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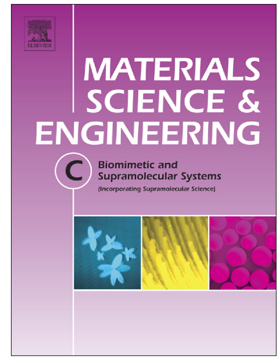

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Preparation and Mechanistic Aspect of Natural Xanthone Functionalized Gold Nanoparticle.

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ABSTRACT: Herein, a facile scale up and shape variable synthesis of gold nanoparticle (AuNP) and reaction mechanism by natural xanthone derivative (mangiferin) has been reported. Mangiferin ($C_{19}H_{18}O_{11}$; 1,3,6,7-tetrahydroxyxanthone-C2-β-D-glucoside), a xanthone derivative is isolated from *Mangifera indica L.* leaves which efficiently reduces Au^{3+} ions to Au^0 and stabilizes the formed AuNP. The structural, optical and plasmonic properties of synthesized AuNP have been investigated through different instrumental techniques like UV-Vis and FTIR spectroscopy, powder XRD, FESEM and TEM analysis. It is observed that variation of the concentration of Au^{3+} ions and mangiferin has a great effect on controlling size and shape of nanoparticles. The role of reaction temperature is also notable. An interesting observation is that with same concentration ratio of $HAuCl_4$/mangiferin (0.025 mM/0.002%) at the room temperature kidney shaped AuNP is produced, whereas it is spherical at boiling temperature. Moreover, mangiferin allows high scale synthesis of AuNPs (0.025 mM to 10 mM) without changing the particles size and shape. The mechanistic investigation through UV-Vis, FTIR and GCMS analyses reveal the cleavage of glucose unit and oxidation of phenolic OH groups during AuNP formation. Non-toxicity of mangiferin conjugated AuNP on normal human breast cell line (MCF-10A) suggesting its future application as a drug delivery system and other related medicinal purposes.

1. INTRODUCTION

Synthesis of size controllable metal nanoparticles and their scale up by physical methods are laborious tasks and the chemical methods which use toxic chemicals makes them environmentally hazardous. Synthesis of nanoparticle (NP) using biomolecules successfully solved this problem along with beneficial properties. Plant extracts containing phytochemicals/biomolecules reduce metal ions into metal nanoparticles and also stabilize them. Using this concept, several research groups have used different plant extracts to synthesize metal nanoparticles like gold, silver, copper etc. and explored their pharmacological activity.[1–7] The main advantages of green synthesis over other conventional synthesis are the preparation of nanoparticles without using any external additives (stabilizing/capping agent) which are sometimes bio-incompatible and toxic to the environment. However, the major disadvantage of green synthesis is that the prepared nanoparticles are not pure as thousands of phytochemicals (such as flavonoids, terpenoids, proteins, reducing sugars and alkaloids etc.) present in plant extract which are sometimes unfavorable for long term storage. Also, it is very difficult to identify the biomolecules which are responsible for reduction, stabilization and capping activity. Therefore, the identification of active chemical constituent(s) with specific pharmacological activity of medicinal plants and the utilization of those specific biomolecules for the synthesis of metal nanoparticles to improve the biological activity are highly appealing. Among different metal nanoparticles, gold generates a huge impact towards various bio-medicinal applications due to their unique fundamental properties.[8–11] In therapeutic field, gold nanoparticles (AuNP) are successfully applied in photothermal therapy, drug delivery, tissue imaging, diagnosis etc. Recently it is also observed that very small size (1 nm or less) AuNP shows antibacterial activity.[12,13] Further, functional modification of AuNP implants various beneficial properties which are suitable for biomedical applications like biosensing, cancer radiotherapy, etc.[14–18] Accordingly, a large number of plant extracts have been used for the preparation of AuNP.[3,19–25] However, their synthesis using isolated active biomolecule(s) and scale up without utilization of any external stabilizer is rare.

In the tropical country like India mango plants are copiously available. Traditionally mango plants (*Mangifera indica* L.) are used for the treatment of leucorrhoea, dysentery, bad blood, bronchitis, urinary discharge, aphrodisiac, tonic, beautifier of complexion etc. as an herbal formulation.[26–32] The main active chemical constituent of mango is mangiferin a polyphenol of C-glycosylxanthone ($C_{19}H_{18}O_{11}$; 1,3,6,7-tetrahydroxyxanthone-C_2-β-D-glucoside) (Figure 1). The isolation of mangiferin is easy and convenient as compared to other natural xanthones.[33] Mangiferin is primarily responsible for various bioactivities such as immunomodulatory, analgesic, antioxidant, antidiabetic, antitumor, antibacterial, radioprotective, and cardioprotective, etc.[32,34–41]

Phenolic and glucose containing compounds are known to exhibit very good reducing capability and commonly employed for the preparation of metal nanoparticles. Mangiferin consists of four phenolic units and a glucose moiety in its xanthone framework. Hence, it may be assumed that mangiferin might exhibit very high reducing capability as multiple phenolic units and glucose unit are present.[42,43] In addition, the phenolic and glucose units present in mangiferin can efficiently stabilize the