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Studies on catalytic, antioxidant, antibacterial and anticancer activities of biogenic gold nanoparticles

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ABSTRACT

Biosynthesis of nanoparticles of precious metals has been attaining a surge of interest in recent years. In the present study, phytochemicals present in *Areca catechu* nut have been used for the synthesis of gold nanoparticles at 300 K, 373 K and under microwave irradiation of 2450 MHz. The synthesized nanoparticles have been characterized using UV–visible, TEM, XRD, and FTIR techniques. Perpetual changes in synthesis conditions are bestowed with appreciable morphological variation. An enhanced formation of monodispersed, spherical gold nanoparticles of size 13.7 nm could be obtained under microwave irradiation. XRD pattern confirms the crystalline nature of the as-synthesized nanoparticles. The biomolecules involved in the reduction and stabilization of nanoparticles have been identified using FTIR spectra. The catalytic efficiency of the synthesized gold nanoparticles of varying size distributions has been portrayed through the degradation of the organic pollutants, Methylene blue, Methyl orange, Eosin yellowish and 4-Nitrophenol. The observed size dependent catalytic activity may aid in the rapid elimination of industrial wastes leading to a green environment. The potential of the phytosynthesized nanogold in scavenging the harmful radical NO and the stable radical DPPH has been evaluated. In addition to its cytotoxic effect on HeLa cell lines, gold nanospheroids synthesized under microwave irradiation have been observed to exhibit an enhanced activity against a broad spectrum of bacterial pathogens as well.

1. Introduction

The rapidly growing field of nanotechnology has witnessed several synthesis strategies, ever since its emergence. However, the increased toxicity of metal nanoparticles (MNPS) synthesized using conventional methods [1–5] prompted scientists to search for a greener method. Biomediated synthesis of MNPS has gained wider acceptance over the years. Synthesis of MNPS using phytochemicals is more advantageous as it do not require elaborate processes. Due to their unique and tunable surface plasmon resonance, gold nanoparticles (GNPS) are of great interest to current researchers in nanotechnology. Besides extending their applications in homogeneous and heterogeneous catalysis [6–8], GNPS have made a significant mark in biological fields as well [9,10]. The fascinating properties of GNPS enable their extensive application as biomedicine, biosensor and as an indispensable component in many electronic and magnetic devices [11–13]. The synthesis of nanogold using extracts of plant species has always been recognized as one of the greener methods of preparation. Few notable works in this field include the use of extracts of *Azadirachta indica* [14], *Cymbopagon flexuosus* [15], *Cinnamomum camphora* [16], *Emblica officinalis* [17] and *Zingiber officinale* [18].

In this paper, the aqueous extract of areca nut has been used as the biological reductant of GNPS. Areca nut is the seed of the *Areca catechu* (Ac) tree cultivated in East Africa, South East Asia and the Pacific Islands. It is usually referred to as 'betel nut' chewed along with betel leaves. Areca nut constitutes carbohydrates, fats, proteins, crude fiber, polyphenols (terpenoids, flavonoids, and tannic acid), alkaloids and minerals. All the plant parts are considered to have therapeutic values. The ingredients present in areca nut have possible uses in cosmeceuticals, schizophrenia and psychosis. Phenolic components in this nut efficiently inhibit hyaluronidase activity. The alkaloid and polyphenols present in Ac enhance the healing of wounds owing to burns and skin graft surgery. Their use further extends to the treatment of constipation, dyspepsia, beriberi and oedema [19–21]. Easy procurement, non toxicity, cost effectiveness and bioactivity make areca nut feasible for use as a reducing agent.

Dyes widely used in textile and dyestuff industries are not readily biodegradable. In addition to being carcinogenic to various life forms, the deleterious effects of these hazardous materials cause severe environmental contamination. Traditional techniques such as flocculation, membrane separation and ultrafiltration are ineffective to decolorize organic dyes due to their stability and complex atomic structure [22,23]. In the present study, the catalytic degradation of Methylene blue (MB), Methyl orange (MO), Eosin yellowish (EY) and 4-Nitrophenol (4-NP) in the presence of the synthesized gold colloids have been carried out.

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