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# Biodiesel from microalgae *Chlorella protothecoides* growing at autotrophic and heterotrophic metabolisms in a new symbiotic bioreactor

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Abstract

Biodiesel is an alternative energy to fossil fuels, and is produced from biomass, therefore provides lower CO2 emissions.

Currently, biodiesel is produced from plant oils, animal fats and used oils. These sources are low-yield which is a limitation to the production of biodiesel in large quantities.

On the contrary, microalgae present a very high yield and can be produced in large amounts.

The bio-refinery of microalgae oil must have a strategy of taking advantage of all by-products to make the whole process economic feasible.

The bio-refinery proposed on this work is based on a first step to produce microalgae in a symbiotic bioreactor. The symbiotic bioreactor consists of an association of a fermenter and a photobioreactor connected by the gas phase on closed circuit. Two sorts of microalgae biomass are obtained: the heterotrophic microalgae from the fermenter and the autotrophic microalgae from the VAP (vertical alveolar panel photobioreactor).

The best strategy is to use the heterotrophic microalgae to extract the oil as it has a higher content in lipids, and, then to produce biodiesel; additionally carotenoids as lutein can be extracted along with lipids from the heterotrophic microalga as a High Value Product (HVP).

On the other hand, the autotrophic microalgae go to a second step of carotenoids accumulation, named carotenogenesis, to produce a biomass rich in carotenoids, also known as HVP. Carotenoids can be extracted and the residue of microalga, join to the other residues of microalgae to be processed by anaerobic digestion.

The heterotrophic microalgae residue after oil and lutein extraction can be submitted to anaerobic digestion to produce methane or hydrogen.

The case of microalga *Chlorella protothecoides* was studied, because it can grow under the two metabolisms referred above, and the lipids obtained are suitable to produce biodiesel.

The yields obtained are quite favourable to the symbiotic system, instead of the separated bioreactors.

The carbon dioxide emissions can be reduced by the autotrophic growth of microalgae.

The sustainability of the bio-refinery was ensured in order to achieve an economic feasible system.

**Reference**

[1] C. A. Santos, M. E. Ferreira, T. Lopes Da Silva, L. Gouveia, J. M. Novais, and A. Reis, "A symbiotic gas exchange between bioreactors enhances microalgal biomass and lipid productivities: taking advantage of complementary nutritional modes.," *Journal of industrial microbiology & biotechnology*, vol. 38, pp. 909–917, Sep. 2011.