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Comparative study of some nano- and micro - sensitizers in photodynamic inactivation of microorganisms

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The development of new virus inactivation procedures became an area of growing interest mainly due to increased demands concerning the safety of biological products. Photochemical processes represent the most promising methods for the future to inactivate viruses. In these methods, dyes are the most widely used photosensitising reagents. The current article covers a new interesting compound microsensitizer as 5,10,15,20-tetra-sulfonato-phenyl porphyrin (TSPP), and nanosensitizers, as fullerenes (C_{60}) –coated TSPP suspension (C_{60}/TSPP). There was studied in this paper the photodynamic inactivation of herpes simplex virus type I (HSV-1) provided from rat, by the above macro and nano-sensitizers. The concentration and temperature effects were evaluated. These sensitizers demonstrate a remarkable virucidal activity upon light activation, more pronounced for (C_{60}/TSPP) than for TSPP, and after an optimum time of 300 minutes.

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1. Introduction

Photodynamic inactivation represents a new antimicrobial method against different microorganisms. This method is based on the photosensitizing substances (photosensitizers) administration, which in preferentially localized in the cell and then it is excited by the optical radiation with the wavelength appropriate with the photosensitizer absorbance maximum. The excitation of the photosensitizers by optical radiation results in the production of cytotoxic species as singlet oxygen and free radicals. Due to the highly reactive nature of these species, they will lead to a certain biological effects resulting in the microorganism death by a selective action on the target cells.

Viral inactivation properties have been described for a wide variety of dyes such as phthalocyanines, merocyanines, porphyrin derivatives, hypericin and rose bengal, and methylene blue was tested, until now, for photodynamic inactivation of microorganisms as bacteria, fungi, yeast, virus and algae using a large variety of both coeherent and non-coeherent light sources [1-4]. Most of them present an inherent disadvantage regarding their poorly water solubility. They are hydrophobic and therefore difficult to administer as they are, and by intravenous injection, especially.

This issue calls for the use of advanced delivery systems and different strategies have been investigated, which mainly include polymer-photosensitiser conjugation as well as encapsulation of the photosensitiser in colloidal carriers such as liposomes, oil dispersions, and polymeric particles [5].

Recently, nanoparticles have received increasing attention as potential delivery systems for photodynamic therapy agents. Quantum dots offer several advantages as potential delivery systems for photosensitisers. The optical properties of this nanomaterial can be tuned to absorb and emit in the near-infrared region of the spectrum by changing their size and composition. Light of low intensity can be used to penetrate tissue several centimetres allowing the access to deep-seated tumours. Importantly, the surface coating of quantum dots can be functionalised to make them more water soluble and biocompatible [6], which facilitates systemic delivery.

Quantum dots can act as photosensitiser alone generating reactive singlet oxygen as well as promote the effect of classical photosensitisers linked to quantum dots (Fig. 1).

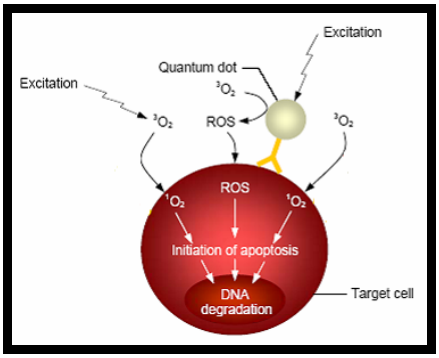

Fig. 1. Schematic illustration of possible mechanisms for quantum dot-induced photodynamic therapy.