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Photodynamic inactivation of microorganisms in waste water: An effective approach with low environmental impact

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Abstract

Waste water (WW) with a high content of pathogens, containing even multidrug resistant microorganisms, particularly when hospital effluents are included, is a current area of concern affecting the quality of natural water. Hospital WW effluents are discharged as conventional urban effluents to the municipal sewage system without prior treatment. Secondary treatment of WW is usually considered sufficient; however, the secondary effluent still contains infective concentrations of microorganisms (MO). In order to reduce the concentration of pathogens in WW to levels comparable to those found in natural water, the tertiary effluent is usually subjected to disinfection with chlorine, ozone or ultraviolet light (UV). Chlorination and UV may lead to the formation of toxic products and also might result to the selection of resistant genes. The antimicrobial photodynamic inactivation (PDI) may represent an alternative to the traditional expensive, unsafe and not always effective disinfection methods. PDI with photosensitizers (PS) and visible light has demonstrated to be effective in the destruction of MO via photogeneration of reactive oxygen species (ROS) able to induce microbial inactivation. As PDI is a multi-target approach, the selection of photo-resistant strains after treatment is unlikely.

The main goal of this work was to assess the efficiency of PDI on non-clinical and on clinical multidrug-resistant (MDR) bacteria in domestic and hospital waste water in order to evaluate its potential use to treat WW effluents.
The efficiency of PDI was assessed using a cationic porphyrin as photosensitizer (PS), non-clinical bacteria and clinical MDR-bacteria either in phosphate buffered saline or in filtrated domestic and hospital waste water. The synergistic effect of PDI and antibiotics (ampicillin and chloramphenicol) was also evaluated. The results show an efficient inactivation of non-clinical and MDR bacteria in PBS (reduction of 6-8 log after 270 min). In waste water, the inactivation of bacteria was also efficient and the decrease in bacterial survival starts even sooner. A faster decrease in bacterial survival occurred when PDI was combined with the addition of antibiotics. It can be concluded that PDI has potential to be an effective alternative for the inactivation of bacteria, even MDR; in waste waters and that the presence of antibiotics in hospital WW may enhance its effectiveness.

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