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Green Synthesis (Using Environment Friendly Bacteria) of Silver-Nanoparticles and Their Application as Drug Delivery Agents

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Abstract : The primary aim of this work is to synthesis silver nanoparticles (AgNPs) through environmentally benign routes to avoid any chemical toxicity related undesired side effects. The nanoparticles were stabilized with drug ciprofloxacin (Cp) and were studied for their effectiveness as drug delivery agent. Targeted drug delivery improves the therapeutic potential of drugs at the diseased site as well as lowers the overall dose and undesired side effects. The small size of nanoparticles greatly facilitates the transport of active agents (drugs) across biological membranes and allows them to pass through the smallest capillaries in the body that are 5-6 μm in diameter, and can minimize possible undesired side effects. AgNPs are non-toxic, inert, stable, and has a high binding capacity and thus can be considered as biomaterials. AgNPs were synthesized from the nutrient broth supernatant after the culture of environment-friendly bacteria Bacillus subtilis. The AgNPs were found to show the surface plasmon resonance (SPR) band at 425 nm. The Cp capped Ag nanoparticles formation was complete within 30 minutes, which was confirmed from absorbance spectroscopy. Physico-chemical nature of the AgNPs-Cp system was confirmed by Dynamic Light Scattering (DLS), Transmission Electron Microscopy (TEM) etc. The AgNPs-Cp system size was found to be in the range of 30-40 nm. To monitor the kinetics of drug release from the surface of nanoparticles, the release of Cp was carried out by careful dialysis keeping AgNPs-Cp system inside the dialysis bag at pH 7.4 over time. The drug release was almost complete after 30 hrs. During the drug delivery process, to understand the AgNPs-Cp system in a better way, the sincere theoretical investigation is been performed employing Density Functional Theory. Electronic charge transfer, electron density, binding energy as well as thermodynamic properties like enthalpy, entropy, Gibbs free energy etc. has been predicted. The electronic and thermodynamic properties, governed by the AgNPs-Cp interactions, indicate that the formation of AgNPs-Cp system is exothermic i.e. thermodynamically favorable process. The binding energy and charge transfer analysis implies the optimum stability of the AgNPs-Cp system. Thus, the synthesized Cp-Ag nanoparticles can be effectively used for biological purposes due to its environmentally benign routes of synthesis procedures, which is clean, biocompatible, non-toxic, safe, cost-effective, sustainable and eco-friendly. The Cp-AgNPs as biomaterials can be successfully used for drug delivery procedures due to slow release of drug from nanoparticles over a considerable period of time. The kinetics of the drug release show that this drug-nanoparticle assembly can be effectively used as potential tools for therapeutic applications. The ease of synthetic procedure, lack of possible chemical toxicity and their biological activity along with excellent application as drug delivery agent will open up vista of using nanoparticles as effective and successful drug delivery agent to be used in modern days.

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