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Degradation of AZO dye using plants based silver nanoparticles through ultraviolet radiation

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ABSTRACT

The present study evaluates the different plant mediated green synthesis of silver nanoparticles which was used to degrade the AZO dye through UV light. The degraded dye was analyzed by UV/Vis spectrophotometer. The AZO dye was highly degraded by the coconut tree inflorescence extract based Ag-NPs, was performing as an excellent catalyst under UV photo catalytic dye degradation method.

1. Introduction

Dyes are very important role in our daily life. The main sources of dyes were extracted from plants and animals called as natural dyes before the nineteenth century (Mariselvam et al., 2015, 2017). The middle of nineteenth century identification of chemical dyes was completely eradicated the natural dye usages (Mariselvam et al., 2016). To increase the chemical dye usages was polluted the environment mainly water resources like river, ponds including ground water (Akpan and Hameed, 2009).

AZO dye is one of the major chemical dyes used in textile industries for dying fibre and fabric materials (Tianwen et al., 2008; Xiukai et al., 2007). The textile industrial waste water (effluents) contains AZO group, it was mixed and polluted the water sources. It caused many environmental problems and health effects on living systems including human (Neppolian et al., 2002; Abdul and Katrina, 2005).

The present study deals with the synthesis of silver nanoparticles from various plant sources and these Ag-NPs used to degrade the AZO dye through ultraviolet photo catalytic method.

2. Materials and methods

2.1. Collection and preparation of plant materials

Rubia cardifolia (L) plant roots were purchased from Nagercoil district, Tamilnadu. Seeds of *Syzygium cumini* (L) and *Cocos nucifera* (L) tree inflorescence were collected from garden in kadayam region, Tirunelveli district, Tamilnadu.

The collected plant materials were washed with distilled water. Then it was shade dried and powered with the help of mortar and pestle. Ten grams of powered plant materials mixed with 90 mL of double distilled water and heated at 90 °C, Filtered using Whatmann No. 1 filter paper for further studies.

2.2. Preparation of Ag-NPs

Ninety millilitres of 1 mM silver nitrate ($AgNO_3$) solution mixed with 10 mL of plant extract. The reaction mixture was continuously stirring at room temperature (Mariselvam et al., 2014). The colour of the reaction mixture was changed to formation of nanoparticles.

2.3. Preparation of AZO dye

The AZO dye was purchased from Merk, India. One grams of AZO dye dissolved in 1000 mL of double distilled water. The dye concentration was 0.1%. Then these prepared dye for further studies.

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2.4. Dye degradation by UV photo catalytic method

Hundred millilitres of 0.1% AZO dye was mixed with 10 mL of prepared plant based Ag-NPs. The reaction mixture was continually stirred under UV light (Mariselvam et al., 2016). The wavelength range of the UV source is 354 nm. The whole reaction carried at room temperature (36 ± 1).

2.5. UV/Vis spectral study

The synthesized plant based nanoparticles, AZO dye, before and after degradation AZO dyes were analyzed by UV–Visible double beam spectrophotometer 2203.

3. Results and discussion

The colour of the *Rubia cardifolia* (L) plant root extract mediated Ag-NPs are brown in colour (Fig. 1a). The major absorbance of *Rubia cardifolia* (L) plant based Ag-NPs present in 340–350 nm (Fig. 2). The yellowish brown colour silver nanoparticles synthesized using *Syzygium cumini* (L) seed extract (Fig. 1b). These silver nanoparticles have a major absorption in the visible range 400 nm (Fig. 2). The *Cocos nucifera* (L) inflorescence extract mediated silver nanoparticles are reddish pink colour (Fig. 1c). This nanoparticles have a major absorption in the range of 420–430 nm (Fig. 2).

AZO dyes are analyzed by UV/Vis spectral study. The UV spectral data contains two major absorbance peak presented in 245–250 nm and 345–355 nm, these two absorption band responsible for n → π* electron transition (Fig. 3).

