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Decolourization of Congo red using Photoinduced Green Synthesized Copper Oxide Nanoparticles

Vaidehi. D, V. Bhuvaneshwari*, B. Pavithra Sheetal and A. Sivaranjini

PG and Research Department of Biotechnology, Kongunadu Arts and Science College, Coimbatore - 641029, Tamil Nadu, India.

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*Author to whom corresponding should be addressed

Email: bhuvana_bt@yahoo.co.in

Abstract: Copper oxide nanoparticles (CuO NPs) synthesized by *Solanum lycopersium* leaf extract using sunlight irradiation were used in this study. The industrial dye, Congo red cannot be decolorized effectively, as they resist fading and thus are persistent to biological degradation. Thus the decolorization potential of green synthesized CuO NPs was evaluated based on the removal of Congo red (CR) in aqueous solution. The extent of CR dye decolourization by CuO NPs was monitored using a UV-visible spectrophotometer could able to the Congo red dye decolorization potential of photoinduced CuO NPs was 25.56±0.2% and 61.2±0.4% after 24h and 48h respectively. The UV-spectral data in the wavelength range of 350-600nm showed simultaneous disappearance of peaks in both visible range and UV range after 48h of treatment with photoinduced CuO NPs. This present study reported that the green synthesized CuO NPs can effectively degrade the textile industrial dye Congo red.

Keywords: *CuO NPs, Congo red, green route, Solanum lycopersium, UV-Vis*

1. INTRODUCTION

Dyes have been widely used as additives and colorant in textile, food, ink, leather, printing, drugs, cosmetics and pharmaceutical industries. Over the years, synthetic dye is overpoweringly used as an alternative of natural dye due to its high performance and cost effectiveness. It was reported that approximately 30% dyes were used in excess of 1000 tons per annum (Forgacs *et al.*, 2004). As a result, the waste dyes and their byproducts contaminate the water sources with unexpecred, unpleased colour and toxic nature (Baban *et al.*, 2010 and Robinson *et al.*, 2011).

The major concern is due to the release of wastewater containing high concentration of dyes that is highly colored and toxic to the environment. Colored water affects the visibility of water and inhibits sunlight penetration to the stream. Furthermore, it should be noted that various kinds of chemicals presence in dyes can cause carcinogenic and mutagenic effects to human beings and wildlife (Namasivayam *et al.*, 1997). Among dyes, the bright red coloured Congo red (CR) and it was mostly used textile industry dye, one such Azo dye is commonly applied in silk cloth manufacturing unit. Congo red is sodium salt of 3,3'-([1,1'-biphenyl]-4,4'-diyl) bis(4-aminonaphthalene-1-sulfonic acid ($C_{32}H_{22}N_6Na_2O_6S_2$) with molecular weight of 696.66 gmol-1 (Maithri *et al.*, 2014).

Congo red cannot be efficiently decolorized because they are designed to resist fading and thus persistent to biological degradation. Difficulties encountered in dyeing wastewater treatment have lead the continuous development of advanced water purification method. The previous studies reported that the attempt of physical process such as adsorption, bio degradation and some chemical process using chlorination and ozonation methods. The organic compound

transfer from the liquid phase to the solid phase. For instance, dyes pollutants are transferred by adsorption onto the absorbent. Among the absorbents, activated carbon is highly effective in removal of dyes. Walker *et al.*, (1997) reported that activated carbon can bind acid dyes. However, activated carbon is not encouraging owing to its high cost (Acemioglu *et al.*, 2004). Besides, further treatments are needed to treat the waste stream generated after filtration for complete degradation of dyes. Additionally, it was observed that green synthesized nanoparticles were found to increase in the different fields such as synthetic chemistry, biotechnology, environment and environmental sciences. Among various nanoparticles, CuO NPs are considered as an alternative source of degradation of atmospheric pollutants.

