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Short Communication

Green synthesis of colloidal copper oxide nanoparticles using *Carica papaya* and its application in photocatalytic dye degradation

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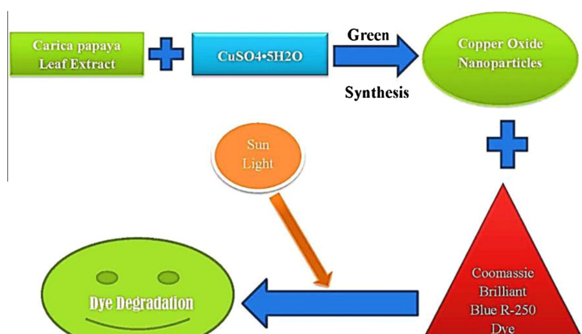
HIGHLIGHTS

- Green synthesis of copper oxide nanoparticles using *Carica papaya* leaves extract.
- The reaction was made at room temperature.
- Characterization of copper oxide nanoparticles by UV–vis spectroscopy, DLS, SEM, FT-IR and XRD.
- Photocatalytic degradation of Coomassie brilliant blue R-250 by copper oxide nanoparticles.

GRAPHICAL ABSTRACT



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ABSTRACT

Copper oxide (CuO) nanoparticles were synthesized by treating 5 mM cupric sulphate with *Carica papaya* leaves extract. The kinetics of the reaction was studied using UV–visible spectrophotometry. An intense surface Plasmon resonance between 250–300 nm in the UV–vis spectrum clearly reveals the formation of copper oxide nanoparticles. The results of scanning electron microscopy (SEM) and dynamic light scattering (DLS) exhibited that the green synthesized copper oxide nanoparticles are rod in shape and having a mean particle size of 140 nm, further negative zeta potential disclose its stability at −28.9 mV. The Fourier-transform infrared (FTIR) spectroscopy results examined the occurrence of bioactive functional groups required for the reduction of copper ions. X-ray diffraction (XRD) spectra confirmed the copper oxide nanoparticles crystalline nature. Furthermore, colloidal copper oxide nanoparticles effectively degrade the Coomassie brilliant blue R-250 dye beneath the sunlight.

Introduction

Recent advances in nanotechnology have led to the extensive development in different fields containing a synthesis of nanoparticles, nanotubes and nanowires, due to their surface enhanced Raman scattering (SERS) and surface Plasmon resonance (SPR). Metal nanoparticles have widespread consideration because of its request in the variety of fields including biomedical sciences, chemical industry, electronics, drug–gene delivery and biosensor

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etc. [1]. Currently, a large number of chemical and physical approaches are available to synthesize diverse types of metal nanoparticles but they are limited only. There are several problems arising when nanoparticles are synthesized by chemical methods which include usage of toxic chemicals and it's dangerous by products. However, synthesis of metal nanoparticles through green route is an ecologically friendly, cost effective method without use of tough chemicals [2]. Between numerous metal nanoparticles, copper oxide nanoparticles have concerned attention due to their mechanical and biological properties with up-to-date technologies [3]. Specially, copper oxide nanoparticles have recently found to be potentially useful in gas sensors and dye-sensitized solar cells [4]. However, limited evidence only accessible for copper oxide nanoparticles green synthesis and its role in photocatalytic dye degradation.

The enormous volume of environmental pollutants, non-degradable and carcinogenic natured colored dye effluents is discharged by the textile and paper industries. Moreover, to unique in their products most of the industry uses color dyes, without any treatment the coloring materials are liquidated in water leads to contamination of resources [5]. These dye pollutants are chemically stable, so technologies relating to UV radiation and hydrogen peroxide oxidation are not effectively deal with degrade the color dyes. At present, photocatalytic method got the extensive attention due to its effective decolorization of dyes [6]. In the photocatalytic reactions the semi conducing materials absorb light energy more than or equal to energy gap which generates the whole and elections, which further gives rise to efficient oxidizers of organic dyes. Besides, the recent findings showed metal nanoparticles were successfully used in the degradation of color dyes. Since plant mediates synthesis of metal nanoparticles can be profitable when compared with chemical and physical method [7–9]. Herein, we have focused our study on the photocatalytic degradation of commercially used organic dye Coomassie brilliant blue R-250 in the incidence of green synthesized copper oxide nanoparticles.

