

From photosynthesis to wastewater treatment: exploitation of gas exchange of an integrated algal-bacteria consortium for bioremediation

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Freshwater is one of the greatest current and future global challenges, and there is the need to develop an efficient, cheap and green wastewater treatment process. The major issues of the current wastewater treatment processes are related to the energy consumption (e.g. for air supply) and to nutrient removal and recovery. In this work, an integrated microalgal-bacteria system to efficiently treat wastewater was investigated, with the aim to exploit the oxygen produced by photosynthesis to supply the aerobic removal of organic compounds by bacteria. On the other hand, the CO₂ produced by heterotrophs can be exploited by microalgae to efficiently uptake nitrogen and phosphorus. Batch experiments with *C. protothecoides* and activated sludge bacteria grown in real and synthetic wastewater were carried out in order to investigate their growth and their nutrient removal capacity under continuous light and under day/night cycle conditions.

Five conditions were studied in order to compare the growth of these microorganisms and their capacity of degrading pollutants when they are cultivated together, alone or with an external supply of O₂ and CO₂ as controls. When microalgal biomass is present, phosphorus and nitrogen are efficiently removed, but the organic carbon is close to the limit imposed by European laws for discharge in superficial water bodies. In addition, it was evidenced the capability of microalgae to perform mixotrophy by exploiting organic carbon. Thus, the reduction of oxygen production by photosynthesis when mixotrophy occurs was measured and further tests were performed to directly measure the evolution of dissolved oxygen concentration in the presence of microalgae and different carbon sources (organic and inorganic) under light and darkness cycles.

Experimental data allowed to draw some considerations and to implement a simplified model based on the stoichiometrical growth equations of microalgae and bacteria, in order to define the optimal ratio between the microorganisms, allowing to balance the oxygen demand/production and the carbon dioxide demand/production, and to estimate the residual nutrients concentrations in wastewater.