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Photocatalytic degradation of environmental perilous gentian violet dye using *leucaena*-mediated zinc oxide nanoparticle and its anticancer activity

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Abstract Phytomediated synthesis of metal oxide nanoparticles has become a key research area in nanotechnology due to its wide applicability in various biomedical fields. The present work explores the biosynthesis of zinc oxide nanoparticles (ZnO-NPs) using *Leucaena leucocephala* leaf extract. The synthesised ZnO-NPs were characterised by ultraviolet–visible (UV–Vis) spectroscopy, scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), transmission electron microscopy (TEM) and selected area electron diffraction (SAED) studies. Biosynthesised ZnO-NPs are found to have wurtzite hexagonal structure with particles distributed in the range of 50–200 nm as confirmed by TEM studies. The anticancer activity of ZnO-NPs against MCF-7 (breast cancer) and PC-3 (human prostate cancer) cell lines was evaluated using 3-(4, 5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. From the assay, biosynthesised ZnO-NPs have better cytotoxic activity on PC-3 cell lines than MCF-7 cell lines. The *in vitro* cytotoxicity studies of biosynthesised ZnO-NPs against Dalton lymphoma ascites (DLA) cells reveal better antitumor activity of 92% inhibition with concentration of 200 $\mu g \cdot ml^{-1}$ of ZnO-NPs, and as the concentration increases, the anticancer efficiency as well increases, and also, it has excellent photocatalytic activity to degrade crystal violet dye in aqueous solution after irradiation of 90 min. The result suggests that the green synthesis of ZnO-NPs could be easily recovered and reused several times without any significant loss of the catalytic activity. The advantage of this technique lies in its low cost, easily climbable and non-use of toxic agents.

Keywords Nanostructured materials; Catalysis; Scanning electron microscopy; X-ray diffraction

1 Introduction

In the current research area of material science, nanoparticles are found to be main building blocks. Various physical properties like size, shape and surface morphology of the synthesised nanosized particles play a vital role in various fields of its application [1]. Among various metal oxides, zinc oxide is a n-type semiconductor and found to have band gap of 3.3 eV [2] and excitation binding energy of 60 meV [3]. Because of these characteristic properties, ZnO finds application as an efficient photocatalyst for degradation of pollutants in water [4–6]. Various strategies have been applied for zinc oxide nanoparticles (ZnO-NPs) synthesis which includes physical and chemical methods [7, 8]. Physical methods include pulsed layer deposition and thermal deposition [9], and chemical methods such as spray pyrolysis, wet chemical, chemical microemulsion and electrodeposition are widely used [10]. But the reported physical and chemical methods are not eco-friendly and associated with several disadvantages for biomedical application of synthesised nanoparticles. Hence, there is a necessity to

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