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Algal Biomass Production from Wastewater

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The aim of this study was to test methods for optimizing algal cultivation in photobioreactors and assess the prospects for sustainable production of algal biomass using effluent from an industrial scale biotech production facility.

Common methods for treating nutrient-rich wastewaters using bacteria, is a process associated with high costs and very little useful bi-products. Nutrients are metabolized and lost to the atmosphere as gasses. There would be great potential for a treatment process that allows for capturing and reuse of the valuable nutrients instead of letting them go to waste. Algal cultivation has long been known for high biomass yield per surface area compared to land grown crops, and has the advantage of not needing soil to grow. But algal biomass remains a niche product, mainly due to high capital cost of facilities and costs of operation, including fertilizers. The idea of combining wastewater treatment and algae production as well as the increasing global demand for fuels and food, have revived optimism about the prospects of producing sustainable algae products, including bio-fuels, animal feed and high value products, at competitive prices in the not so far future. Yet further research and development is needed to achieve this goal.

Lab experiments were carried out in flat panel (14mm) and pond simulating photobioreactors (PBR) with the microalgae C. Sorokiniana, grown on wastewater. The effect of wastewater (nutrient) concentration and light input intensity on the algal growth, as well as the efficiency of the algae to use these under different conditions, was tested in both batch and continuous cultivation experiments. A key parameter is the dilution rate, which during the continuous cultivation has a large effect on growth rate, culture density and thus productivity of the reactor. The dilution rate was optimized for both high and low light inputs by deceleration-stat experiments where the dilution rate was gradually decreased over the experiment. This method has earlier been proposed, but has never been applied to real wastewater cultivation.

Maximum productivity in the flat panel PBR's with a light input at full sunlight intensity (2100 μmol photons/m^2/s) was found to be 5 g/L/day or 70 g/m^2/day, comparable to some of the highest values for land grown crops. At 200 μmol photons/m^2/s, the maximum productivity was 1.6 g/L/day or 22.4g/m^2/day. The pond simulating PBR, demonstrated a maximum productivity of 0.2 g/L/day or 42 g/m^2/day with a light intensity of 2000 μmol photons/m^2/s. Yield of biomass per mol of photons was highest at low light intensities in the flat panel reactors with a maximum of 1.2 g/mol photons equivalent to that which has been demonstrated using optimized synthetic medium. Nutrient analysis indicate that phosphate could be a limiting factor, and thus that productivity could be further increased by adding phosphate to the wastewater.

The methods applied seem to be effective at optimizing and measuring important parameters for algal biomass cultivation, including dilution rate and produced data can be used as a useful tool in assessing the environmental and economic feasibility of large scale algae productions. Results show that the tested wastewater is well suited for algal cultivation, giving hope for the economic feasibility of commercial scale production.