

Glucose-Responsive Type 2 Diabetes Mellitus Drug Delivery System Based on Zeolitic Imidazolate Framework (ZIF-8) Integrated Glucose Oxidase & Gold Nanoparticles

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ABSTRACT

Diabetes mellitus (DM) is a chronic metabolic disease whose prevalence increases significantly every year. Conventional treatments such as insulin injection often cause unstable fluctuations in blood glucose levels, while oral treatment may be missed due to patient's busy routine, thus encouraging the development of more effective and glucose-responsive drug delivery systems. This study explores a Zeolitic Imidazolate Framework (ZIF-8)-based drug delivery system integrated with Glucose Oxidase (GOx) and gold nanoparticles (AuNP) for the treatment of type 2 DM. The combination of acidic pH-sensitive ZIF-8 which is sensitive to acidic pH with GOx which reacts to glucose, has the potential to reduce blood glucose fluctuations in diabetes through controlled drug release. Characterization results show that the synthesized ZIF-8 has the same structure and morphology as ZIF-8 synthesized by a similar method. The addition of guest materials such as metformin, GOx and AuNP did not change the crystal structure of ZIF-8, as evidenced by the consistent characterization results with XRD, FT-IR and FE-SEM either before or after modification. In vivo tests showed that this sample was able to regulate the release of metformin with precision, thus regulating fluctuations in blood glucose levels in diabetic rats to be more stable and controllable compared to metformin administration without encapsulation. The mechanism of controlled metformin release based on blood glucose availability is also able to minimize the risk of hypoglycemia and hyperglycemia. Encapsulation of metformin in ZIF-8 integrated with GOx and AuNP (Met GOx@ZIF8/AuNP) proved to be effective and has high potential as a therapy in the treatment of glucose-responsive DM-2. Therefore, this slow-release drug system is an appropriate solution for people with diabetes with dense mobility.

Keywords: Diabetes mellitus, GOx, ZIF-8, metformin, AuNP