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Biogenic synthesis of nanostructured Gd_2O_3: Structural, optical and bioactive properties

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ABSTRACT

Nanostructured Gd_2O_3 has been synthesized using the leaf broth of *Annona reticulate*. The formation of nanoparticles is confirmed by XRD and TEM analysis. UV–visible and PL studies are employed to characterize the optical nature of the samples and the thermal analysis of the as prepared material has been performed to ascertain the proper annealing temperature. XRD pattern shows cubic structure with average particle size of about 25 nm. FTIR spectra reveal the possible biomolecules responsible for the formation of nanoparticles and their stabilization. Raman spectrum with characteristic band located at 360 cm^{-1} for the F_g mode supports the cubic phase of the nanostructured Gd_2O_3. Biocompatibility of synthesized nanoparticles is evaluated by carrying out the cytotoxic test against normal fibroblast cell lines and surviving fraction of normal cell lines are found to be above 75% up to a concentration of 50μg/mL. The antimicrobial activity of developed nanoparticles are screened against *K. Pneumonae* and *S.aureus* bacterial cell lines and substantial inhibition zones are observed in the dose dependent study. Moreover, this study also investigates the antioxidant efficacy of Gd_2O_3 nanoparticles using DPPH and superoxide free radical scavenging assays. With a concentration of 20μg/mL of the synthesized nanoparticles 70% scavenging is observed. The method of synthesis is simple, cost-effective and unexplored as it follows an ecofriendly protocol for the production of biologically active nanostructured Gd_2O_3.

1. Introduction

Rare earth oxides are of interest to researchers as they find applications as catalysts, ultra energetic luminescent gadgets, magnets and other functional materials. Their physico-chemical and optical characteristics result from the 4f electrons. As compared to other metal oxides, gadolinium oxide (Gd_2O_3) is widely investigated because of enormous properties including, crystallographic stability, large mechanical strength, thermal conductivity and high optical band gap energy [1,2]. Several methods, including physical, chemical and biological techniques have been employed to synthesize Gd_2O_3 nanoparticles. The synthesis of nanoparticles by chemical procedures utilizes chemicals as reducing, stabilizing, or capping agents, which are hazardous and not environment friendly [3]. As there is no involvement of toxic materials, the biosynthesis of nanoparticles has been regarded as a green chemistry approach. Biosynthetic method is not only simple, reliable, and inexpensive but also eco-friendly. Plant based products have gained substantial attention as appropriate alternatives to physical and chemical methods for the synthesis of nanomaterials. Among the biosynthetic approaches, plants or plant products have several advantages such as availability, non hazardous nature, simplicity, and suitability for large scale fabrication [4,5].

Annona reticulata (*A. reticulate*) belonging to the family *Annonaceae* is mostly found in tropical (America, West Indies and India) and subtropical regions (Taiwan and Vietnam). The leaves of this plant contain wide range of phytochemicals like carbohydrates, proteins, amino acids, steroids, tannins, phenolics and flavonoids. It is one of the traditionally important plants used for the medication of several ailments such as cardiac problems, bacterial infection, dysentery, haemorrhage, dysuria, tumor, toothache and styptic epilepsy [6,7]. Due to low toxic activity and extremely high surface to volume ratio, nanomaterials are successfully utilized for the transportation of drugs, genes and other biological molecules. Biogenic nanoparticles are largely used as catalytic, free radical scavenging, bactericidal and anticancer agents in various fields. Owing to the extended treatment period or utilization of higher drug doses, the bacterial resistance to antibiotics has an

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