研究报告

卫昆,陈烁娜,尹华,叶锦韶,彭辉,刘则华.蜡状芽胞杆菌对芘的降解特性及降解酶研究[J].环境科学学报,2016,36(2):506-512

蜡状芽胞杆菌对芘的降解特性及降解酶研究

The biodegradation characteristics of Pyrene *Bacillus cereus* and its enzyme

关键词：芘 蜡状芽胞杆菌 生物降解 代谢产物 酶活 降解途径

基金项目：国家自然科学基金委-广东联合基金重点项目(No.U0933002);广东省自然科学基金重点项目(No.S2013020012808)

作 者 单位

卫 昆 华南理工大学环境与能源学院, 工业聚集区污染控制与生态修复教育部重点实验室, 广州 510006

陈烁娜 暨南大学环境学院, 广州 510632

尹 华 华南理工大学环境与能源学院, 工业聚集区污染控制与生态修复教育部重点实验室, 广州 510006

叶锦韶 暨南大学环境学院, 广州 510632

彭 辉 暨南大学化学系, 广州 510632

刘则华 华南理工大学环境与能源学院, 工业聚集区污染控制与生态修复教育部重点实验室, 广州 510006

摘要：考察蜡状芽胞杆菌(*Bacillus cereus*)对水体中芘的降解特性,分析其代谢产物和降解酶的活性.结果表明, 1 mg·L^{-1} Mn^{2+}、0.1 mg·L^{-1} Fe^{3+}和10 mg·L^{-1}葡萄糖混合物对芘的降解有明显促进作用; 1 g·L^{-1}菌体在120 h内对2.5 μmol·L^{-1}芘的降解率达到61.4%.利用LC-MS/MS分析芘代谢产物,检测到1-萘酚、2-萘酚、9-羟基菲和1-羟基芘4种单羟基多环芳烃,表明芘在单加氧酶作用下开环降解,且*B. cereus*能有效分解利用4种代谢产物,其最高利用率分别为100%、90.3%、98.3%和52.7%.酶活力分析实验结果表明, *B. cereus*具有的水杨酸羟化酶,邻苯二酚1,2-双加氧酶和邻苯二酚2,3-双加氧酶在芘的降解中起关键作用,其酶活力经芘诱导后均有明显提高.结合产物分析及酶活测定,推断*B. cereus*对芘的降解途径以及降解过程是由单加氧酶和双加氧酶联合起作用.

Abstract: The characteristics and metabolites of pyrene degradation in water by *Bacillus cereus* and its enzyme activity were studied. The results show that pyrene degradation was promoted when mixing with Mn^{2+}, Fe^{3+} and glucose at the concentrations of 1 mg·L^{-1}, 0.1 mg·L^{-1} and 10 mg·L^{-1}, respectively. Within 120 hours, the degradation rate of 2.5 μmol·L^{-1} pyrene by 1 g·L^{-1} biomass was 61.4%. Four hydroxyl metabolites of pyrene, namely 1-naphthol, 2-naphthol, 9-phenanthrol and 1-pyrenol were detected by using LC-MS/MS, which suggestes that the ring-cleavage of pyrene was initiated by monooxygenase, and these four hydroxyl metabolites were utilized by *B. cereus* effectively. The utilization rates of theses metabolites were 100%, 90.3%, 98.3% and 52.7%, respectively. The results of enzyme activities analysis show that salicylate hydroxylase, catechol 1,2-dioxygenase and catechol 2,3-dioxygenase of *B. cereus* played a key role in degradation of pyrene, and the enzyme activities were obviously enhanced after pyrene treatment. Based on the product analysis and enzymatic determination, it was speculated that the degradation pathway of pyrene by *B. cereus* was due to the combined effects of monooxygenase and dioxygenase system.

Key words: pyrene *Bacillus cereus* biodegradation metabolite enzyme activity degradation pathway