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ORIGINAL RESEARCH

Functionalized chitosan with super paramagnetic hybrid nanocarrier for targeted drug delivery of curcumin

Kamaraj Sriram[1] · Palanisamy Uma Maheswari[2] · Kadhar Mohamed Meera Sheriffa Begum[1] · Gangasalam Arthanareeswaran[1]

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Abstract
Recently, hydrophobically functionalized polymers have been deployed as carriers to improve the encapsulation of hydrophobic drugs. The metal nanocomposites are extensively used to improve the biocompatibility of the formulation and target the drug to the specialized site. In our current study, naphthalene acetate (NAA) was incorporated into the amine group of chitosan to form a hydrophobically functionalized chitosan–NAA drug delivery carrier. The calcium ferrite nanoparticles (CFNP) were embedded in the chitosan–NAA matrix to form a super paramagnetic hybrid nanocarrier for controlled curcumin drug delivery. Various analytical techniques were performed to ensure the functional group modifications, thermal stability, surface nature and morphological behavior of synthesized hybrid carriers. The maximum encapsulation efficiency of 93.6% was obtained under the optimized conditions of drug to chitosan–NAA at 0.1, CFNP to chitosan–NAA at 0.75 and TPP to chitosan–NAA at 1.0 (w/w) ratios, respectively, by adapting Taguchi method. Drug release studies were conducted to determine the effect of pH, drug loading concentrations and magnetic field responses. The drug release data were fitted to various kinetic release models to understand the drug release mechanism. The biocompatibility of the hybrid material was tested using L929 mouse fibroblast cells. The cytotoxicity test against breast cancer cells (MCF-7) was also performed to study the anticancer property of the hybrid paramagnetic material. The prepared curcumin-loaded chitosan–NAA/CFNP was very active against cancer cells in comparison to the normal cells. The results confirmed the applicability of the hybrid nanocarriers in cancer cell-targeted drug delivery.

Keywords Chitosan–NAA · Calcium ferrite · Curcumin · Drug delivery · Taguchi

Introduction

Drugs derived from natural sources have more advantages than chemical drugs. Curcumin is a natural plant-based alkaloid derived from *Curcuma longa* which has been used extensively in traditional Indian medicine. The modern medical science recently proves its antimicrobial [1], anti-inflammatory [2], anti-diabetic [3] and anticancer [4] properties. Curcumin also has curative potential against certain chronic neurological diseases like Parkinson's disease and Alzheimer's disease. However, the complete potential of curcumin has not been successfully utilized because of its low water solubility and bioavailability. Various nano formulations have been developed to improve the bioavailability and solubility of curcumin. The biocompatible and biodegradable materials are commonly used for controlled drug delivery applications. The drug delivery carriers are usually developed by both natural [5] and synthetic [6] polymers to improve the efficiency of drugs towards human system.

Chitosan is a natural, highly biocompatible polysaccharide obtained from deacetylation of chitin, which is derived from sea foods' waste. The application of chitosan is extensive from ordinary cosmetics to advanced drug delivery carriers [7–9]. Chitosan has been formed as nanoparticles by various methods like reverse micellar, precipitation, spray

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✉ Kadhar Mohamed Meera Sheriffa Begum
meera.nitt.edu@gmail.com

[1] Department of Chemical Engineering, National Institute of Technology, Tiruchirappalli, Tamilnadu 620 015, India

[2] Department of Chemistry, National Institute of Technology, Tiruchirappalli, Tamilnadu 620 015, India