

Phenothiazines as efficient redox mediators for dye-decolorization at neutral / alkaline pH by bacterial laccases

Lucy Coria-Oriundo¹, Fernando Battaglini¹, and Sonia Wirth²

¹Instituto de Química Física de los Materiales Medio Ambiente y Energía

²Universidad de Buenos Aires Facultad de Ciencias Exactas y Naturales

September 11, 2020

Abstract

Laccases are oxidoreductases with the outstanding ability to oxidize phenolic and non-phenolic substrates coupled to the reduction of O₂ to H₂O. Among them, bacterial enzymes are suitable biocatalysts for application in industrial processes under harsh conditions. However, to be active on high redox potential substrates, bacterial laccases requires of redox mediators: electron carriers between the laccase and other compounds not directly oxidizable by the enzyme. Here we demonstrate that β -(10-phenothiazyl)-propionic acid can be used as an efficient and low-cost redox mediator for decolorization of synthetic dyes by bacterial laccases. Using this laccase-mediator system, more than 80% of Indigo Carmine and Malachite Green decolorization was reached after 1 h or 2 h of incubation, respectively, both at pH 8 and in tap water (pH 6.8). Furthermore, more than 40% of Remazol Brilliant Blue R and 80% of Xylidine ponceau were decolorized after 5 h at pH 8 and 50°C. In addition, we showed this system supports at least 3 decoloration cycles without loss of activity, representing a promising biological process for cost-effective and environmentally friendly decolorization and degradation of synthetic dyes and for other industrial applications of laccases requiring neutral or alkaline pH.

Abstract

Laccases are oxidoreductases with the outstanding ability to oxidize phenolic and non-phenolic substrates coupled to the reduction of O₂ to H₂O. Among them, bacterial enzymes are suitable biocatalysts for application in industrial processes under harsh conditions. However, to be active on high redox potential substrates, bacterial laccases requires of redox mediators: electron carriers between the laccase and other compounds not directly oxidizable by the enzyme. Here we demonstrate that β -(10-phenothiazyl)-propionic acid can be used as an efficient and low-cost redox mediator for decolorization of synthetic dyes by bacterial laccases. Using this laccase-mediator system, more than 80% of Indigo Carmine and Malachite Green decolorization was reached after 1 h or 2 h of incubation, respectively, both at pH 8 and in tap water (pH 6.8). Furthermore, more than 40% of Remazol Brilliant Blue R and 80% of Xylidine ponceau were decolorized after 5 h at pH 8 and 50°C. In addition, we showed this system supports at least 3 decoloration cycles without loss of activity, representing a promising biological process for cost-effective and environmentally friendly decolorization and degradation of synthetic dyes and for other industrial applications of laccases requiring neutral or alkaline pH.