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GENE FOR DEGRADATION OF ORGANOMERCURIAL COMPOUNDS AND ITS APPLICATION TO BIOREMEDIATION OF MERCURY CONTAMINATION

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Abstract

Organomercury lyases (MerBs) are key enzymes in bacterial degradation and detoxification of organomercurial contaminants, and essential for bioremediation of environmental pollution caused by several types of organomercurials. MerBs are encoded by merB-genes in mer operons of environmental mercury-resistant bacteria. Each bacterial mer operon contains none to three merB genes. In this study, first, organomercury removal capabilities and specificities of Bacillus megaterium MB1, Bacillus megaterium MK64-1, Bacillus cereus RC607, Staphylococcus aureus RN23, and Pseudomonas sp. K-62 that are possessing merB gens were tested as wild-type organomercurial-resistant bacterial strains. Second, to investigate the substrates specificities of MerB enzymes, the different merB genes, i.e., merB1, merB2, and merB3 genes from B. megaterium MB1, merB1 and merB2 genes from Pseudomonas sp. K-62, and a merB gene from S. aureus RN23, were cloned into Escherichia coli with the mercuric ion reductase gene (merA) from B. cereus RC607 and the organomercury removal (volatilization) capabilities and specificities of the E. coli recombinants were investigated. Five chemical species of organomercurial compounds, i.e., methylmercury chloride (MMC), ethylmercury chloride (EMC), and phenylmercury acetate (PMA), thimerosal (TH) and p-chloromercuribenzoate (PCMB) were used as substrates for the removal by the wild-type mercury resistant bacterial isolates and the recombinant E. coli strains. The assay results showed that all Bacillus species used in the assay degraded and volatilized MMC, EMC, TH and PCMB rapidly, S. aureus RN23 volatilized MMC, EMC and TH but slightly volatilized PCMB, and Pseudomonas sp K-62 volatilized EMC, TH and PCMB but slightly volatilized MMC. MerBs cloning assay using E. coli strain showed that the merB1 gene from B. megaterium MB1 conferred the highest removal abilities against MMC, EMC, TH and PCMB, while the merB1 gene from Pseudomonas sp. K-62 conferred the highest removal ability against PMA. The recombinant E. coli strain that produced MerB1 protein of B. megaterium MB1 conferred the highest mercury volatilization abilities to MMC, EMC, and TH, while the recombinant strain that produced MerB3 protein of B. megaterium MB1 conferred the fastest mercury volatilization activity against PCMB. The recombinant strain that produced MerB2 protein of B. megaterium MB1 could slightly decompose EMC, TH, and PCMB but not MMC and PMA. These results suggested that there are organomercurial substrate specificities among these six MerB enzymes. The substrate specificities indicate importance of selection of the appropriate bacterial strains or merB genes to apply them in bioremediation engineering for cleaning up specific organomercurial pollution sites.