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Injectable Hydrogel for Controlled Release of Insulin: In-vivo Diabetic Animal Model Study

Diabetes mellitus is a chronic metabolic disorder characterized by impaired insulin secretion or insulin resistance, leading to disrupted glucose homeostasis and elevated blood glucose levels. Conventional management typically relies on frequent subcutaneous insulin injections to maintain normoglycemia; however, this approach often suffers from low patient compliance, localized insulin amyloidosis, and limited therapeutic duration. Several alternative routes of insulin administration, such as oral, inhalation, buccal, and transdermal delivery, have been extensively explored to overcome the limitations and patient discomfort associated with frequent subcutaneous insulin injection. we have developed an injectable cyclodextrin-extended polyurethane /carboxymethyl cellulose hydrogel for sustained insulin delivery. The unique structural design of the copolymer, combined with CMC, enables the formation of an injectable hydrogel matrix suitable for controlled drug release. The synthesis and structural properties of the copolymer are confirmed through spectroscopic, chromatographic, and rheological analyses. In vivo studies using diabetic Swiss albino mice demonstrated that subcutaneous administration of insulin-loaded hydrogel achieved prolonged and steady insulin release for up to 72 hours, significantly outperforming conventional insulin injections (<12 hours). Histopathological evaluations confirmed the biocompatibility and biodegradability of the hydrogel, with no observed adverse effects on major organs. These findings suggest that the hydrogel is a promising platform for sustained insulin delivery, offering an effective strategy for improved diabetes management. The gel depot formation in mice model and the in vivo insulin release profile are evaluated by monitoring blood glucose levels after subcutaneous administration of injectable hydrogel.

Keywords: diabetes; insulin delivery; injectable hydrogel; sustained release.

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Biography

Dr. Pralay Maiti is currently a senior professor and ex-coordinator in the School of Materials Science and Technology, IIT (BHU), Varanasi. Prof. Maiti has received his Master in Chemistry from Indian Institute of Technology, Kharagpur in 1991 and Ph.D. in Polymer in 1996 from The Indian Association for the Cultivation of Science (Jadavpur University). He was COE Researcher and Lecturer at Venture Business Laboratory, Hiroshima University, Japan (1997-1999) and was post-doctoral fellow at Toyota Technological Institute, Japan (1999-2001). He was Visiting Scientist at Cornell University, USA from 2002 to 2004. His current research interests include drug delivery vehicle, biomaterials and energy materials. Most innovative contribution of Prof. Maiti is in the field of materials chemistry related to drug delivery using biodegradable polymers, self-assembly and energy materials through nanotechnology and their uses in energy sector. He has published more than 270 papers in high impact journals, 39 patents (few of them are commercialized) and 34 book chapters and h-index of 61 and his citation is more than 18,000.

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