Materials and methods

Green synthesis of copper oxide nanoparticles

Intended for the synthesis of copper oxide nanoparticles *Carica papaya* (*C. papaya*) leaves were washed systematically with deionized water and shadow dried for 14 days. The dried leaves were powdered using a mixer grinder. Formerly, 10 g of powder dispersed in 100 ml of deionized water in an Erlenmeyer flask followed by boiling at 60 °C for 10 min. After bringing back to room temperature, the extract filtered using Whatman No. 1 filter paper and the filtrate was stored at 4 °C until further use. Meant for copper oxide nanoparticles synthesis 90 ml of 5 mM cupric sulphate ($CuSO_4{\cdot}5H_2O$) solution was mixed with 10 ml of leaves extract and allow to stand at room temperature until further color change occurs. An indicator for synthesis of nanoparticles the color change was compared with (leaf extract and 5 mM Copper sulphate) control solution.

Characterization of copper oxide nanoparticles

UV–visible double beam spectrophotometer (UV-1601, Shimadzu, Japan) used for confirming the synthesized copper oxide nanoparticles. Fourier transform infrared spectroscopy (FT-IR) spectrum was achieved by spectrum RX-1 instrument in diffuse reflectance mode functioned at a resolution of 4 cm^{-1}. Malvern

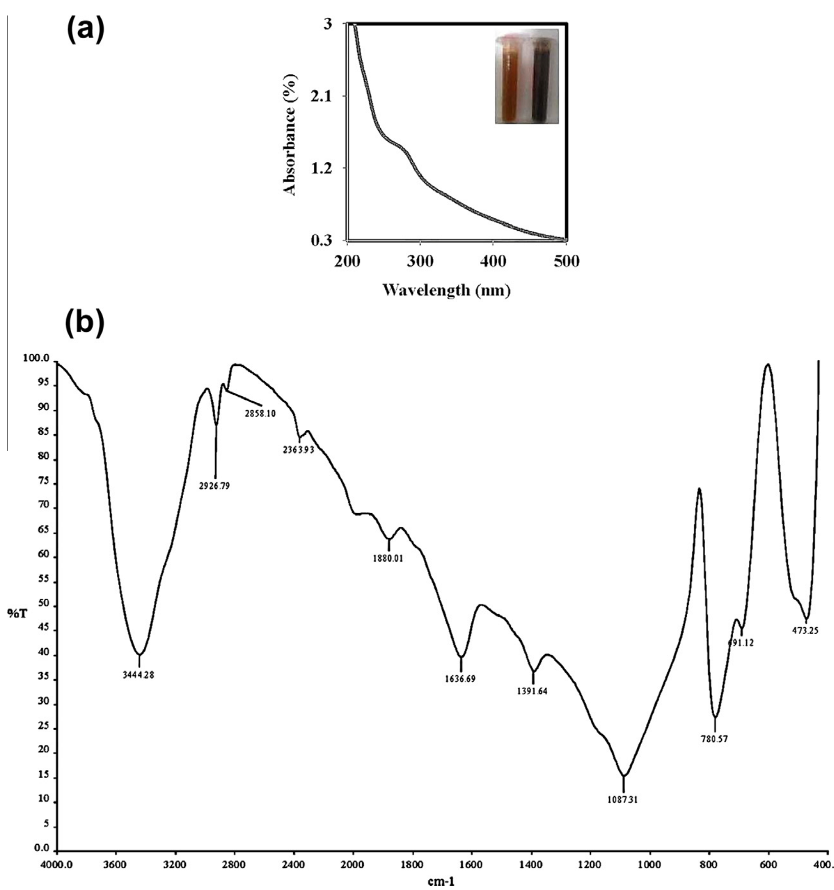

Fig. 1. (a) UV–vis spectra of copper oxide nanoparticles; (b) FT-IR spectrum.