

Accepted Manuscript

Title: Photodynamic properties and photoinactivation of microorganisms mediated by 5,10,15,20-tetrakis(4-carboxyphenyl)porphyrin covalently linked to silica-coated magnetite nanoparticles

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PII: S1010-6030(17)30142-9
DOI: <http://dx.doi.org/doi:10.1016/j.jphotochem.2017.06.039>
Reference: JPC 10718

To appear in: *Journal of Photochemistry and Photobiology A: Chemistry*

Received date: 3-2-2017
Revised date: 20-6-2017
Accepted date: 25-6-2017

Please cite this article as: Ana C.Scanone, Natalia S.Gsponer, M.Gabriela Alvarez, Edgardo N.Durantini, Photodynamic properties and photoinactivation of microorganisms mediated by 5,10,15,20-tetrakis(4-carboxyphenyl)porphyrin covalently linked to silica-coated magnetite nanoparticles, *Journal of Photochemistry and Photobiology A: Chemistry*<http://dx.doi.org/10.1016/j.jphotochem.2017.06.039>

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Photodynamic properties and photoinactivation of microorganisms mediated by 5,10,15,20-tetrakis(4-carboxyphenyl)porphyrin covalently linked to silica-coated magnetite nanoparticles

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Highlights Porphyrin was covalently linked to silica-coated magnetite nanoparticles.

- Singlet molecular oxygen was produced in water.
- Nanoparticles sensitized the photooxidation of L-tryptophan in water.
- Photosensitized inactivation of microorganisms was induced by nanoparticles.
- Nanoparticles were still efficient after three cycles of photoinactivation.

Abstract

Magnetic nanoparticles of Fe_3O_4 (MNP) were synthesized by co-precipitating Fe^{2+} and Fe^{3+} ions in an ammonia solution. This MNP was coated with silica using sodium metasilicate to obtain silica-coated MNP (MNPSi). Grafting of aminopropyl groups on MNP or MNPSi was performed with (3-aminopropyl)trimethoxysilane to form MNPNH_2 or MNPSiNH_2 , respectively. 5,10,15,20-Tetrakis(4-carboxyphenyl)porphyrin (TCPP) was covalently bound onto the MNPNH_2 or MNPSiNH_2 via carbodiimide activation to obtain MNPNH-TPCC or MNPSiNH-TPCC , respectively. These MNP presented an average diameter of about 15 nm. UV-visible absorption spectra presented the characteristic Soret and Q bands of TCPP covalently linked to the nanoparticles. The MNP containing TCPP produced a high photodecomposition of 2,2-(anthracene-9,10-diyl)bis(methylmalonate), which was used to detect singlet molecular oxygen $\text{O}_2(^1\Delta_g)$ production in water. Moreover, these nanoparticles sensitized the photooxidation of L-tryptophan in water, mainly mediated by a type II photoprocess. Photoinactivation of microorganisms was investigated in

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