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Catalytic and antioxidant properties of biogenic silver nanoparticles synthesized using *Areca catechu* nut

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ABSTRACT

The paper reports a simple, versatile and ecofriendly protocol for the synthesis of silver nanoparticles using the aqueous extract of *Areca catechu* nut and its application in catalysis and antioxidant activity. Nanoparticles of varying sizes have been synthesized at 300 K and 373 K. The synthesized nanoparticles are characterized by UV–visible spectroscopy, Transmission Electron Microscopy, X-ray diffraction analysis and Fourier Transform Infra-Red Spectroscopy. The newly formed silver nanoparticles are stable, spherical and crystalline with average particle size varying from 18.2 to 24.3 nm on changing the temperature. The phytochemicals involved in the reduction and stabilization of silver nanoparticles are identified using FTIR spectra. The synthesized silver nanoparticles show potent catalytic activity in the degradation of organic pollutants (methylene blue, Eosin-yellowish, methyl orange, and 4-nitrophenol). The catalytic activity is found to be size dependent and the degradation reaction is observed to obey pseudo-first order kinetics. Moreover, antioxidant studies on the as synthesized nanoparticles reveal efficient scavenging of the stable or harmful free radicals including DPPH, NO and OH. The catalytic and antioxidant activities of the biogenic nanoparticles would find applications in environmental and biomedical field.

1. Introduction

Nanotechnology is an emerging field dedicated to creation, improvement, and utility of nano-scale structures [1]. Noble metal nanoparticles have shown remarkable potential for numerous applications in various fields due to their distinctive properties, when compared to their bulk counter parts [2]. As a relatively inexpensive noble metal, silver nanoparticles (SNPs) have received more consideration due to their tremendous applications especially in the fabrication of sensors, electronic devices, ultrafast data communication, catalysis, optical materials and biomedicine [3–5]. SNPs of desired size and morphology can be synthesized by several physical and chemical methods such as electrochemical reduction, thermal evaporation and photochemical reduction [6,7]. However, the hazardous chemicals, toxic organic solvents and harmful reducing compounds used in the synthesis protocol may bind the surface of nanoparticles hindering their application in biomedical field [8]. Hence there is a growing need to develop biocompatible, robust, and environmental friendly synthetic strategies for the synthesis of SNPs.

In this study we have explored the potential of *Areca catechu* (AC) nut as a biological reductant in the formation of SNPs. AC nut frequently known as betel nut can be chewed wrapped in betel leaves and is a common drug masticator in various countries. The AC nut contains phytochemicals such as polyphenols (flavanoids, terpenoids, and tannic acid) proteins and alkaloids (guvacine, guacoline, arecoline etc.). It is widely used in the preparation of ayurvedic and traditional Chinese medicines and also for the treatment of various diseases such as leucoderma, leprosy, anemia, obesity, constipation, beriberi, dyspepsia, elimination of tapeworms and intestinal parasites [9–12]. The biocompatibility, non-toxicity, and easy availability of this dried nut motivate the investigator to utilize it in the phytosynthesis of SNPs.

Synthetic dyes used in many industries including production of cosmetics, food, paint, paper, plastics, and textiles cause serious environmental problems due to their intense color and are refractory to degradation. Conventional treatment methods like adsorption, ultrafiltration, coagulation, reverse osmosis etc. are ineffective for decolorization and mineralization of these pollutants due to their complex aromatic structure and stability. Therefore, a new treatment technique is required either for the elimination of these persistent pollutants or for their conversion to a harmless product. Nanocatalysis is a fast developing area of research in which metal nanoparticles are used as catalysts for a wide range of chemical reactions [13–16]. In the present work, the catalytic degradation of the dyes methylene blue (MB), eosin yellowish (EY) and methyl orange (MO) by sodium borohydride ($NaBH_4$) in the presence of the synthesized silver colloids has been carried out. Further, the catalytic reduction of 4-nitrophenol (4-NP), an anthropogenic pollutant, has been investigated.

Aerobic organisms produce a number of reactive free radicals in cells during respiration and metabolism. These free radicals formed within

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