**Hydrogen production in a pressurized photobioreactor: phototrophic bacterium *Rhodobacter capsulatus***

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**Highlights**

* Biohydrogen production
* photo-fermentation, *Rhodobacter capsulatus*,
* Wastewater valorization
* Partial changing pathway from growth into survival for Rhodobacter capsulatus

**1. Introduction**

Energy consumption from fossil feed-stocks increases with human growth and economic growth of emerging countries and lead to the CO2 formation and consequently to climate changing [1]. Therefore, the large-scale transition from fossil fuel to hydrogen fuel and renewable hydrogen technology can substantially improve air quality and reduce climate change [2]. Biological energy such as photobiohydrogen exhibits a positive global warming potential, low acidification potential, relevant social cost of carbon and a low potential production cost [3]. To make economically possible the use of biohydrogen as energetic vector, high purity of produced hydrogen shall be reached using a pressurized tank process to gas storage. Therefore, the main disadvantage of hydrogen is the difficulty of inexpensive easy storing and dispensing of the hydrogen gas. Direct compression of biohydrogen is a benefit to reach the widespread commercial applications. In the present work, hydrogen production process was achieved on anaerobic photosynthesis using the purple non-sulphur bacterium *Rhodobacter capsulatus*. The bacterial culture was carried out in a photo-bioreactor operated in a closed vessel or opened vessel, using lactate as a carbon source and LED illumination is provided. In previous work [4], we have observed when the gas pressure increases with the bacterial growth (in closed vessel), the pressurized hydrogen production is improved (80%) versus atmospheric hydrogen production.

**3. Results and discussion**

In present work , we have exhibited the opportunity to obtain pressurized hydrogen close to 1o bar by photofermentation of lactate. We have observed an unexpected enhancement of bio- hydrogen production by the phototrophic bacterium *Rhodobacter capsulatus* in a pressurized photobioreactor: the amount of produced hydrogen from synthetic media (lactate (35 mmol L-1) glutamate (5mmol L-1)) under pressurized vessel is multiplied by 1.8 versus atmospheric vessel. Hydrogen purity has overcome 90 % with lactate conversion rate was up to 70 %. It is suspected that the energetic demand of *Rhodobacter capsulatus* increases during culture under pressurized condition and improves hydrogen production. We have observed that the addition of nitrogen sources can drive the lactate conversion rate. In our cultures, the partial changing pathway is possible from growth to survival; this mechanism could explain the lower growth in the closed vessel than in the open vessel. Therefore, during culture under pressurized conditions, stress appears, and this stress increases the energetic demand and improves hydrogen production. However, we do not know the nature of this stress, and we do not have a hypothesis regarding its origin.

**4. Conclusions**

The hydrogen production in closed vessel is multiply by 1.8 versus atmospheric opened vessel. Numerous advantages due to the high operating pressure can be itemized:

1. Self-compression of produced hydrogen
2. Easier control of fed bath or continuous operation
3. Lower risk of contamination
4. Easier storage

**References**

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