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Ecological roles and release patterns of acylated homoserine lactones in *Pseudomonas* sp. HF-1 and their implications in bacterial bioaugmentation

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HIGHLIGHTS

- This is the first report of release pattern of autoinducers in *Pseudomonas* sp. HF-1.
- Detailed autoinducer-threshold for specific quorum sensing was studied in HF-1.
- The modulation of biofilm formation based on quorum sensing was reported.
- Regulation of quorum sensing will facilitate construction of bioaugmented system.

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ABSTRACT

To enable development of a better bacterial bioaugmentation system for tobacco wastewater treatment, the roles and release patterns of acylated homoserine lactones (AHLs) in *Pseudomonas* sp. HF-1 were evaluated. Swarming was found to be induced by *N*-hexanoyl-homoserine lactone (C_6-HSL) and *N*-3-oxo-hexanoyl-homoserine lactone (3-oxo-C_6-HSL); the formation of extracellular polymeric substances (EPS) was induced by 3-oxo-C_6-HSL, C_6-HSL and *N*-3-oxo-octanoyl-homoserine lactone (3-oxo-C_8-HSL); and biofilm formation was induced by C_6-HSL and 3-oxo-C_8-HSL. When the culture conditions were 25 °C, pH 5–6, 3% inoculum, 1.5 g L^{-1} nicotine and 1% NaCl, the amount of AHLs released was sufficient for quorum sensing of swarming and EPS formation for strain HF-1, which was beneficial to the startup stage during bioaugmentation. When strain HF-1 was cultured at pH 8 in the presence of 1.2–1.8 g L^{-1} of nicotine and 1% NaCl, the threshold for quorum sensing of biofilm formation was reached and the bioaugmentation system showed an efficient performance.

1. Introduction

Quorum sensing, which is cell–cell communication among bacteria, has recently become an area of intense research. This process is accomplished through the exchange of extracellular signaling molecules called auto-inducers to regulate gene expression, which allows bacterial populations to enhance the effectiveness of community cooperation. These processes include virulence factor expression, antibiotic production, biofilm development and horizontal gene transfer (Chen et al., 2002).

Bioaugmentation is a technique in which a functional gene, strain or microbial consortium is introduced into an indigenous bacterial population (Teng et al., 2010). This method has been proposed as an effective strategy for the removal of pollutants (Paynet et al., 2011). The technical core of bioaugmentation is colonization, which means maintaining persistent survival rates and activities of the introduced bacteria in the remediation system (El Fantroussi and Agathos, 2005). However, many factors including predation, competition and sorption hamper colonization. During the process of bioaugmentation, the inoculated bacteria can release auto-inducers to stimulate quorum sensing in the remediation system, which can modulate community cooperation to enable successful bacterial colonization. However, little research has been conducted to the influence of quorum sensing on bacterial bioaugmentation (Jiang et al., 2006; Paliwal et al., 2012).

In our previous study, the nicotine-degrading bacterium *Pseudomonas* sp. HF-1 was bioaugmented in a sequencing batch reactor to treat tobacco wastewater. The bioaugmentation system showed high efficiency, with 100% nicotine degradation and more than

Abbreviations: AHLs, acylated homoserine lactones; C_6-HSL, *N*-hexanoyl-homoserine lactone; EPS, extracellular polymeric substances; β-Gal, β-Galactosidase; HPLC, high-performance liquid chromatography; ISM, inorganic salt medium; LB, Luria–Bertani; 3-oxo- C_6-HSL, *N*-3-oxo-hexanoyl-homoserine lactone; 3-oxo-C_8-HSL, *N*-3-oxo-octanoyl-homoserine lactone; SDS, sodium dodecyl sulfate.

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