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Effect of surfactant-induced cell surface modifications on electron transport system and catechol 1,2-dioxygenase activities and phenanthrene biodegradation by *Citrobacter* sp. SA01

Feng Li [a,b,c], Lizhong Zhu [a,b,*]

[a] Department of Environmental Science, Zhejiang University, Hangzhou 310058, China
[b] Zhejiang Provincial Key Laboratory of Organic Pollution Process and Control, Hangzhou, Zhejiang 310058, China
[c] Zhejiang Yuying College, Hangzhou, Zhejiang 310018, China

HIGHLIGHTS

- ▶ Tween 80 and SDBS increased lipopolysaccharide (LPS) release from strain SA01 cells.
- ▶ LPS release increased cell surface hydrophobility (CSH) of strain SA01.
- ▶ The increased CSH enhanced the electron transport system activities of strain SA01.
- ▶ The increased CSH enhanced catechol 1,2-dioxygenase activities of strain SA01.
- ▶ The increased CSH enhanced phenanthrene biodegradation by strain SA01.

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ABSTRACT

In order to better understand how surfactants affect biodegradation of hydrophobic organic compounds (HOCs), Tween 80 and sodium dodecyl benzene sulfonate (SDBS), were selected to investigate effects on cell surface hydrophobicity (CSH), electron transport system (ETS) activities and phenanthrene biodegradation by *Citrobacter* sp. SA01. Tween 80 and SDBS increased CSH by 19.8–25.2%, ETS activities by 352.1–376.0 μmol/g min, catechol 1,2-dioxygenase (C12) activities by 50.8–52.7 U/L, and phenanthrene biodegradation by 8.9–17.2% separately in the presence of 50 mg/L of surfactants as compared to in their absence. Lipopolysaccharide (LPS) release was 334.7 μg/mg in the presence of both surfactants whereas in their absence only 8.6–44.4 μg/mg of LPS was released. Thus, enhanced LPS release probably increased ETS and C12 activities as well as phenanthrene biodegradation by increasing CSH. The results demonstrate that surfactant-enhanced CSH provides a simple, yet effective strategy for field applications of surfactant-enhanced bioremediation of HOCs.

1. Introduction

Surfactant-enhanced bioremediation (SEBR) has been considered as an effective remediation technique for soil contaminated with hydrophobic organic compounds (HOCs) such as polycyclic aromatic hydrocarbons (PAHs) (Randhir and Karl, 2003; Kim et al., 2001; Andreas, 1994). In general, surfactants can improve transfer of PAHs from the soil solid phase into the aqueous phase by increasing their solubility in micelles above the critical micelle concentration (CMC, Paria, 2008; Zhou and Zhu, 2007; Fuangswasdi et al., 2006; Zhu et al., 2003), and enhancing microbial cell surface hydrophobicity (CSH) for uptake of PAHs (Zhao et al., 2011; Kaczorek et al., 2008; Prabhu and Phale, 2003). However, studies also found negligible or even negative effects of surfactants on biodegradation of HOCs (Chen et al., 2001; Laha and Richard, 1991). The contradictory results may due to the decreased bioavailability of PAHs when sequestered in micelles (Li and Chen, 2009), inhibition of microbial attachment between soil and organic surface (Laha and Richard, 1991), and surfactant toxicity (González et al., 2011). The extent of enhancement or inhibition varied with the types of surfactants and microbes involved. The underlying mechanism has been suggested to be the interactions between either surfactants and PAHs or surfactants and microbes (Johnsen et al., 2005; Volkering et al., 1998). To date, most studies focused on the interactions between surfactants and PAHs, but studies have suggested that the effectiveness of surfactants in the biodegradation of HOCs involve

* Corresponding author at: Department of Environmental Science, Zhejiang University, Hangzhou 310058, China. Tel./fax: +86 571 88273733.
E-mail address: zlz@zju.edu.cn (L. Zhu).

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