GREEN SYNTHESIS AND FORMULATION OF *SESBANIA GRANDIFLORA* MEDIATED GOLD NANODRUG FOR HEPATOPROTECTIVE STUDIES

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Introduction:

Nanoparticle synthesis by conventional physical and chemical methods has proven to be expensive and potentially hazardous to the environment. These methods also pose various biological risks and may contribute to several health disorders. In contrast, plant-mediated synthesis of nanoparticles enable the synthesis of nanoparticles both intracellularly and extracellularly in an eco-friendly manner. Gold nanoparticles (AuNPs) exhibit bactericidal activity against animal and food-borne pathogens and possess diverse pharmacological properties.

Sesbania grandiflora (SG) has been reported to enhance the body's natural antioxidant defense system and shows promise as a source for the development of novel therapeutic agents. The development of AuNP-based drugs with antibacterial and antifungal activity is particularly promising. Due to the antioxidant properties of AuNPs, oxidative stress-related diseases such as inflammatory disorders, atherosclerosis, aging, and cancer may be prevented.

Although AuNPs synthesized using various plant extracts have been extensively studied, AuNPs synthesized using *Sesbania grandiflora* have rarely been evaluated for hepatoprotective or hepatotoxic effects.

Therefore, the present work focuses on the development of AuNPs synthesized using *Sesbania grandiflora* plant extracts, with emphasis on nanoparticle morphology and identification of phytochemicals involved in nanoparticle synthesis.

The objective of this study is to develop a nanodrug with significant therapeutic potential while meeting stringent safety and efficacy requirements. The identification and implementation of suitable bioassays, along with scalable production of bioactive molecules, are expected to yield outcome that will be beneficial to society.

Objectives:

1. To synthesize AuNPs using *S. grandiflora* extract.
2. To characterize and formulate drug preparation.
3. To check the bioactivity of drug using *in silico* tool.
4. To assess *in vitro* and *in vivo* hepatoprotective activity of drug in cell line and animal model.

Methodology:

1. **Plant Extract and AuNP Synthesis**
   Fresh Sesbania grandiflora leaves were boiled and filtered to obtain the extract, which is screened for phytochemicals using TLC. When added to $HAuCl_4$(Chloroauric acid) under controlled conditions, the solution turns ruby red, indicating the formation of gold nanoparticles. This is further confirmed using UV-Vis and FT-IR analysis.
2. **In Silico Analysis**
   The synthesized nanodrug will be evaluated computationally for bioactivity and safety using ADMET and PASS tools, while molecular interactions will be studied using AutoDock and validated with Discovery Studio.
3. **In Vitro Studies using cell culture assay**
   HepG2 liver cells will be used to assess hepatoprotective activity. Cell viability will be checked using the trypan blue assay, metabolic activity through the MTT assay, and apoptosis will be analysed using Annexin V-FITC/PI staining.
4. **In Vivo Studies using animal model**
   Wistar rats are divided into control and treatment groups and administered the drug for 6 weeks. Liver function and protective effects are evaluated through biochemical markers like LDH, ALP, lipid profile, and antioxidant enzymes such as SOD and catalase.

Result and Conclusion:

The final result will be summarised after the completion of the study.
The current status includes:

- Green synthesis of gold nanoparticles (AuNPs) using *Sesbania grandiflora* extract has been successfully standardized, with preliminary confirmation achieved through colour change and UV–Vis spectroscopy, followed by characterization using FT-IR analysis.
- *In vitro* hepatoprotective evaluation is in progress using HepG2 cell lines, with cell viability and cytotoxicity being assessed through Trypan blue exclusion and MTT assays.

Expected Outcome of the project:

1. Development of novel, eco-friendly nanodrug formulation for liver disease treatment using gold nanoparticle.
2. Generate patentable data leading for the development of a Nano Hepatoprotectant product ready for clinical trials or technology transfer.
3. Provide the pharmaceutical industry with cost-effective and scalable green synthesis method for drug development.

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Future Scope:

The future scope of this project includes:

1. **Clinical Translation and Human Trials**: Bridging the gap from animal models to human patients, which involves conducting Pharmacokinetic and Pharmacodynamic (PK/PD) profiling to understand human absorption and clearance, performing precise dose scaling, and securing regulatory approval within frameworks adapted for nanomaterials.
2. **Detailed Molecular Mechanistic Studies**: Future research can aim to identify specific signaling pathways alongside deeper exploration of anti-apoptotic and anti-inflammatory mechanisms at genomic and proteomic levels.
3. **Development of Theranostic Platforms**: Creation of multifunctional "theranostic" platforms which could provide personalized hepatoprotection through real-time imaging of liver health combined with targeted drug delivery to minimize systemic toxicity.
4. **Comprehensive Safety and Toxicity Assessment**: Establishing a complete safety profile requires standardized assays to conduct chronic toxicity assessments.
5. **Expansion of Therapeutic Applications:** SG-mediated nanoparticles can be explored for broader medical uses, such as anticancer activity against various cell lines (e.g., breast or lung cancer), and environmental remediation, leveraging their catalytic properties to degrade industrial pollutant