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Phytochemical-capped biogenic gold nanocrystals with chemocatalytic and radical scavenging potential

Vidya Vilas [a,b], Daizy Philip [a,*], Joseph Mathew [b]

[a] Department of Physics, Mar Ivanios College, Thiruvananthapuram 695015, India
[b] Department of Chemistry, Mar Ivanios College, Thiruvananthapuram 695015, India

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ABSTRACT

A refined phytosynthetic protocol for the synthesis of gold nanoparticles has been presented in the paper. Nano-gold is synthesized using essential oil of leaves of *Myristica fragrans*. The synthesized nanoparticles have been characterized using UV–vis spectroscopy, TEM, XRD and FTIR. The morphology and dispersity of the particles are found to depend on the quantity of diluted oil used in the synthesis. The gold nanoparticles formed are poly-disperse varying in morphology (spheres, pentagons, hexagons), at lower oil concentrations and spherical, monodisperse gold nanoparticles are obtained on increasing the quantity of oil added at 373 K. XRD analysis revealed the fcc crystalline structure of the synthesized gold nanoparticles. Detailed analysis of FTIR data leads to the result that tertiary alcohols are responsible for the reduction of gold nanoparticles, and in synergism with other groups they bring about the stabilisation of these metallic nanoparticles. FTIR spectral analysis reports are in accordance with GC–MS analysis results. The synthesized gold nanoparticles are efficient nanocatalysts. The activation energy for the reduction of methylene blue, methyl orange and para-nitrophenol is lowered and their degradation is completed in 10, 7 and 20 min, respectively, on the addition of 0.7 mL of the synthesized gold colloid. The synthesized gold colloid with homogenous, monodisperse particles is used for catalytic and antioxidation studies. The biogenic gold nanoparticles are found to be potential antioxidants as revealed through their superoxide radical scavenging activity, hydroxyl radical scavenging activity, hydrogen peroxide scavenging activity, NO scavenging activity, DPPH scavenging activity and reducing power activity.

1. Introduction

Synthesis of gold in the nanoregime is of importance owing to their unique optical, electronic and catalytic properties. Natural appearance of gold nanoparticles (Au NPs) in hydrothermal and geothermally-active systems, through colloidal processes has led scientists to mimic them in laboratories [1,2]. However, the adoption of a synthetic strategy, obeying the principles of green chemistry, is the need of the hour. Hyperaccumulation and biomineralisation of heavy metals in the reduced and nanoparticulate form in living plants enabled their identification as efficient nanofactories [3].

Water soluble phytochemicals like phenolics, flavonoids, proteins, sugars and terpenoids are excellent reducing agents and hence the aqueous extracts of plant parts are considered to be good reducing and stabilising agents for the phytosynthesis of Au NPs. Nano-Au of varying shapes and sizes with diverse applications are obtained from aqueous extracts of different plant parts. In most cases the morphology of the biogenic NPs can be tuned by perpetual variation of synthesis conditions. Their properties are attributed to the nature of the reducing and capping agents in the plant extract. Philip [4] synthesized 17 nm sized spherical Au NPs using aqueous leaf extract of *Mangifera indica*. Morphological tuning of photoluminescent Au NPs was successfully demonstrated by Smitha et al. [5] using *Cinnamomum zeylanicum* leaf broth. Katti et al. [6] have effectively enunciated the biocompatibility of Au NPs fabricated using cumin phytochemicals, an essential criterion in their employment for biomedical applications. The synergic effect of the phytochemicals was studied in detail in the paper. Research activities in the field are also extended towards the use of various combinations of medicinal herbs. Aromal et al. [7] synthesized Au nanospheres using a series of arishtams. Efforts were also laid to determine the exact biomolecules involved in reduction and stabilisation. Dhas et al. [8] synthesized nano-Au using aqueous extract of *Sargassum myriocystum* and showed that a dodecane derivative acted as the capping molecule through GC–MS analysis. Besides aqueous extracts, extracts of green solvents were also employed for nano-Au synthesis. Banoee et al. [9] synthesized 2.5 nm sized nano-Au using ethanol extract of black tea and studied in detail the effect of tannin in their formation and stabilisation.

Diverse approaches in this field include the use of a plant derived natural product (gum kondagogu) for the synthesis of homogeneous, monodisperse Au NPs [10]. Stable nanocrystalline Au particles of varying morphology including spheroids, nanorods and nanoprisms were

* Corresponding author.
E-mail addresses: daizyp@rediffmail.com, philipdaizy@yahoo.co.in (D. Philip).

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