PHOTOHETEROTROPHIC PRODUCTION OF HYDROGEN USING DARK-FERMENTATION EFFLUENT AS SUBSTRATE

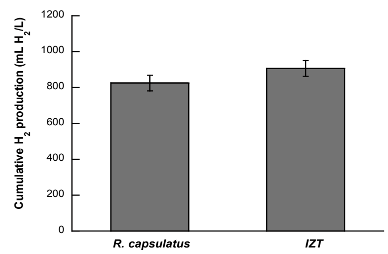
Virginia Montiel[1], Elvia I. García[2], Sergio Revah[3], Marcia Morales[3]
[1] Doctorado en Biotecnología, UAM-Iztapalapa, México, D.F., 09340.
[2] Departamento de Bioprocesos, UPIBI-IPN, México, D.F, 07340
[3]Departamento de Procesos y Tecnología. UAM-Cujimalpa, México D.F., 01120
Email: vmontielcorona@yahoo.com.mx, mmorales@correo.cua.uam.mx

Key words: Hydrogen, photoheterotrophic consortia, partial vacuum.

Introduction. Anaerobic processes offer a promising alternative for producing H_2 from renewable resources. However, during dark fermentation, the organic matter is not degraded completely and generates liquid effluents with organic acids that constitute a disposal problem. To globally increase the H_2 yields, these effluents can be converted to additional H_2 through photo-fermentation by purple non sulfur bacteria (PNSB) [1]. Nevertheless, most studies to H_2 production by PNSB are carried out in small scale, indoor, with pure cultures, sterile conditions, model substrates [2] and argon to promote anaerobic conditions [3] and reduce H_2 partial pressure. These unrealistic ideal conditions and the involved costs have precluded large-scale applications.
This work studies the effect of CO_2, Ar and partial vacuum in the headspace, indoor/outdoor conditions and a new photoheterotrophic consortium for H_2 production using a dark fermentation effluent.

Methods. A consortium (IZT) obtained from a wastewater treatment plant located in Mexico City or the pure strain *R. capsulatus* were inoculated in vials with 85 mL of diluted dark fermentation effluent (COD of 2.3 g/L). Photoheterotrophic H_2 production was assayed with CO_2, Ar, and partial vacuum, at indoor/outdoor conditions. These variables were tested in a 2x3x3 experimental factorial design. Experiments were carried out in batch, static incubation and non-sterile conditions. Indoor conditions: 3.5 klux, 30 °C. H_2 production, polyhydroxybutyrate (PHB) content, volatile fatty acids (VFA), COD and biomass concentration were quantified.

Results. Results showed that averaged cumulative H_2 production reached by *R. capsulatus* and IZT consortium were not significantly different from each other (see Fig. 1); both cultures grew to an averaged final concentration of 0.42 g of protein/L. However, flushing gases had a significant effect on the accumulated H_2: partial vacuum showed the highest value (1120 mL of H_2/L), followed by Ar and CO_2 with 813 and 862 mL of H_2/L, respectively (see Fig 1). Hydrogen yields in outdoors were 47% below values at controlled conditions. The greatest H_2 yield (1478 mL of H_2/L) was achieved using IZT with partial vacuum and indoor conditions. In outdoor conditions IZT achieved 883 mL of H_2/L and *R. capsulatus* 866 mL of H_2/L with partial vacuum. COD removal was higher with IZT consortium (90%) than with *R. capsulatus* (73%).



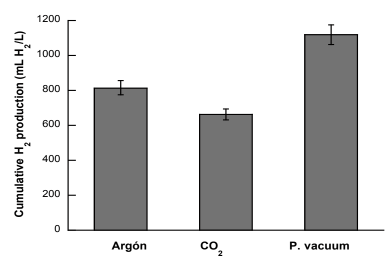


Fig.1 Averaged cumulative H_2 production by *R. capsulatus* and IZT (above) and (below) when employment Ar, CO_2 and partial vacuum.

Conclusions. This study suggests that the use of a photoheterotrophic consortium can be as productive as pure cultures and Ar could be replaced with partial vacuum. Both factors can contribute to reduce the costs for photoheterotrophic production of hydrogen. Besides, yields at ambient conditions are technically attractive considering the energy savings by using natural lighting as energy source.

References.

[1] Özgür E., Uyar B., Öztürk Y., *et al*. 2010. *Resour. Conserv. Recy.* (54) 310 – 314.
[2] Cai J., Wang G., Pan G. 2012. *Int. J. Hydrogen Energy.* (37) 4057-4067.
[3] Liu B.F., Ren N.Q., Ding J., *et al*. 2009. *Bioresource Technology*. (100) 1501–1504.