Nanoparticles are synthesised by conventional methods such as solvo-thermal micro emulsion, co-precipitation, sol-gel spray pyrolysis and solo-thermal methods, the limitations are remarkably taken into account due to the poisonous compounds used for preparation of nanoparticles. Further, the green synthesis method developed to overcome all the environment destructive chemicals. The plant extract mediated nanoparticles were used for several pharmacological and environment friendly application due to presence of phenolics, flavonoids and alkaloids etc., (Madhumitha *et al.*, 2009; Madhumitha *et al.*, 2014; Madhumitha *et al.*, 2013; Madhumitha *et al.*, 2012 and Roopan *et al.*, 2013).

2. MATERIALS AND METHODS

2.1 Materials: Green synthesised and photo induced CuO NPs were used for Congo red dye decolourization. Congored purchased from HiMedia, India.

2.2 Preparation of CuO NPs for dye decolourization: About 1mg /10ml concentration of CuO NPs was prepared by sonication (20 min). The dispersed CuO nanoparticle was used for the dye degradation of Congo red.

2.3 Preparation of Congo red dye: About 1mg/ml final concentration of Congo dye was mixed with 1000µl of CuO NPs (1mg/10ml) and made up with 10ml of distilled water and incubated at room temperature. The dye decolourization was observed in different time intervals (0hour, 24hour and 48hour). At intervals of 24 hours and 48 hours aliquots of the different dye treatments were read against the water blank in the UV-Visible spectrophotometer at the maximum absorption λ_{max}= 497 nm. The percentage decolorization was calculated as follows:

% dye decolorization = A0-A1/A0 X 100

Where,

A0 - untreated dye Absorbance and

A1 - Absorbance after dye treatment

2.4 UV-Visible spectroscopy for dye decolorization: The UV spectra pattern of dye degradation, wavelength survey scans of absorbance values from 350-600 nm range was generated for each treatment along with untreated control.

3. RESULTS AND DISCUSSION

3.1 Analysis of Dye degradation by CuO NPs: CR dye decolorization was carried out with and without CuO NPs. The absorbance of decolourization of CR dye using CuO NPs showed reduced absorbance after 24h and 48h at 495nm. The degradation pattern has been monitored using VU-Vis spectro-photometer. The results from the absorbance of dye degradation reveal that there is no shift of absorption peak of dye (Fig.1). However, depends on the discoloration and reduced peak area of CR dye peak and reduced absorbance at 495nm, the CR dye degradation was observed in the presence of photo-induced green synthesized CuO NPs.

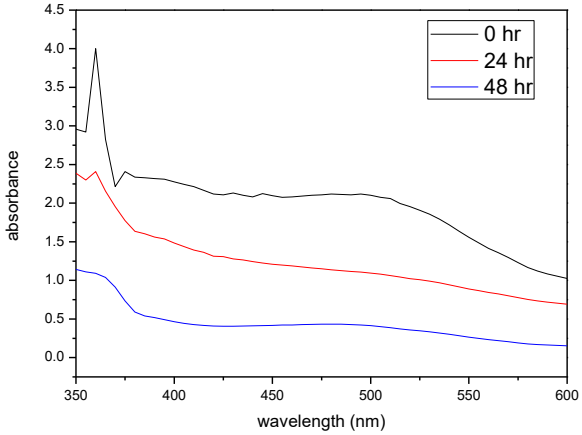

Fig.1: UV-Vis spectrum of NPs treated dye

From the degradation peak pattern, the Congo red showed a main maximum peak at 500nm and other absorption peak at 360nm. The positive hole on CuO NPs was the major constituents of degradation of Congo red

dye (Laouedj *et al.,* 2011). The degraded product was identified using their mass fragment via cleavage of benzene ring, cleavage of C–S bond from the aromatic ring, breaking of C–N and C–C bond of chromophore and N=N cleavage (Erdemoglu *et al.,* 2008).

4. CONCLUSION

In this research work, CuO NPs prepared by green synthesis and sunlight irradiation were used to decolourize CR as measured by UV-Vis spectrophotometer. The CuO NPs are capable to decolourize 61.2±0.4% CR after 48h. Therefore, the photoinduced and green synthesized nanoparticles may lead to many applications including industrial dye effluent treatment.

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Conflict of Interest: The authors declare that they have no conflict of interests.

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