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RESEARCH

# Nanoengineered Bezafibrate-Loaded Calcium Nanoparticles for Osteoporosis: A Repurposing Approach for Targeted Bone Therapy

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**Abstract**

Osteoporosis is a progressive skeletal disorder marked by reduced bone mineral density and increased fracture risk. Bezafibrate (BZ), a lipid-lowering agent, has shown potential as a repurposed therapeutic for osteoporosis. This study aimed to develop and evaluate bezafibrate-loaded calcium nanoparticles (BZ-CNPs) to enhance their therapeutic efficacy for targeted bone delivery. Calcium nanoparticles (CNPs) were prepared by chemical precipitation due to their bonetargeting properties and biocompatibility. BZ-CNPs were optimized using Box-Behnken Design (BBD) and characterized for particle size, PDI, zeta potential, entrapment efficiency, and morphology using SEM, XRD, and DSC. In vivo performance was assessed in a dexamethasone-induced osteoporotic rat model. The optimized BZ-CNPs showed a particle size of 242.1 nm, PDI of 0.302, zeta potential of − 32.7 mV, and entrapment efficiency of 87.2%. Morphological and thermal analyses confirmed nanoparticle stability. In vivo and biochemical analyses demonstrated a significant improvement in bone turnover markers, indicating reversal of osteoporosis-induced bone loss. The developed BZ-CNP formulation offers a promising nanocarrier for the targeted delivery of bezafibrate, demonstrating improved therapeutic potential for osteoporosis management through drug repurposing.

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