Enhanced microalgal growth and hydrogen generation by addition of iron-based nanoparticles

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Introduction

The generation of **hydrogen as a by-product of waste effluent** treatment may not be far off in the future, just as methane is today. Biological processes that can lead to hydrogen production from an organic-rich waste stream are well known.

However, the major handicap to be overcome in all cases is that the efficiency and cost of these processes still need to be improved in order to achieve their large-scale implementation. This is why research is needed to make these processes economically viable and their integration into the energy system a reality.

Biohydrogen generation from microalgae has been reported as a highly attractive approach that can achieve carbon neutrality and bioenergy sustainability by producing a benign clean energy carrier. Microalgae fix CO_2 and produce H_2 naturally by biophotolysis. *Chlorella sp*., *Scenedesmus sp*. and *Chlamydomonas sp*. have been reported to be very versatile algae because are able to produce H_2 through direct or indirect photolysis mechanisms.

Materials & Methods / Results & Discussion

The present work, developed in the frame of the **H24NEWAGE** project, proposes a novel hybrid biological H_2 generation approach which consists of an integrated microalgae-based H_2 production process, using a microalgae mix-culture growing in natural media, that includes *Chlorella sp*. and *Scenedesmus sp*. among other species (Figure 1), and using low toxicity wastewater as carbon and nutrients source, which will provide a possible avenue for commercialisation in the near future.

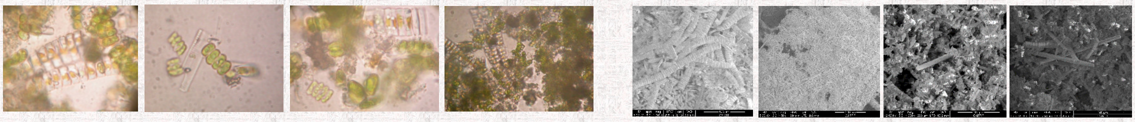

Figure 1: Microalgae mix-culture growing in natural media: Optical Microscopy (right) and Scanning Electron Microscopy (left) analysis.

Three advanced approaches have been designed to be jointly implemented (Figure 2):

1) microalgae-bacteria consortia as a strategy to advance H_2 production;

2) electro-bio-hydrogenation as a new method for algal biohydrogen; and

3) Fe^0 nanoparticles addition for increasing enzyme stability and hydrolytic efficiency.

Furthermore, the integration of these three approaches for the improvement of bio-H2 production and its economic feasibility will be evaluated.

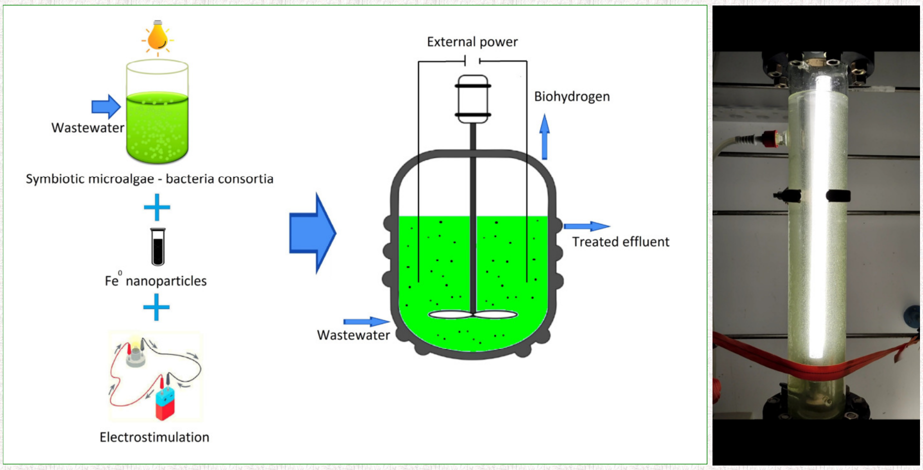

Figure 2: Hybrid biological H_2 generation approach (right) and lab set-up for experimentation (left).

Conclusions and next steps

Preliminary tests on a laboratory scale show that consortia of microalgae grown in natural media can be used as inoculum in bioreactors for hydrogen production. These microalgae are usually naturally adapted to adverse environmental conditions and therefore allow more robust processes. Working with natural microalgae-bacteria consortia may be the best strategy from an economic point of view when working with wastewater streams, as it avoids the need to work under sterile conditions to avoid contamination.

Previous works have illustrated that biohydrogen generation can be dramatically enhanced with the presence of metal nanoparticles, considering they may improve the bioactivity of hydrogenase and ferredoxin oxidoreductase as well as electron transfer. On the other hand, previous studies have also indicated that the yield and efficiency of biohydrogen could be improved with the participation of electricity when working with microalgae. Next steps in this research will try to combine both strategies with the already tested use of natural microalgae-bacteria consortia to maximize bio-H2 production.

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