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Synthesis, characterization, and evaluation of chloroaluminium phthalocyanine incorporated in poly(ε-caprolactone) nanoparticles for photodynamic therapy

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ABSTRACT

Background: The use of nanotechnology has been widely used in biomedical science, including orthopedic implants, tissue engineering, cancer therapy and drug elution from nanoparticle systems, such as poly-caprolactone (PCL) nanoparticles, which stand out mainly for their biocompatibility, being considered as effective carriers for photosensitizing drugs (PS) in photodynamic therapy (PDT) protocols.

Methods: This manuscript describes the synthesis and characterization of PCL nanoparticles for controlled release of the drug chloro-aluminum phthalocyanine (ClAlPc) as a photosensitizer for application in PDT. The PCL-ClAlPc nanoparticles were developed by the nanoprecipitation process. The structure and morphology of the nanoparticles were studied with scanning electron microscopy (SEM) and with Fourier transform infrared (FTIR). The size of nanomaterials was studied using the Dynamic Light Scattering (DLS) method. Photophysical and photochemical characterizations were performed. Subsequently, photobiological studies were also used to characterize the system.

Results: The nanoparticles had an average diameter of 384.7 ± 138.6 nm and a polydispersity index of 0.153. SEM analysis revealed that the system formed a spherical shape typical of these delivery systems. Charging efficiency was 82.1% ± 1.2%. The phthalocyanine-loaded PCL nanoparticles maintained their photophysical behavior after encapsulation. Cell viability was determined after the dark toxicity test, and it was possible to observe that there was no evidence of toxicity in the dark, for all concentrations tested. The assay also revealed that adenocarcinoma cells treated with free ClAlPc and in the nanoformulation showed 100% cell death when subjected to PDT protocols. The intracellular location of the photosensitizer indicated a high potential for accumulation in the cytoplasm and nucleus.

Conclusions: From the photophysical, photochemical and photobiological analyzes obtained, it was possible to observe that the development of PCL nanoparticles encapsulated with ClAlPc, by the nanoprecipitation method was adequate and that the *in vivo* release study is efficient to reduce the release rate and attenuate the burst of PS loaded on PCL nanoparticles. The results reinforce that the use of this system as drug delivery systems is useful in PDT protocols.

1. Introduction

Photodynamic therapy (PDT) is a treatment that combines light energy with a drug (photosensitizer) designed to destroy cancerous and precancerous cells after light activation. Photosensitizers (PS) are activated by a specific wavelength of light energy, usually from a laser. The photosensitizer is nontoxic until it is activated by light. However, after light activation, the photosensitizer becomes toxic to the targeted tissue generate species highly reactive oxygen [1–3].

Photodynamic therapy may also damage blood vessels in the tumor, which prevents it from receiving the blood it needs to keep growing. And it may trigger the immune system to attack tumor cells, even in other areas of the body [4–6]. Photodynamic therapy limits damage to healthy cells because the photosensitizers tend to build up in abnormal cells and

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