Bioresource Technology 104 (2012) 342–348

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

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

Pre-treatment optimization of *Scenedesmus obliquus* microalga for bioethanol production

J.R. Miranda, P.C. Passarinho, L. Gouveia *

Laboratório Nacional de Energia e Geologia (LNEG), Unidade de Bioenergia, Estrada do Paço do Lumiar 1649-038 Lisboa, Portugal

ARTICLE INFO

Article history:
Received 8 September 2011
Received in revised form 17 October 2011
Accepted 18 October 2011
Available online 25 October 2011

Keywords:
Scenedesmus obliquus
Microalga
Pre-treatment
Sugars
Bioethanol

ABSTRACT

The present work deals with the optimization of cellular disruption and sugar extraction from the microalgae *Scenedesmus obliquus* (Sc) for bioethanol production.

Among the physical and physicochemical methods tested, the best results were obtained with acid hydrolysis by H_2SO_4 (2 N), at 120 °C for 30 min and using dried biomass. The sugar extraction efficiency level reached was 95.6% when compared to the harsh quantitative acid hydrolysis. The influence of other parameters such as biomass loading and number of extraction cycles were also evaluated. The results obtained in the latter case showed that a unique hydrolysis step is sufficient.

1. Introduction

Research on fuels from algae in the last 20 years has illustrated the potential of this feedstock to be used for the conversion into liquid transportation energy. The increase in petroleum prices and concerns about energy dependency, security, and climate change, has led to an increased interest in the use of microalgal feedstocks for biofuel production. In the future, algal biofuels may become sustainable for generations to come – as they consume CO_2 as a nutrient, have a much higher yield potential than other terrestrial biomass feedstocks, can be grown in a wide variety of water sources (fresh, brackish, saline, and wastewater) without the need of using high-value arable land, are a non-food based feedstock, can be harvested daily and can produce both biofuels and valuable co-products.

However, despite their huge potential, the state of technology for producing algal biofuels is regarded by many in the field as still being in its infancy (Roadmap, 2008). There is a general consensus that a considerable amount of research, development, and experimentation is still to be carried out prior to algal biofuels being produced at a sufficient scale. Algal-based fuels should be produced in an environmentally and economically sustainable way to be cost-competitive with petroleum-based fuels.

While cellulosic biofuels present tremendous potential in the near future, these will be surpassed by biofuels from algae in the longer term (perhaps 10 years) (Roadmap, 2008).

Microalgae represent an exceptionally diverse but highly specialized group of microorganisms adapted to various ecological habitats which can live in harsh conditions due to their unicellular or simple multicellular structure (Li et al., 2008). The autotrophic algae use photosynthesis to harness energy in the form of sunlight and fix inorganic carbon from atmospheric CO_2 which is then assimilated in the form of reserve compounds such as oils, carbohydrates and protein. Other bioactive compounds such as pigments, antioxidants, polyunsaturated fatty acids, antiviral and antibacterial agents, amongst others, may also be present in the biomass (Parmer et al., 2011).

The production of bioethanol requires the extraction and saccharification of the carbohydrates to make them metabolizable by the microorganisms that will carry out the fermentation. Cell disruption is often required to recover the intracellular products of microalgae, such as oil and starch for biodiesel and ethanol production respectively, as well as added-value compounds (Brennan and Owende, 2010).

In order to disrupt the cell wall, various methods have been tested. After the disruption, the carbohydrates are released from the intracellular medium requiring further processing to obtain monosaccharides (Brennan and Owende, 2010). The physical methods could be high-pressure homogenizers, microwaves, bead beating, freezing, sonication, and autoclaving. The chemical lysis is a different approach to the biomass processing, where chemical agents acid or alkaline, must to be added (e.g. hydrochloric or sulfuric acid, sodium hydroxide) in order to hydrolyze the biomass into its constituent molecules (Molina Grima et al., 2004; Lee et al., 2010).

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

0960-8524/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biortech.2011.10.059