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Abstract

Light-Driven Therapies: Antioxidant and Photodynamic Potential of Nanoemulsions †

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Introduction: Curcumin and annatto oil are rich in bioactive compounds with well-documented antioxidant and therapeutic properties; however, their applications are limited by their low solubility and potential toxicity in free forms. Nanotechnology offers an alternative to improve stability and reduce cytotoxic effects. This study evaluated the antioxidant potential of curcumin and annatto oil nanoemulsions and their application in photodynamic therapy (PDT) with blue LED light. Methodology: Nanoemulsions and free compounds were tested at different concentrations. Reactive oxygen species (ROS) generation was assessed through the 1,3-diphenyl-isobenzofuran (DBF) assay, while antioxidant activity was determined by DPPH and ABTS colorimetric methods. Cell viability assays were also used to evaluate human and murine fibroblasts to compare the effects of nanoemulsions with those of free compounds. Results: The nanoemulsions exhibited significant antioxidant activity, with higher efficiency than free curcumin and annatto oil. In addition, controlled ROS generation under blue LED irradiation was observed. Treatment with nanoemulsions also resulted in reduced cytotoxicity in human and murine fibroblasts compared to the higher toxicity of the free compounds. Conclusions: Curcumin and annatto oil nanoemulsions showed strong potential for photodynamic therapy, reducing cytotoxicity compared to free compounds and enabling controlled ROS generation while preserving antioxidant capacity. These findings reinforce the relevance of nanotechnology in developing safer and more effective therapeutic approaches.

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