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Functionalizing Gold Nanostars with Ninhydrin as Vehicle Molecule for Biomedical Applications

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Abstract : In recent years, there has been an explosion in Gold NanoParticle (GNP) research, with a rapid increase in publications in diverse fields, including imaging, bioengineering, and molecular biology. GNPs exhibit unique physicochemical properties, including surface plasmon resonance (SPR) and bind amine and thiol groups, allowing surface modification and use in biomedical applications. Nanoparticle functionalization is the subject of intense research at present, with rapid progress being made towards developing biocompatible, multi-functional particles. In the present study, the photochemical method has been done to functionalize various-shaped GNPs like nanostars by the molecules like ninhydrin. Ninhydrin is bactericidal, virucidal, fungicidal, antigen-antibody reactive, and used in fingerprint technology in forensics. The GNPs functionalized with ninhydrin efficiently will bind to the amino acids on the target protein, which is of eminent importance during the pandemic, especially where long-term treatments of COVID- 19 bring many side effects of the drugs. The photochemical method is adopted as it provides low thermal load, selective reactivity, selective activation, and controlled radiation in time, space, and energy. The GNPs exhibit their characteristic spectrum, but a distinctly blue or redshift in the peak will be observed after UV irradiation, ensuring efficient ninhydrin binding. Now, the bound ninhydrin in the GNP carrier, upon chemically reacting with any amino acid, will lead to the formation of Rhumann purple. A common method of GNP production includes citrate reduction of Au [III] derivatives such as aurochloric acid (HAuCl4) in water to Au [0] through a one-step synthesis of size-tunable GNPs. The following reagents are prepared to validate the approach. Reagent A solution 1 is0.0175 grams ninhydrin in 5 ml Millipore water Reagent B 30 µl of $HAuCl_4.3H_2O$ in 3 ml of solution 1 Reagent C 1 µl of gold nanostars in 3 ml of solution 1 Reagent D 6 µl of cetrimonium bromide (CTAB) in 3 ml of solution1 ReagentE 1 µl of gold nanostars in 3 ml of ethanol ReagentF 30 µl of $HAuCl_4.{}_3H_2O$ in 3 ml of ethanol ReagentG 30 µl of $HAuCl_4.{}_3H_2O$ in 3 ml of solution 2 ReagentH solution 2 is0.0087 grams ninhydrin in 5 ml Millipore water ReagentI 30 µl of $HAuCl_4.{}_3H_2O$ in 3 ml of water The reagents were irradiated at 254 nm for 15 minutes, followed by their UV Visible spectroscopy. The wavelength was selected based on the one reported for excitation of a similar molecule Pthalimide. It was observed that the solution B and G deviate around 600 nm, while C peaks distinctively at 567.25 nm and 983.9 nm. Though it is tough to say about the chemical reaction happening, butATR-FTIR of reagents will ensure that ninhydrin is not forming Rhumann purple in the absence of amino acids. Therefore, these experiments, we achieved the functionalization of gold nanostars with ninhydrin corroborated by the deviation in the spectrum obtained in a mixture of GNPs and ninhydrin irradiated with UV light. It prepares them as a carrier molecule totake up amino acids for targeted delivery or germicidal action.

Keywords : gold nanostars, ninhydrin, photochemical method, UV visible specgtroscopy
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