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ORIGINAL PAPER

Biotransformation of iminodiacetonitrile to iminodiacetic acid by *Alcaligenes faecalis* cells immobilized in ACA-membrane liquid-core capsules

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Biotransformation of iminodiacetonitrile (IDAN) to iminodiacetic acid (IDA) was investigated with a newly isolated *Alcaligenes faecalis* ZJUTBX11 strain showing nitrilase activity in the immobilized form. To reduce the mass transfer resistance and to increase the toleration ability of the microorganisms to the toxic substrate as well as to enhance their ability to be reused, encapsulation of the whole cells in alginate–chitosan–alginate (ACA) membrane liquid-core capsules was attempted in the present study. The optimal pH and temperature for nitrilase activity of encapsulated *A. faecalis* ZJUTBX11 cells were 7.5 °C and 35 °C, respectively, which is consistent with free cells. Based on the Michaelis–Menten model, kinetic parameters of the conversion reaction with IDAN as the substrate were: K_m = (17.6 ± 0.3) mmol L^{-1} and V_{max} = (97.6 ± 1.2) μmol min^{-1} g^{-1} of dry cell mass for encapsulated cells and (16.8 ± 0.4) mmol L^{-1} and (108.0 ± 2.7) μmol min^{-1} g^{-1} of dry cell mass for free cells, respectively. After being recycled ten times, the whole cells encapsulated in ACA capsules still retained 90 % of the initial nitrilase activity while only 35 % were retained by free cells. Lab scale production of IDA using encapsulated cells in a bubble column reactor and a packed bed reactor were performed respectively.

Keywords: biotransformation, iminodiacetic acid, microencapsulation, *Alcaligenes faecalis*, nitrilase, bubble column reactor

Introduction

Nitrilases have recently attracted increasing attention and interest in the biochemistry fields owing to their ability of conducting nitrile hydrolysis at ambient conditions with high chemo-, regio- and enantioselectivity, which also meet the demand of green chemistry and environmental protection (Banerjee et al., 2002; O'Reilly & Turner, 2003; Huang & Xu, 2006; Martínková & Křen, 2010). A lot of microorganisms possessing high nitrile-converting enzyme activity were obtained from soil environment by employing the high-throughput screening methods (Sosedov et al., 2009; He et al., 2011; Xue et al., 2011; Zhang et al., 2011; Jin et al., 2013).

Iminodiacetic acid (IDA) is an important compound widely utilized as a key intermediate in fine chemical industry, especially in the production of glyphosate which has been a dominant herbicide all over the world for the past decade (Woodburn, 2000). Biotransformation of IDA from iminodiacetonitrile (IDAN) by nitrilase led to a promising technique with the potential to substitute the conventional process (He et al., 2011; Liu et al., 2011a, 2011b, 2012; Zhang et al., 2012, 2013). Regarding the future industrial applications, it is necessary to achieve a biocatalyst with high enzyme activity and to improve the re-

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