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UGC Centre of Advanced Study (UGC-CAS)
PANJAB UNIVERSITY, CHANDIGARH 160 014 INDIA
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Brief Summary of the project

Polymeric magnetic nanoparticles have been shown to diagnose and treat cancer at higher efficacies than conventional chemotherapies. In the present study, we reported the synthesis of magnetic lignin nanoparticles with subsequent loading of chemotherapeutic drug, methotrexate, employing anti-solvent precipitation and ultrasonication method. We subsequently conjugated the nanoparticles to methotrexate at a lignin-to-drug ratio of 1:3. The ensuing nanoparticles are magnetic, bear a smooth, polyhedral geometry and have a characteristic dimension of 110-130 nm. Moreover, we calculated the drug loading and encapsulation efficiencies to be 66.0% and 64.9%, respectively. The nanoparticles exhibit a concentration-dependent release of methotrexate for the initial 24 hours, followed by slow, sustained release. Moreover, the nanoparticle formulation is non-hemolytic and also scavenges radicals owing to the antioxidant properties of lignin. Additionally, methotrexate delivered using the nanoparticles exhibited higher cytotoxicity in cell viability assays employing breast cancer and macrophage cell lines compared to the pure form of the drug. Synergistic action of lignin, iron oxide and methotrexate contribute to enhanced caspase-3 activity and reduced glutathione levels in the breast cancer cells. The receptor-mediated endocytosis was also confirmed with higher internalization of the drug. This study confirms the potential of lignin magnetic nanoparticles as a sustainable and biocompatible alternative to current therapeutics. The study shows that lignin is not only sustainable and biocompatible, but it can also be selectively modified using a rapidly expanding toolkit of biocatalytic and chemical reactions in order to yield 'intelligent' theranostic nanoprobes that are significantly more efficacious than current therapeutics.

Dr. Sandip V. Pawar
Assistant Professor
University Institute of Pharmaceutical Sciences
Panjab University, Sector 14, Chandigarh, India
+91-9860578580; Email:pawars@pu.ac.in