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| **Biogenic Synthesis of Eco-Benign Silver Nanoparticles Loaded with Isoniazid: A Novel Therapeutic Strategy for Multidrug-Resistant Tuberculosis** |
| Tamara Akpobolokemi1, Bahijja Raimi-Abraham1, Rocio Martinez Nunez2 |
| 1Institute of Pharmaceutical Science, School of Cancer and Pharmaceutical Sciences, King’s College London, Waterloo Campus, Franklin Wilkins Building, Stamford Street, London SE1 9NH, UK 2Department of Infectious Diseases, School of Immunology & Microbial Sciences, Faculty of Life Sciences & Medicine, King’s College London, Guy’s Hospital, London, UK |
| **Background:** Eco benign synthesis is defined as a synthesis process that utilises nontoxic and biocompatible raw materials that cause no harm to the environment. As such, it prioritises reducing the environmental impact of chemical synthesis, which is a promising strategy for developing infectious disease drugs. Tuberculosis (TB) is a major global health burden exacerbated by drug resistance and toxicity issues, especially with first-line TB drugs such as isoniazid (ISO). Metallic nanoparticles, specifically silver nanoparticles (AgNPs), have shown potential in increasing drug efficacy and reducing toxicity. Plant-mediated synthesis is an eco-benign process that avoids the use of toxic chemicals and utilises natural reducing and stabilising plant phytochemicals for AgNP synthesis. This study aimed to establish an eco-benign approach to the functionalisation of silver nanoparticles (AgNPs) with isoniazid (ISO), using Spinacia Oleracea leaf extract (SLE) as the reducing and stabilising agent and polyvinylpyrrolidone (PVP) for enhanced stabilisation. |
| **Methods:** AgNPs were synthesised using SLE, functionalised with ISO (NP+ISO), and further stabilised with PVP (NP-ISO-PVP). To achieve maximum ISO loading efficiency, two conjugation methods were explored: ISO was added either before or after PVP i.e. PVP 1 (NP + ISO + PVP) and PVP 2 (NP + PVP + ISO). PVP concentration was also varied: PVPa 0.0125 and PVPb 0.025, as PVP is known to provide stability through particle coating; however, the coating amount may affect drug loading. Synthesised AgNPs were characterised spectrophotometrically using ultraviolent-visible spectroscopy (UV-VIS), morphology, size and elemental characterisations were conducted using transmission electron microscopy (TEM), dynamic light scattering (DLS) and TEM – Energy Dispersive Xray (TEM-EDX).  |
| **Results:** The results confirmed the successful synthesis of spherically monodispersed, ISO-loaded AgNPs with sizes ranging from 73 – 131nm and polydispersity values below 0.3. Notably, the PVP 1 conjugation method exhibited superior performance, facilitating optimum drug loading efficiency of ~93%. Additionally, the pivotal role of PVP in particle size reduction was also established. |
| **Conclusions:** These results validate the potential of using eco-benign synthesis to develop novel nanotherapeutics against TB. Further investigations will be conducted on the antituberculosis effects of ISO-AgNPs, which could have positive implications for the treatment of drug-resistant TB. |