Scenedesmus obliquus: biogas production from residues of biodiesel/bioethanol extraction processes

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Abstract

Microalgae are a potential feedstock for the production of a variety of chemicals and energy carriers. These photosynthetic microorganisms can grow faster than terrestrial plants, and can be cultivated in non-arable lands under harsh climate conditions. Thus, they do not compete with food cultures, being considered as 3rd generation biofuel sources. *Scenedesmus obliquus* has already shown potential for bioethanol, biodiesel and bioH_2 production by our research team [1-4]. However, after sugar or oil extraction the algal biomass residues remaining account for up to 70% of the harvested biomass. This residual biomass could be digested (anaerobically) giving an additional energy output. Anaerobic digestion allows the valorization of all the remaining biomolecules (proteins, carbohydrates and lipids) through the production of an energy carrier gas (biogas) and a digestate for agricultural application, enhancing the feasibility of the process in an integrated biorefinery concept.

The aim of the present study was to evaluate the digestibility and the potential of biomethane production of *S. obliquus* microalga, considering different biomass substrates: i) untreated, ii) residual after sugar extraction with H_2SO_4; iii) residual after oil extraction with *n*-hexane. Batch experiments were conducted in encapsulated glass serum bottles at mesophilic conditions of temperature (37ºC), for 60 days. Microalgal biomass concentrations ranging from 2.5 to 10 g/L were digested using the anaerobic sludge from an urban waste-water treatment plant in Loures (Portugal) as *inoculum* 30% (v/v). The volume of biogas was measured daily with a pressure transducer (calibrated at STP conditions) and the biogas composition was determined by gas chromatography (GC-TCD). The liquid phase was analyzed in terms of pH, total solids (TS), Volatile Solids (VS), Chemical Oxygen Demand (COD), Kjeldhal Nitrogen, NH_3-N, Volatile Fatty Acids (VFA) at the beginning and end of the assays. The specific methane yield of 546 L CH_4/kg VS_{alga}, obtained from untreated biomass (2.5 g/L) digestion, was the highest value attained. However, the yield of 346 L CH_4/kg VS_{alga} was reached in the residual oil-extracted biomass. In both cases, the proportion of CH_4 in the produced biogas was always above 65%. For the experiments with residual sugar-extracted biomass an inhibition of the methanization process was observed, mainly due to H_2S formation (up to 2.2%) caused by the presence of residual sulfates from the acid hydrolysis. The results obtained showed that microalgal substrates can be valorized by anaerobic digestion, even after oil extraction for biodiesel production.

References [1] Miranda JR, Passarinho PC, Gouveia L. (2012). Pre-treatment optimization of *Scenedesmus obliquus* microalga for bioethanol production. Bioresource Technology, 104, 342-348. [2] Miranda JR, Passarinho PC, Gouveia L. (2012). Bioethanol production from *Scenedesmus obliquus* sugars: the influence of photobioreactors and culture conditions on biomass production. Applied Microbiology and Biotechnology, 96, 555-64. [3] Gouveia L, Oliveira AC. (2009). Microalgae as a raw material for biofuels production. Journal of Industrial Microbiology and Biotechnology, 36, 269-274. [4] Batista AP, Moura P, Marques PASS, Ortigueira J, Alves L, Gouveia L. (2014). *Scenedesmus obliquus* as feedstock for biohydrogen production by *Enterobacter aerogenes* and *Clostridium butyricum*. Fuel, 117, 537-543.