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Gold nanoparticles conjugated to benzoylmercaptoacetyltriglycine and L-cysteine methylester

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ABSTRACT

Benzoyl-protected mercaptoacetyltriglycine, a synthetic precursor used in the preparation of Technetium-99 m-mercaptoacetyltriglycine, a radiopharmaceutical for renal tubular function and L-cysteine methylester, a small, non-zwitterionic amino acid derivative, were used as capping agents of gold nanoparticles obtained by borohydride reduction method. The capped gold nanoparticles composites were prepared from aqueous solutions and characterized by UV–Vis, infrared and Raman spectra and Transmission Electron Microscopy images. The presence of the ligands and its different binding mode to the particles as a consequence of the benzoyl-protection of the thiol group in benzoyl-protected mercaptoacetyltriglycine were evidenced from infrared and Raman spectra. The stability on aging in water solution of the formed composites is discussed from the obtained UV–Vis spectra.

1. Introduction

The applications of surface functionalized metal nanoparticles have been explored in a wide variety of areas [1]. Colloidal gold nanoparticles (AuNPs) have found technologically uses since ancient times related to their optical properties, but only in the last decades their potential biological applications in labeling, delivering, heating and sensing processes have been demonstrated [2–5]. Among noble metal particles, AuNPs have attracted intensive attention related to their easy preparative routes available, their low toxicity, and the gold surface affinity for the bonding to molecules of biological interest [5,6]. Gold and other noble metal nanoparticles have great potential for applications in biochemical sensing and biological imaging because of their unique optical properties originated from the excitation of local surface plasmon resonances [7,8]. The surface plasmon resonance is a coherent oscillation of the surface conduction electrons excited by electromagnetic radiation. It is sensitive to the local dielectric environment [9]. Typically, local surface plasmon resonances devices sense changes in the local environment through a shift for the resonance wavelength. Apart from the environmental effect, the surface resonance plasmon of nanoparticles is dramatically affected by their size, shape, and surface modifications [7,10]. The highly confined local electric field enhancement that accompanies the excitation of the plasmon supports variety spectroscopic and imaging techniques [11–13].

The synthesis of AuNPs with diameters ranging from a few to several hundreds of nanometers in aqueous solution as well as in organic solvents is well established [10,14–17]. In typical syntheses, Au salts are reduced by addition of a reducing agent such as sodium citrate or borohydride. In addition, a stabilizing agent (surfactant) is also required which is either adsorbed or chemically bound to the surface of AuNPs. The surfactant is typically charged, so that the equally charged NPs repel each other so that they remain stable in colloidal state. Most biological or biomedical applications require that the clusters readily dissolve in aqueous media which is favored if the aggregation is prevented through electrostatic interactions. Biological molecules can be attached to the particles in several ways. If the biological molecules have a functional group which can bind to the Au surface (like thiols, cyano, amino or specific peptide sequences), the biological molecules can replace some of the original stabilizer molecules when they are added directly to the particles solution. Studies on the interaction of Au with biomolecules is an active research area where useful information is being obtained [18,19]. Benzoyl-protected mercaptoacetyltriglycine ($BzMAG_3$) is a synthetic ligand used in the preparation of Technetium-99 m-mercaptoacetyltriglycine, a radiopharmaceutical for renal tubular function [20]. From the conjugation of AuNPs to $BzMAG_3$ a useful tool for imaging or diagnostic of renal tubular function could be obtained. Furthermore, it opens up several novel possibilities as the $BzMAG_3$ structure could be derivatized because of its free carboxylic group. Different active groups capable of performing specific functions like

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