FERMENTATIVE HYDROGEN PRODUCTION, IMPLICATIONS OF HYDROGENOTROPHIC MICROORGANISMS

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Introduction. The fermentative hydrogen production using wastes such as cheese whey is a promising alternative energy to the fossil fuels (1). Nevertheless, hydrogen production in fixed biomass reactors can be undermined due to the hydrogen consumption by methanogenic and homoacetogenic microorganisms (2). The latter is the H_2 and CO_2 consumption to produce acetate. The relevance of the hydrogen consuming activities in continuous systems is not clear, mainly in fixed biomass reactors with long cellular retention time that favor the attachment and growth of hydrogenotrophic microorganisms.
The aim of the present work was to evaluate the hydrogen consumption specific activity in two fermentative fixed biomass reactors, an UASB and a packed-bed reactor, fed with cheese whey powder (CWP) solution.

Methods. The UASB reactor was inoculated with a heat treated hydrogen producing biomass which had presented methanogenic activity, whereas the packed-bed reactor was inoculated with a naturally fermented CWP. Both reactors were operated during 30 days at an organic loading rate (OLR) of 48 g COD/L-d, and a hydraulic retention time of 8 and 2 hours for the UASB and the packed-bed reactor, respectively. The specific hydrogenotrophic activity (SHA) was measured using biomass withdrawn from the reactors periodically (Table 1). The SHA tests were carried out in batch mode, flushing the headspace with a H_2:CO_2 mixture (2:1), and calculated according to the maximum hydrogen consumption rate and the biomass concentration, and expressed as mmol $H_{2\ consumed}$/g VS-d. The mineral medium, buffer solution and analytical techniques are described elsewhere (1).

Results. The packed-bed reactor presented a higher hydrogen production rate than the UASB reactor (Figure 1).

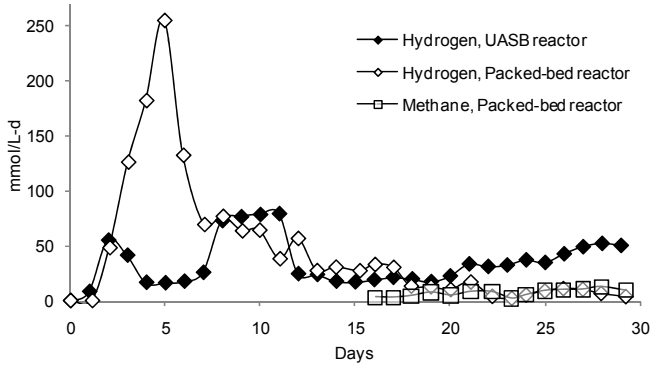

Figure 1. Hydrogen and methane production rates.

Nevertheless after day 16, methane started to be produced coincident to a drop in the hydrogen production. Even thought the low hydrogen production rate in the UASB reactor, it increased slightly at the last operation days, without methane occurrence (Figure 1).
The SHA results (Table 1), show an increase in the consuming hydrogen activity over the time in both reactors. A second feed in the batch assay of the SHA with H_2:CO_2 show that the homoacetogenic activity was replaced completely by the methanogenesis.

Table 1. Specific hydrogenotrophic activity (homoacetogenic or methanogenic) results from biomass withdrawn from the reactors.

UASB			Packed-bed		
Day	mmol H_2/g VS-d	Activity	Day	mmol H_2/g VS-d	Activity
Ino*	0		Ino*	3.76(0.53)	1
			6-15 (First)**	4.83(0.51)	1
15	0.99(0.2)***	1	6-15 (Second)**	6.28(0.79)	2
30	1.10(0.04)	1	20	6.53(0.49)	2
			30	6.59(2.82)	2

1, Homoacetogenic activity; 2, Methanogenic activity; *Ino, Inoculum; **Results corresponding to the first and the second H_2/CO_2 feed; ***(standard deviation, n=2).

The maximum yield obtained in the packed-bed reactor (2.55 mol H_2/mol lactose) and the hydrogen production rate were similar to previous reported results (1, 3). However, the UASB reactor presented a more stable hydrogen production rate and lower SHA.

Conclusions. The SHA by homoacetogenesis was as relevant as the methanogenesis, the latter replacing completely to the former. Nevertheless, the methane occurrence in the packed-bed reactor produced a less stable system compared to the UASB reactor. A study is needed to identify the homoacetogenesis control factors, in order to develop a sustainable hydrogen producing system.

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