环境科学学报
ACTA SCIENTIAE CIRCUMSTANTIAE

蒋晓军,肖文丰,鲁莉萍,张杭君.环境因子对脱氯功能念珠藻*Nostoc* PD-2降解多氯联苯过程中基因表达的影响[J].环境科学学报,2014,34(9):2447-2454

环境因子对脱氯功能念珠藻*Nostoc* PD-2降解多氯联苯过程中基因表达的影响

Effects of environmental factors on expression of genes in *Nostoc* PD-2 during polychlorinated biphenyl-degradation process

关键词：多氯联苯 *Nostoc* 双加氧酶 细胞色素b_6f复合体铁硫蛋白

基金项目：国家自然科学基金面上项目（No.21077030）；杭州师范大学优秀中青年教师支持计划（No. JTAS2011-01-012）；杭州市‘131’人才计划支持项目；杭州师范大学学生科研立项项目（No.1283XXM09）；杭州师范大学本科生创新能力提升工程立项项目（No. CX2013078）

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摘要：以分离筛选自多氯联苯污染水稻田中的脱氯功能蓝藻*Nostoc* PD-2为材料，两种典型的三氯代多氯联苯PCB28和PCB30为目标污染物，在不同的氮源、碳源和培养温度条件下，研究了脱氯功能藻种*Nostoc* PD-2中双加氧酶基因和细胞色素b_6f复合体铁硫蛋白基因的表达情况及两种基因对脱氯作用的影响.结果显示，以硝酸钠作为氮源时，与氮气氮源组相比，PCB28和PCB30降解组中的两种基因均显著上调表达，双加氧酶基因的上调倍数分别为1.9和5.7倍，铁硫蛋白基因的上调倍数分别为1.1和1.7倍；添加碳酸钠时，与对照相比，双加氧酶基因最高上调了2.2倍，铁硫蛋白基因最高上调了3.4倍；提高温度对双加氧酶基因和铁硫蛋白基因的表达均有促进作用.相较于铁硫蛋白，双加氧酶基因相对表达量与PCB28和PCB30的脱氯百分比之间的相关系数分别为0.872和0.832，表明双加氧酶基因活性与功能藻种PD-2脱氯降解PCBs的相关性更高.本研究结果表明，不同环境因子可引起脱氯功能藻种*Nostoc* PD-2降解PCBs过程中双加氧酶基因和铁硫蛋白基因的差异表达，添加碳源对降解效果的促进作用最明显，脱氯功能藻种在工程应用中采用优化的环境条件有利于提高降解效率.

Abstract: Cyanbacterium *Nostoc* PD-2 isolated from polychlorinated biphenyl (PCB)-contaminated paddy soils was used to biodegrade two kinds of typical trichlorodiphenyls (2,4,4'-trichlorobiphenyl and 2,4,6-trichlorobiphenyl). The expressions of dioxygenase genes and cytochrome b_6f complex Fe-S protein genes in *Nostoc* PD-2 during the PCB-degradation were determined under the conditions of different nitrogen sources, carbon sources, and cultural temperatures. In addition, the relationships between both genes expressions and PCB-dechloriantion efficiencies were also analyzed. Results showed that, the expressions of both genes in the sodium nitrate group were significantly up-regulated comparing to that in the nitrogen group. The up-expression folds of dioxygenase gene under the exposure of PCB28 group and PCB30 group were 1.9 and 5.7, respectively. While the up-expression folds of Fe-S protein gene were 1.1 and 1.7, respectively. Compared to the control group, the maximum up-regulated folds of dioxygenase gene and Fe-S protein gene in the sodium carbonate group were 2.2 and 3.4, respectively. Elevated temperature could facilitate the expressions of dioxygenase gene and cytochrome b_6f complex Fe-S protein gene. The expression of dioxygenas gene more significantly correlated with the dechlorination percentages of both PCB congeners than that of Fe-S protein gene. The correlation coefficients between dioxygenase gene expressions and the dechlorination percentages of both PCBs congeners were 0.872 and 0.832, respectively. Such findings can demonstrate a new insight to clarify the molecular mechanism of PCB-biodegradation by *Nostoc* PD-2. In addition, using sodium carbonate as carbon source can promote the efficiencies of PCB-dechlorination by *Nostoc* PD-2. Our study can provide the new application of cyanobacteria in bioremediation engineering.

Key words: polychlorinated biphenyls *Nostoc* dioxygenase cytochrome b_6f complex Fe-S protein

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