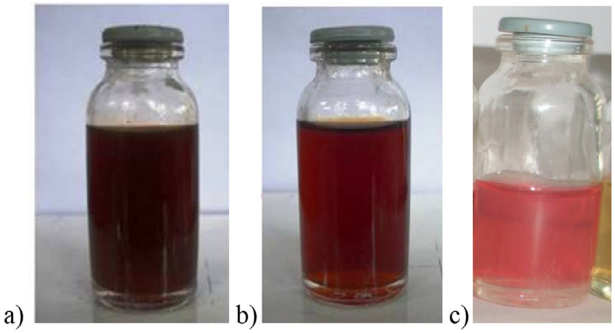

Fig. 1. Plant extract mediated green synthesized silver nanoparticles. 1a. *Rubia cardifolia* plant root extract mediated Ag-NPs. 1b. *Syzygium cumini* seed extract based silver nanoparticles. 1c. *Cocos nucifera* inflorescence extract mediated silver nanoparticles.

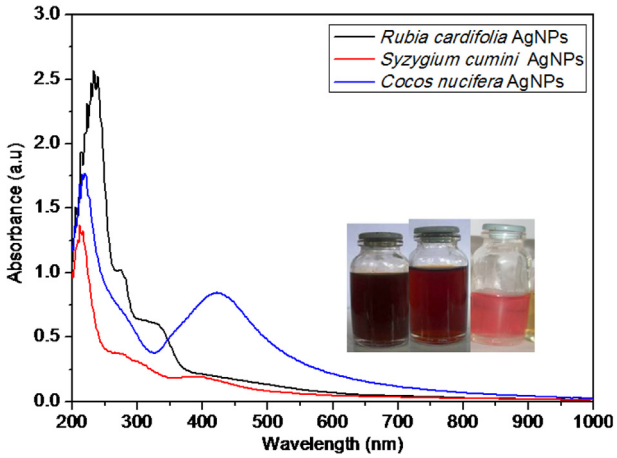

Fig. 2. UV/Visible spectral analysis of green synthesized Ag-NPs.

Three different plants based Ag-NPs were used to degraded the AZO dye. After 2 h UV light incubating, the *Cocos nucifera* (L) tree inflorescence extract mediated nanoparticles was highly degrade the AZO dye compare than *Rubia cardifolia* (L) and *Syzygium cumini* (L) plant based silver nanoparticles (Figs. 4–6).

The absorbance of AZO dye in 250 and 354 nm at 2.408, 2.400 respectively (Fig. 3 & Table 1). The absorption of *Rubia cardifolia*

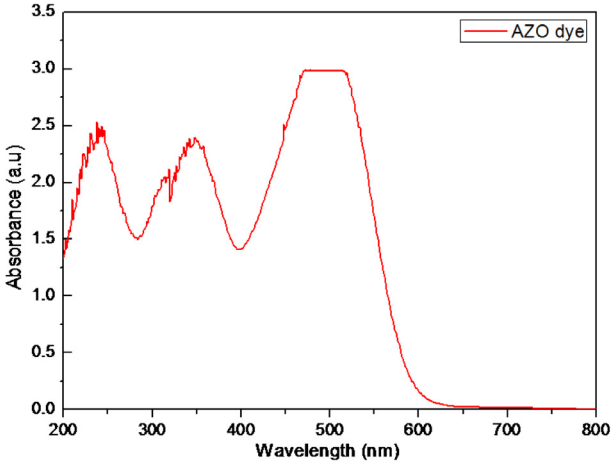

Fig. 3. UV/Visible spectral analysis of AZO dye.

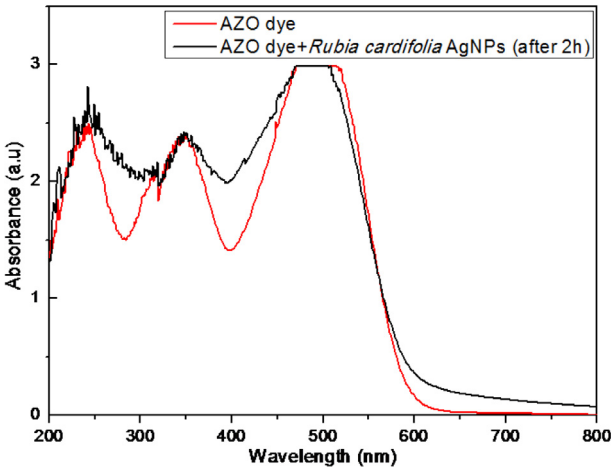

Fig. 4. UV/Visible spectral analysis of *Rubia cardifolia* plant root extract based silver nanoparticles mediated degraded AZO dye.

