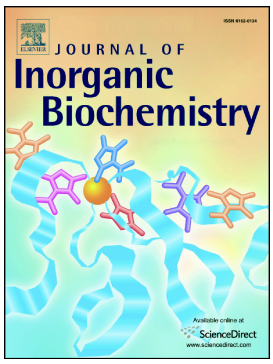

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Photo-antimicrobial efficacy of zinc complexes of porphyrin and phthalocyanine activated by inexpensive consumer LED lamp.

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Abstract

The properties and antimicrobial efficacies of zinc complexes of tetrakis(N-methylpyridinium-4-yl) tetraiodide porphyrin and tetrakis(N-methylpyridinium-4-yl) tetraiodide phthalocyanine impregnated to paper were evaluated. Photo-inactivation of microbes using inexpensive consumer light-emitting diode lamp was assessed on surface of dyed papers. Antimicrobial experiments of phthalocyanine-dyed paper by live cell assessment through colony forming units counting demonstrated 3.72 and 4.01 log reduction against *Escherichia coli* (*E. coli*) and *Acinetobacter baylyi* (*A. baylyi*) respectively after 1 h of illumination with 35 mW/cm^2 light. The porphyrin-dyed paper exhibited 1.66 and 2.01 log reduction in colony forming units against *E. coli* and *A. baylyi* respectively after 1 h exposure with 4 mW/cm^2 light. Both dyed papers were photo-stable after 64 h of continuous exposure with 42 mW/cm^2 light, while phthalocyanine-dyed paper exhibited superior leaching stability in phosphate-buffered saline.

1. Introduction

Light-activated antimicrobial substances are gaining new momentum and attract more and more attention of researchers. State of the art is covered in a recent series of excellent reviews, which demonstrate that significant success has been achieved in photodynamic treatment of bacteria [1–4], fungi [4–7], and biofilms [8]. Considerable application field is dentistry and treatment of carious infections in particular [9][10]. Applicability of Photodynamic antimicrobial chemotherapy (PACT) is not limited with the above-mentioned examples [4,11,12], but extends from fish farming [13] to blood sterilization [14].

Most commonly, the derivatives of phenothiazine, porphyrin and phthalocyanine are used as photosensitizers for PACT [15]. Regarding the latter two, porphyrinoid ligand is usually employed to chelate an inorganic ion, which improves dramatically the efficiency of photodynamic action. The choice between porphyrin and phthalocyanine ligand is a matter of debate, with both macrocycles having their advantages. However, it is commonly accepted that the ligand should bear cationic species, preferably quaternized amino groups, which renders the molecule much more active against microorganisms compare to neutral or anionic substances [16]. Among the most popular, zinc(II) ions [1,17–26] along with silicon [27–29] and aluminium [9] complexes have demonstrated best efficacies.

Photosensitizers are mostly used in form of solutions against planktonic microbes or biofilms. Examples of photoactive surfaces with chromophores immobilized on solid a support are however quite rare [30]. Immobilization requires significant synthetic efforts since both the substrate and the chromophore should be modified to create a covalent link between them. This in turn requires synthesis of asymmetric porphyrinoids, which is laborious and proceeds with lower yields. Indeed, there are very good examples of substances with

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