Microbiology 2007 vol.76 N6, pages 676-682

Hydride-mediated reduction of 2,4,6-trinitrotoluene by yeasts as the way to its deep degradation

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Abstract

Broad screening of microorganisms from natural and anthropogenic ecological niches has revealed strains Candida sp. AN-L15 and Geotrichum sp. AN-Z4 which transform, 2,4,6-trinitrotoluene (TNT) via alternative pathways (with the domination of hydride ion-mediated reduction of the aromatic ring) and produce relatively high amounts of nitrites. According to the spectrophotometry data, the hydride attack of TNT by Candida sp. AN-L15 and Geotrichum sp. AN-Z4 grown at pH 5.0-8.0 leads to the mono-and dihydride complexes of TNT (H --TNT and 2H--TNT, respectively) and to protonated forms of the latter. Analysis by HPLC, GC-mass spectrometry, and ion chromatography revealed the products of deep conversion of TNT. The growth of the yeast strains in a weakly acidic medium with TNT (440 μM) is accompanied by formation of 2,4-dinitrotoluene (2,4-DNT, up to 18.2 μM). Together with accumulation of nitrites (up to 76.0 μM, depending on pH of the medium), these findings demonstrate the capacity of both strains for TNT denitration. Formation of 2,4-DNT reflects the realization of one of the possible mechanisms of TNT ortho-nitro group elimination and switching over to the pathways of metabolism of dinitrotoluenes, which are much more easily biodegradable than TNT. Simultaneously with the dominating TNT hydride attack, the mechanism of 4-and 6-electron reduction of the nitro group also functions in Candida sp. AN-L15 and Geotrichum sp. AN-Z4. Realization of the studied mechanisms of TNT transformation under growth of Candida sp. AN-L15 on n-alkane is important for bioremediation in the cases of combined pollution by oil products and explosives. © 2007 Pleiades Publishing, Ltd.

http://dx.doi.org/10.1134/S0026261707060057

Keywords

2,4,6-trinitrotoluene, 2,4-dinitrotoluene, Hydride complexes, Nitrites, Yeast