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Synthesis, Characterization, and Evaluation of Cytotoxicity Effects of Curcumin-Loaded Chitosan Nanoparticles on Human Dental Pulp-Derived Mesenchymal Stem Cells

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ABSTRACT

Introduction: Curcumin, the primary compound in the Curcuma longa plant, possesses many therapeutic properties. These include antibacterial and anti-inflammatory activities and neuroprotective and regenerative effects. Curcumin plays a role in neurodegenerative disorders, modulates wound healing, and promotes osteogenesis, neurogenesis, and angiogenesis. Due to the hydrophobic properties and poor bioavailability of curcumin, this study was conducted to create and optimize curcumin-loaded chitosan nanoparticles (Cur-NPs) to improve the bioavailability of curcumin.

Methods and Materials: NPs were fabricated using the ionic gelation method with optimized chitosan concentration, temperature, rotations per minute (rpm), and pH of chitosan solution. NPs were characterized for particle size using Dynamic light scattering (DLS) and drug-polymer compatibility using Fourier transform infrared spectroscopy (FTIR) analysis. The experiment also involved extracting healthy pulp from teeth, isolating dental pulp-derived mesenchymal stem cells (DPSCs), confirming cell surface markers using flowcytometry analysis, and evaluating the effect of Cur-NPs on cell viability and proliferation using the MTT test. The cells were exposed to different concentrations of Cur-NPs and curcumin (1, 5, 10, and 20 µg/ml) and incubated for 24, 48, and 72 hours. The viability of each plate was measured using an ELISA Reader, and the cytoprotective effect of Cur-NPs was studied using AO/PI staining.

Results: DLS results displayed particles with a mean hydrodynamic diameter of about 100 nm. FTIR analysis characterized the structure of synthesized NPs at the molecular scale and showed curcumin-chitosan polymer compatibility. Flow cytometry analysis showed positive and negative markers of DPSCs as described: (99.7%) CD29 - (100%) CD44 - (0.486%) CD34 - (0.416%) CD45. The results of the MTT test confirmed the effectiveness and biocompatibility of Cur-NPs in different doses compared to the curcumin. Treatment of DPSCs with Cur-NPs at a concentration of 5 µg/ml for 48 h showed a significantly higher cell viability and proliferation rate than the other groups (p = 0.05). Viable cells were also observed in different doses of Cur-NPs using AO/PI fluorescent staining.

Conclusion and Discussion: According to this study, Cur-NPs were successfully fabricated and displayed superior properties to curcumin. Cur-NPs significantly impact the survival and proliferation of DPSCs and can be utilized to stimulate these cells for applications in regenerative medicine.

Keywords: Cell survival, Curcumin, Mesenchymal stem cells, Nanoparticles

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