism and algal-bacterial symbiosis under light and carbon conditions. This study demonstrates a promising route of using electrochemical-derived formate to support algal biorefining.

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