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Biohydrogen Fermantative Production: Energetic Valorization of Microalgae Biomass

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Abstract

Renewable, sustainable and carbon-neutral energy production is needed to deal with the challenges of growing energy demand and climate change. Hydrogen (H_2) is most promising in the succession of fuel evolution, with several technical, socio-economic and environmental benefits to its credit [1]. It is an excellent energy carrier as it has the highest energy content per unit weight/mass of any known fuel (142 kJ/g) and upon oxidation produces only water [1]. H_2 is being explored for use in combustion engines and fuel-cell electric vehicles, and it is expected that H_2 demand increases significantly in the near and long term [2].

Biological hydrogen production processes are found to be more environmentally friendly and less energy intensive as compared to thermochemical and electrochemical processes [1]. In dark fermentation, carbohydrate-rich substrates can be used to produce bioH_2 in a process mediated by hydrogenase enzymes of anaerobic microorganisms. Moreover, residues and byproducts from agricultural and food industries or wastewaters can be used, providing inexpensive energy generation with simultaneous waste treatment [3]. Recently, there has been an increasing interest on using microalgal biomass for biofuels production. Besides oil extraction for biodiesel purposes [4] or sugar extraction for bioethanol production [5-6], microalgal biomass can also be fermented into bioH_2.

In this work, Scenedesmus obliquus biomass was used as feedstock for biohydrogen production by Enterobacter aerogenes and Clostridium butyricum. The concentration of microalgal biomass used as fermentation substrate was optimized for each microorganism: 2.5 g/L for E. aerogenes and 50 g/L for C. butyricum. The values of hydrogen production by using "wet" (75% moisture) and dried (oven, 80°C) microalgal biomass were compared, as the suppression of an intermediate biomass drying step is economically advantageous. The highest H_2 yield (113.1 mL/g alga$_{AFDW}$) was attained by C. butyricum with dried microalgal biomass. Hydrogen production by E. aerogenes was clearly improved by using S. obliquus wet biomass, generating an H_2 yield of 72.3 mL/g alga$_{AFDW}$.

Keywords: *Scenedesmus obliquus; dark fermentation; Enterobacter aerogenes; Clostridium butyricum*

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