Comparison of mixotrophic to cyclic autotrophic/heterotrophic growth strategies to optimize productivity of Chlorella sorokiniana

In addition to providing cheap or free mineral nutrients, wastewaters may contain organic carbon compounds that could increase productivity of algal cultures. This study defined a strategy for the addition of organic carbon to photobioreactors in order to improve their productivity compared to autotrophic growth. Chlorella sorokiniana was cultivated in medium supplemented with sodium acetate in concentrations equivalent to the volatile fatty acid concentration found in anaerobic digester effluent. Flat-panel photobioreactors were operated using 16:8 light:dark cycles, with different strategies for acetate addition. Acetate was added during the light period for the mixotrophic strategy and during the dark one for the cyclic autotrophic/heterotrophic strategy. Autotrophic productivity of up to 0.99 g L⁻¹ day⁻¹ was obtained using the optimal tested dilution rate of 0.031 h⁻¹. The highest mixotrophic productivity was 1.04 g L⁻¹ day⁻¹. When a constant dilution rate was applied throughout the day, cyclic heterotrophy/autotrophy (1.2 g L⁻¹ day⁻¹) showed higher productivity than during mixotrophic growth, while using only half as much acetate. By diluting and adding acetate only during the eight dark hours, a maximal productivity of 1.6 g L⁻¹ day⁻¹ was obtained. Whenever acetate was added, lutein and chlorophyll content decreased, but overall lutein productivity increased. Carotene also increased during the cyclic treatment. These results show that dilution and carbon addition during the dark period resulted in an increased efficiency of the photobioreactor.

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