Bioresource Technology 184 (2015) 230–235

Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

Combining urban wastewater treatment with biohydrogen production – An integrated microalgae-based approach

Ana Paula Batista [a], Lucas Ambrosano [b], Sofia Graça [a], Catarina Sousa [a], Paula A.S.S. Marques [a], Belina Ribeiro [a], Elberis P. Botrel [b], Pedro Castro Neto [b], Luisa Gouveia [a,*]

[a] LNEG-Laboratório Nacional de Engenharia e Geologia, I.P. Unidade de Bioenergia, Estrada do Paço do Lumiar 22, 1649-038 Lisboa, Portugal
[b] Universidade Federal de Lavras, Programa de Pós-Graduação Fitotecnia/Agronomia, Lavras, Brazil

HIGHLIGHTS

- Efficient treatment of urban wastewater with microalgae.
- Energetic valorization of microalgae biomass.
- Production of biohydrogen through dark fermentation using *Enterobacter aerogenes*.
- Fermentation kinetics monitored and fitted to a modified Gompertz model.
- Highest bioH_2 production yield (56.8 mL H_2/g_{VS}) obtained for *Scenedesmus obliquus*.

ARTICLE INFO

Article history:
Received 22 August 2014
Received in revised form 12 October 2014
Accepted 13 October 2014
Available online 30 October 2014

Keywords:
Microalgae
Wastewater treatment
Biohydrogen
Dark fermentation

ABSTRACT

The aim of the present work was the simultaneous treatment of urban wastewater using microalgae and the energetic valorization of the obtained biomass. *Chlorella vulgaris* (*Cv*), *Scenedesmus obliquus* (*Sc*) and a naturally occurring algal *Consortium C* (*ConsC*) were grown in an urban wastewater. The nutrient removals were quite high and the treated water fits the legislation (PT Dec-Lei 236/98) in what concerns the parameters analysed (N, P, COD). After nutrient depletion the microalgae remained two more weeks in the photobioreactor (PBR) under nutritional stress conditions, to induce sugar accumulation (22–43%). The stressed biomass was converted into biohydrogen (bioH_2), a clean energy carrier, through dark fermentation by a strain of the bacteria *Enterobacter aerogenes*. The fermentation kinetics were monitored and fitted to a modified Gompertz model. The highest bioH_2 production yield was obtained for *S. obliquus* (56.8 mL H_2/g_{VS}) which was very similar when using the same algae grown in synthetic media.

1. Introduction

The modern societies have to face big challenges, such as food and energy supply, scarcity and security of water, and environment/climate protection.

The connection between these issues is very strong: (1) the food and energy (for heat, light, power and transportation) demand is estimated to double in the 2008–2035 period; (2) the annual global freshwater demand is expected to grow by about 10–12% per decade. Agriculture is by far the largest consumer of freshwater – about 70% of all freshwater withdrawals go to irrigated agriculture (Oilgae, 2014).

All these challenges and drawbacks of the society so far, must be supported by an (1) agriculture/algaeculture providing food and feed in a sustainable way using as less freshwater as it can be; (2) intensive wastewater treatment and/or desalination of brackish and salt water; (3) production, as much as possible, of bioenergy and biofuels using economically and environmentally more sustainable renewable energy sources. Avoiding the use of fossil fuels can also limit the global warming and climate change.

Microalgae biotechnology can contribute to solve these main key challenges.

The wastewater treatment using microalgae offers some interesting advantages over conventional methods, such as low energy requirement (no need of agitation to oxygenate) (Oswald, 2003), Green House Gas emission reduction (the entire system is carbon negative), reduction of sludge formation (no use of hazardous chemicals), lower costs and all in parallel with the production of useful algal biomass. The biomass produced by nutrient remediation from the wastewater is energy rich and can be further processed to make biofuels or other valuable products such as

* Corresponding author.
E-mail address: luisa.gouveia@lneg.pt (L. Gouveia).

http://dx.doi.org/10.1016/j.biortech.2014.10.064
0960-8524/