MICROALGAE GROWTH IN PHOTOBIOREACTOR AS A TOOL FOR THE ATMOSFERIC CO_2 SEQUESTRATION

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Figure 1. Inoculum and 300 L C. sorokiniana *culture kept under semi-controlled conditions. Image: Lombardi AT, Algae Biotechnology Laboratory, Botany Department (UFSCar) (UFSCar)*

The increase of CO_2 and other greenhouse gases in the atmosphere has led to global warming problems of difficult solution. As a consequence, drastic climatic alterations have been observed. The development/application of new technologies for the mitigation of atmospheric CO_2 is a contribution to the generation of clean development mechanisms. A strategy being considered for atmospheric CO_2 mitigation relies on plant photosynthesis. Photosynthetic microbes, which have high surface/volume ratios present substantially high productivity, thus high CO_2 sequestration potential. Literature data show that biological CO_2 mitigation processes may counteract up to 20% of fossil fuel emissions by 2050. The present research aims the use of microalgae for atmospheric CO_2 mitigation, which is accomplished through algal photosynthetic process. This main goal is to produce microalgae biomass through cultivation in outdoor photobioreactor systems of 3.5 m^3 that should produce up to 3 to 5 kg day-1 dry algal biomass. Firstly, the microalgae will be cultivated in the laboratory, where growth conditions (pH, major and minor nutrients concentrations, and gas bubbling) will be defined as to obtain lower cost and high biomass prodcution (thus high CO_2 sequestration). Secondly, the laboratory defined conditions will be applied to continuous flow systems in laboratory based experiments and outdoor photobioreactor. CO_2 balance and microalgae biochemical composition will be determined and compared to those obtained in controled conditions. Water quality parameters: CO_2, pH and temperature will be determined. The final product of the photobioreactor (used culture media and microalgae cells) will be tested for agriculture use through lettuce (an ecological indicator) and native vegetation growth.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

The experimental results showed that LC Oligo (Afnor, 1980) culture medium (the cheapest) was the best for *Chlorella vulgaris* among all other media tested because it resulted in optimum algal growth, highest biomass production and chemical composition of *C. vulgaris* cells similar to more expensive culture media. Variation in phosphorus (P) concentrations showed that calorific value and chlorophyll a synthesis for *C. vulgaris* increased with the increase of P in the culture, varying from 14 (control) to 33 kJ g^{-1} (P deficient *C. vulgaris*). Introduction of a trace metal into the culture has taken to increase of triacylgicerol synthesis in *C. vulgaris*, with 26 times more lipid than the control. This same situation resulted in 14 times higher content of protein and 45 times the carbohydrates accumulated in *C. vulgaris* cells. This suggests that the use of industrial effluent can be a promising alternative for the manipulation of the biochemical composition of algal cells. In relation to potential uses of microalgae biomass for aquaculture, agriculture and energy, thermogravimetric and differential thermal analysis, zooplancton feeding, and seeds germination were also investigated. The results showed no inhibition of seeds germination and *Lactuca sativa* development using the effluent from microalgae culture, suggesting that the effluents of a large scale algae production system may be used in agriculture. Thermogravimetric analysis showed that healthy *C. vulgaris* cells presented three different stages of decomposition corresponding to humidity, volatile material and carbon, as well as ash. Two exotermic peaks (360 and 565 ºC), with entalpy values of 741 Jg_{-1} and 797 Jg_{-1} respectively were obtained. These results suggest that the algal material is a promising source of biofuel. Elemental analysis of *C. sorokiniana* has showed 6.9N : 41.3C : 6.4H : 2.7S. Scale up of the cultures from laboratory controlled 20L to 200 L hybrid photobioreactor in semi-controlled environment are being performed considering the biochemical manipulation of the cells. The next step is to test the biochemical manipulation in 1000L culture set up in the natural environment using similar photobioreactor design.

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