Green Synthesis of Platinum and Palladium Nanoparticles Using Peganum harmala L. Seed Alkaloids: Biological and Computational Studies

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Abstract

This study reports a facile and eco-friendly method for the green synthesis of platinum
and palladium nanoparticles (Pt NPs and Pd NPs) using Peganum harmala seed alkaloid fraction.
The ɛ-potential of the synthesized Pt NPs, Pd NPs and PtïPd NPs were ī11.2 Ñ 0.5, ī9.7 Ñ1.2, and
ī12.7 Ñ 2.1 mV; respectively. Transmission electron microscopy (TEM) revealed the formation of
spherical-shaped nanoparticles with smooth margins. The mean diameters of the synthesized Pt NPs,
Pd NPs, and PtïPd NPs were determined using TEM analysis and were found to be 20.3 Ñ 1.9,
22.5 Ñ 5.7, and 33.5 Ñ 5.4 nm, respectively. The nanoparticlesô bioreduction was confirmed by
ultravioletïvisible (UVïvis) spectroscopy, X-ray diffraction (XRD) and Fourier transform infrared
(FTIR) spectroscopy, and their organic contents were determined by thermal gravimetric analysis
(TGA). The PtïPd NPs mixture showed more pronounced antioxidant activity of 843.0 Ñ 60 ÕM
Trolox equivalent (TE)/mg NPs compared to the individual Pt NPs (277.3 Ñ 13.5 ÕM TE/mg NPs)
and Pd NPs (167.6 Ñ 4.8 ÕM TE/mg NPs). Furthermore, the PtïPd NPs exhibited significant
cytotoxic activities against lung cancer (A549) and breast adenocarcinoma (MCF-7) cells, IC50 of
8.8 and 3.6 Õg/mL, respectively; as compared to Pt NPs (IC50 of 10.9 and 6.7 Õg/mL, respectively)
and Pd NPs (IC50 of 31 and 10.8 Õg/mL, respectively and compared to carboplatin (IC50 of 23
and 9.5 Õg/mL, respectively). Moreover, molecular docking studies were conducted to explore the
possible anticancer and antioxidant mechanisms of the biogenic nanoparticles. Pt NPs, Pd NPs,
and their mixture showed inhibitory activity against cysteine proteinase, which supports their high
antitumor activity, but moderate antioxidant activity. In conclusion, Pd-Pt NPs mixture prepared
using harmala seed alkaloid fraction showed potential as effective antineoplastic agents.

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