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## Development of a gelatin-halloysite nanotube-carrageenan polyelectrolyte complex for pH-responsive oral delivery of lipoic acid

Dikshita Sharma & Tarun K Maji\*

Department of Chemical Sciences, Tezpur University, Napaam, Sonitpur 784 028, Assam, India

E-mail: tkm@tezu.ernet.in

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This study investigates the formulation and characterisation of a novel glutaraldehyde crosslinked gelatin-halloysite nanotube-carrageenan (GHC) polyelectrolyte complex (PEC) designed for the controlled oral delivery of lipoic acid, a therapeutic agent limited by poor solubility and instability in acidic environments. The properties of the complex were studied with respect to the variation of concentration of crosslinker and nanofiller. The pH-responsive release mechanism of the composite was evaluated under simulated gastrointestinal conditions, showing minimal drug release in acidic conditions and substantially increased release at intestinal pH levels. Characterisation through Fourier Transform Infrared Spectroscopy (FTIR) and X-ray Diffraction (XRD) confirmed the structural integrity and successful drug encapsulation within an amorphous matrix. Biological assays, including glucose uptake and cell viability studies, validated the composite's bioactivity and non-toxic nature, emphasising its potential for enhancing lipoic acid's bioavailability and therapeutic efficacy. The findings demonstrate the GHC complex's capability to provide a targeted, controlled release, positioning it as a promising system for advanced drug delivery applications.

**Keywords:** Biopolymer, Controlled drug delivery, Diabetes, Sustained hypoglycaemia, Targeted drug delivery