Brewery wastewater treatment by the microalga *Parachlorella kessleri* using a 70L bubble-column photobioreactor

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Abstract

The wastewater generated by different industries has a high level of organic matter, which makes this a major environmental problem. If nitrogen, phosphorus and chemical-oxygen demand (COD) in wastewater could be recovered and converted by microorganisms into biofuels and valuable biocompounds, the waste would be used as a resource reducing the cost of wastewater treatment (Raposo *et al.*, 2010; Ling *et al.*, 2014).

Microalgae are usually efficient in removing nutrients (nitrogen and phosphorus) from wastewaters, while uptaking CO_2 and producing oxygen.

In this work, the growth of the green microalgae *Parachlorella kessleri* Pa-001 in primary and secondary effluent from a brewery industry in Lisbon, Portugal – Sociedade Central de Cervejas e Bebidas S.A. was studied.

The primary effluent (PE) is obtained with the removal of the largest particles and the removal of a fraction of the suspended solids and organic matter content in the raw wastewater. The secondary effluent is obtained by the removal of the biodegradable organic matter and the remaining suspended solids. The effluents were not sterilised, and contained bacteria. In fact, mixed cultures offer a number of advantages over pure cultures, since bacteria are able to use ammonia, converting it to nitrate, which would be eventually used by the microalgae. Also, bacteria produce CO_2 during metabolism, which is necessary for microalgae to carry out photosynthesis.

A 70 L bubble-column photobioreactor was used to grow the strain in batch mode, indoor, in the laboratory with a light intensity of approximately 3.5klux.

P. kessleri were more efficient in removing COD on the primary effluent compared to the secondary effluent (91.6% and 74% COD removal, respectively). The lipid content, measured as fatty acid methyl esters, was higher in the biomass collected at the end of the cultivation with secondary effluent but low in both cultivations (< 5% w/w), but the biomass collected from both cultures displayed high protein content (33.75 in primary effluent and 18.85 in secondary effluent % w/w).

This work shows a method to treat primary and secondary brewery effluent using microalgae and bacteria without any dilution, supplementation or pre-treatment. Moreover, because there was no sterilization of the effluent, the high removal rate of nutrients was obtained from a symbiotic relationship using the bacteria flora existing in the effluent. The significant amounts of protein produced by the microalgae can be used for animal feed. More work for optimizing the culture conditions to maximize biomass and fatty acid productivities for biodiesel production is in progress.

Image

Table 1 – Summary of experimental results.

	P. kessleri PE	*P. kessleri* SE
Maximum Dry Weight (g/L)	1,218299 (t=362h)	1,233114 (t=989h)
FAME Content (%) (final t)	3,30	4,53
Protein Content (%) (final t)	33,75	18,85
Final COD (mg/L)	334,7	113,6
Removed COD (%)	91,6	74
Final NH4+	2,8	0
Removed NH4+ (%)	89,6	100

Recent Publications

1 – Ana Paula Batista, Emílio Palomo López, **Carla Dias**, Teresa Lopes da Silva, Isabel Paula Marques (2017). "Wastes valorization from *Rhodosporidium toruloides* NCYC 921 production and biorefinery by anaerobic digestion", Bioresource Technology, *Bioresource Technology,* 226:108-117.

2 – **Dias C**, Silva C, Freitas C, Reis A, da Silva TL (2016) "Effect of Medium pH on *Rhodosporidium toruloides* NCYC 921 Carotenoid and Lipid Production Evaluated by Flow Cytometry", *Appl Biochem Biotechnol*, 179: 776-87.

3 – Alberto Reis, **Carla Dias,** João Caldeira, Marta Teles, Bruno Oliveira, Paula Cristina Passarinho, Teresa Lopes da Silva. Downstream processing towards a yeast biorefinery: biodiesel and fine carotenoids from *Rhodosporidium toruloides* NCYC 921. 12th Yeast Lipid Conference, Ghent, Belgium, 20-22 May 2015.

4 – **Dias C**, Sousa S, Caldeira J, Reis A, Lopes da Silva T (2015) "New dual-stage pH control fed-batch cultivation strategy for the improvement of lipids carotenoids production by the red yeast *Rhodosporidium toruloides* NCYC 921", *Bioresource Technology*, 189: 309-18.

5 – Herrero de Dios C, Román E, **Diez C**, Alonso-Monge R, Pla J (2012) "The transmembrane protein Opy2 mediates activation of the Cek1 MAP kinase in *Candida albicans*", *Fungal Genet Biol* 50: 21-32.



Biography

My name is Carla Dias and I have a master degree in Biochemistry from the University of Coimbra, Portugal. I have worked in several research groups in different areas. My involvement in different research projects and teams allowed me to expand my knowledge in different areas of development and research, gaining experience in diverse techniques and methodologies, which allowed me to obtain a strong multidisciplinary scientific training. Recently, I started my PhD in Biotechnology and Biosciences from Instituto Superior Técnico, in Lisbon, Portugal. The objective of my work is to develop a novel brewery waste biological symbiotic treatment system to generate biofuels and valuable bioproducts. This system will allow transforming the wastes from breweries, containing high COD, phosphorous and nitrogen levels, into valuable biomass and bioproducts, thus not only reducing the environmental impact of breweries activities, but also recovering nutrients contained in these wastes.

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Notes/Comments:

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