Development of an Innovative Drug-Delivery System for Improving the Bioavailability and Release of Curcumin Using Phosphatidylcholine and Silica-Based Nanoparticles

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Curcumin has gained prominence for its pharmacological and medicinal applications, including antioxidant and anticarcinogenic properties. However, its low oral-bioavailability and stability render its physicochemical properties not ideal for systemic delivery. This study aimed to establish a long-term release-profile for curcumin by characterizing its properties and optimizing release through the fabrication of curcumin-nanoparticles. I developed an innovative platform which investigated the effects of re-engineering curcumin by synthetically attaching phosphatidylcholine (PC) and loading curc-PC complexes into silica-based nanoparticles as potential enhancers of drug-delivery. Nanoparticles (NPs) were fabricated by loading synthesized curc-PC into integrated silica-polymer networks using top-down processing and refining. NP release-rate characterization by UV-Vis spectroscopy showed a ~320% increase in maximum release and a ~54% decrease in release-rate in high-ratio (1:2) curc-PC NPs, compared to traditional curc-NPs, facilitating more gradual release at higher percentages. Independent profiling of loading-solvents (LS) and release-solvents (RS) showed NP bioavailability was dependent on LS but not RS, promoting varying of the loading-solvent to optimize particle nanokinetics. Photon-correlation-spectroscopy showed higher ratios of PC inducing larger NP radii, increasing delivery loads. These results present curc-PC NPs as a novel method for improving drug bioavailability, promoting delivery of large, sustainable quantities of curcumin, and allowing for a wide array of tunable properties (independent of release medium). Thus, optimizing high-ratio (1:2) curc-PC nanoparticles and varying LS may provide nontoxic, inexpensive ($4-5 per delivery) drug-delivery options.

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