Synthesis, Characterization, and Cytotoxic Evaluation of Poly(α-lipoic acid) Nanoparticles as a Biocompatible Anticancer Platform

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Abstract:

Poly(α-lipoic acid) (PαLA) has emerged as a promising biodegradable polymer for drug delivery due to its intrinsic biocompatibility. In this study, α-lipoic acid (αLA) was polymerized via thermal ring-opening polymerization to yield PαLA, which was subsequently fabricated into nanoparticles (PαLA-NPs) using a modified nanoprecipitation method. The structural transformation from αLA to PαLA was confirmed through UV-Vis and FTIR analyses, which revealed the disappearance of dithiolane peaks and the shift in key functional groups. The resulting nanoparticles exhibited a mean diameter of 83.29 nm with a narrow polydispersity index (0.178) and a zeta potential of –14.6 mV, indicating good colloidal stability. Transmission electron microscopy confirmed their spherical morphology and uniform size. In vitro cytotoxicity studies revealed that PαLA-NPs reduced HCT-116 cell viability in a dose-dependent manner while exhibiting significantly less toxicity toward normal fibroblast cells. These findings demonstrate that PαLA-NPs are a promising candidate for selective drug delivery in cancer therapy due to their nanoscale size, stability, and biocompatibility.