Bioresource Technology 114 (2012) 484–491

Contents lists available at SciVerse ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech

# Assessment of the metabolic capacity and adaptability of aromatic hydrocarbon degrading strain *Pseudomonas putida* CSV86 in aerobic chemostat culture

Anshul Nigam [a], Prashant S. Phale [a], Pramod P. Wangikar [b,*]

[a] Department of Biosciences and Bioengineering, Indian Institute of Technology Bombay, Powai, Mumbai 400 076, India
[b] Department of Chemical Engineering, Indian Institute of Technology Bombay, Powai, Mumbai 400 076, India

ARTICLE INFO

*Article history:*
Received 29 October 2011
Received in revised form 2 March 2012
Accepted 2 March 2012
Available online 14 March 2012

*Keywords:*
*Pseudomonas putida* CSV86
Benzyl alcohol
Dilution rate
Oxygen uptake rate
Chemostat

ABSTRACT

*Pseudomonas putida* CSV86 utilizes aromatic compounds preferentially over sugars and co-metabolizes aromatics along with organic acids. In the present study, the metabolic capacity and adaptability of strain CSV86 were assessed in a chemostat at benzyl alcohol concentrations ranging from 1 g $l^{-1}$ to 3 g $l^{-1}$ and in the presence of glucose and succinate by systematically varying the dilution rate. Complete removal of benzyl alcohol was achieved for loadings up to 640 mg $l^{-1}$ $h^{-1}$ in presence of benzyl alcohol alone. The strain responded within 1 min towards step changes in substrate loading as indicated by an increase in the oxygen uptake rate, presumably as a result of excess metabolic capacity. These results suggest that CSV86 exhibits considerable metabolic elasticity upon increase in substrate load. Metabolic elasticity of the microorganism is an important parameter in wastewater treatment plants due to the changing substrate loads.

© 2012 Elsevier Ltd. All rights reserved.

## 1. Introduction

The presence of aromatic hydrocarbons in waste water poses a challenge since these compounds are not readily degraded in conventional activated sludge (Petrasek et al., 1983). Specialized microbes in consortia capable of degrading aromatics have been reported (Komukai-Nakamura et al., 1996; Ozaki et al., 2006). However, these microbes are subject to potential cellular toxicity and growth inhibition imparted by aromatic substrates, and may show a preference towards simple substrates such as sugars and organic acids over aromatics via catabolite repression (CCR) (Collier et al., 1996; Duetz et al., 1994; McFall et al., 1997; Muller et al., 1996). *Pseudomonas putida* CSV86 is known to consume naphthalene, salicylate and benzyl alcohol (Balc) preferentially over sugars and co-utilize them with organic acids (Basu et al., 2006).

Several studies have reported on the metabolic capacities of microorganisms, defined as the volumetric or specific substrate consumption rate. These include evaluation of metabolic capacity of *Bacillus subtilis* for the production of purine nucleosides, riboflavin and folic acid (Sauer et al., 1998) and studies on *Saccharomyces cerevisiae* for ethanol production (Van Hoek et al., 1998). However, such reports are scarce for microorganisms involved in bioremediation processes. Metabolic capacity is an important parameter in wastewater treatment plants involving microbial degradation of substrates under aerobic conditions because of mass transfer limitations of oxygen in hydrocarbon based bioprocess (Preusting et al., 1993). Although metabolic capacity has been reported in terms of degradation rates for aromatic degrading organisms, it is not clear as to whether the estimated values are under oxygen limiting conditions or not. For instance, Bi et al. (2004) have reported degradation of toluene in the presence of ethanol or Balc in chemostat cultures of *Pseudomonas putida* ATCC23973. In another study, Landa et al. (1994) demonstrated degradation of trichloroethylene in the presence of toluene using *Pseudomonas cepacia* G in a lab-scale bioreactor. Hence, investigations for estimating metabolic capacities of such microorganisms under non-limiting dissolved oxygen (DO) conditions are needed.

In the present study, the metabolic capacity of *P. putida* CSV86 was estimated in chemostat cultures where substrate (Balc) inhibition is significantly alleviated. Microorganisms are known to utilize both the preferred and less preferred substrates simultaneously at low dilution rate ($D$) and only the preferred substrate at high $D$ (Egli et al., 1982). Similar observations were expected for *P. putida* CSV86, further, the organism is expected to be more active at higher $D$ thereby affording a higher degradation rate.

Accordingly, the degradation rates of Balc alone or in the presence of other substrates known to cause CCR were systematically

* Corresponding author. Tel.: +91 22 25767232; fax: +91 22 25726895/+91 22 25723480.
*E-mail address:* wangikar@iitb.ac.in (P.P. Wangikar).

0960-8524/$ - see front matter © 2012 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.biortech.2012.03.007