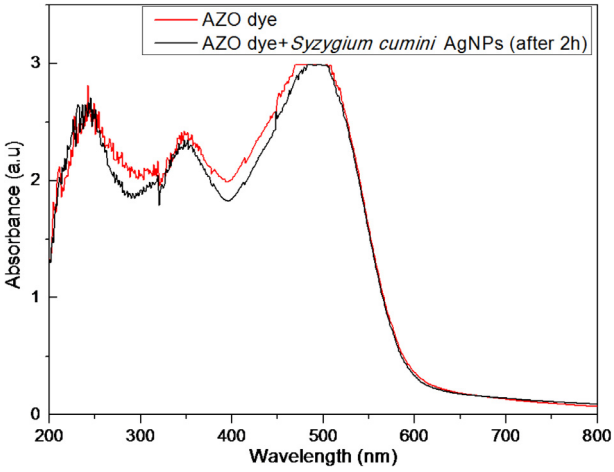

Fig. 5. UV/Visible spectral analysis of *Syzygium cumini* plant seed endosperm extract based silver nanoparticles mediated degraded AZO dye.

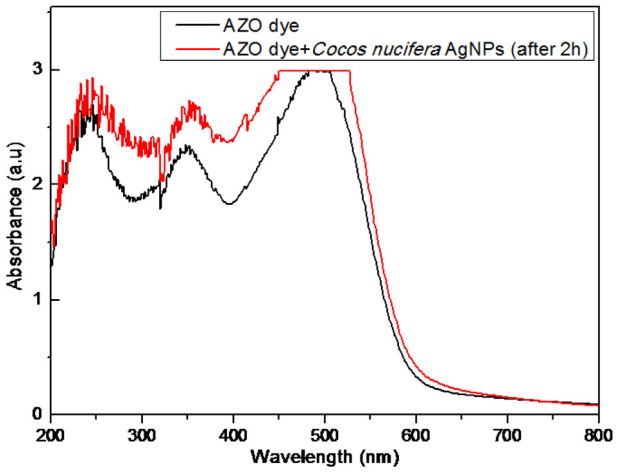

Fig. 6. UV/Visible spectral analysis of *Cocos nucifera* inflorescence extract based silver nanoparticles mediated degraded AZO dye.

Table 1
The major absorbance of AZO dye.

S.No	Dye	Absorbance at 250 nm	Absorbance at 354 nm
1	AZO dye	2.408	2.400

Table 2
The major absorbance of degraded AZO dye using different plant based silver nanoparticles.

S. No	Plants used in Ag-NPs preparation	After degradation of AZO dye	
		Absorbance at 250 nm	Absorbance at 354 nm
1	*Rubia cardifolia*	2.502	2.405
2	*Syzygium cumini*	2.505	2.401
3	*Cocos nucifera*	2.709	2.800

(L) plant based silver nanoparticles mediated degraded AZO dye at 2.502, 2.405 respectively in the wavelength of 250 and 354 nm (Fig. 4 & Table 2). The absorption of *Syzygium cumini* (L) seed endosperm extract based silver nanoparticles mediated degraded AZO dye at 2.505, 2.401 respectively in the wavelength of 250 and 354 nm (Fig. 5 & Table 2). The absorbance range at 2.709, 2.800 in the wavelength of 250 and 354 nm in UV spectral data of the *Cocos nucifera* (L) inflorescence based Ag-NPs mediated degraded AZO dye (Fig. 6 & Table 2).

4. Conclusion

The poverty of AZO dye proceeds mainly during the monochromatic UV light irradiation as reflect by the radical move. The comparable of different plant based silver nanoparticles are used to degrade the AZO dye under UV light radiation. The AZO dye was highly degraded by the coconut tree inflorescence extract based Ag-NPs, was performing as an excellent catalyst under UV photo catalytic dye degradation method.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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