Biosynthesis of Silver Nanoparticles using MANJARI leaves and its Photocatalytic Activity

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Abstract

Nanoparticles (NPs) are extensively employed in numerous fields. Researchers' interest in environmentally friendly nanoparticle biogenesis is growing as green nanotechnology advances. Using MANJARI leaf extract and its photocatalytic degradation of MB dye, this study explores an effective and sustainable method of biosynthesis of stable silver nanoparticles (Ag NPs). The impact of several parameters, such as the concentration of dye, PH, and the amount of nano catalyst, is also examined. A straightforward, economical, and environmentally beneficial process was used to create Ag NPs using MANJARI leaf extract and aqueous silver nitrate solution. The produced silver nanoparticles were then examined with a UV-Vis spectrophotometer.

Keywords: Biosynthesis, MANJARI leaves, photocatalytic activity, Ag NPs

1. Introduction

The need for clean drinking water is growing at an alarming rate, making it a global concern. Three main causes of this dilemma are the growing population, changing climate, and fast industrialization. It will need a team effort from people, institutions, and governments to solve this problem. Researchers have become more interested in the photocatalytic activity of biosynthetic nanoparticles in recent years. Businesses alone discharge a significant volume of effluents into water bodies that contain organic dyes. MB dyes are widely employed as colourants in a variety of factories, including those that produce plastic, paper, cosmetics, textiles, and pharmaceuticals (1). These dyes are extremely toxic, detrimental, deadly, and non-biodegradable. They can cause serious illnesses like cancer and skin conditions, as well as occasionally trigger allergic reactions. The composition of the chemical. Numerous methods of treating waste water, including adsorption, membrane filtration, ion exchange, co-aggulation-flocculation, and others (2). Nevertheless, these methods are quite costly and frequently transfer some very poisonous pollutants. Therefore, it is imperative to develop a low-cost, environmentally friendly method for degrading a dye contaminant from industrial waste water. Many sources, including plants, animals, and microbes, have been used to create nanoparticles (3). There are numerous uses for green synthesised silver-based nanoparticles in biology, medicine, and the environment. Such as an antibacterial, antimicrobial, and photocatalytic activity (4-5). The reason for the interest in MANJARI is the high concentration of triterpens, flavonoids, and eugenol in the leaf extract, which may diminish the characteristics of silver ions to silver nanoparticles (6–8). The MANJARI leaves broth was utilised in the current effort to synthesise. This plant has strong antimicrobial and antioxidant activity and is widely used to stimulate the appetite and ease stomach upset (9). Hence, the present preliminary work represents the simple, cost-effective and eco-friendly technique for green synthesis of Ag NPs using MANJARI leaf broth and studied its photocatalytic activities. MANJARI leaves are available in the local college campus. The effects of different operational parameters on the degradation of dye have also been studied along with their reaction kinetics.

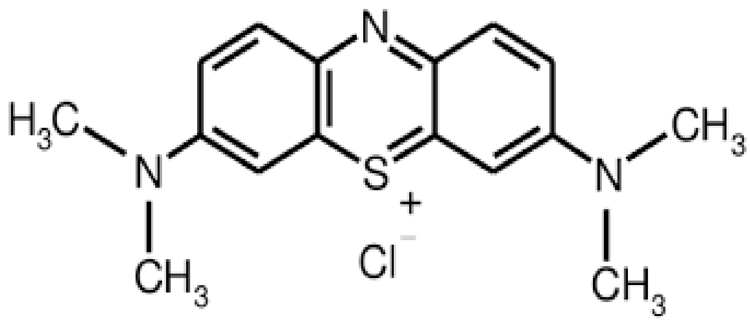

Fig. 1 chemical structure of the MB dye

2. Reagents and chemicals

Silver nitrate ($AgN0_3$) was purchased from Merk (Germany). All chemicals and reagents used were of the analytical grade as received and without further purification. All aqueous solutions were prepared with doubly-distilled water. Hydrocloric aid and Sodium hyrooxide used to maintain to pH.

2.1 Preparation of the leaf extract

Fresh and healthy leaves were collected locally and rinsed by double distilled water to remove all the soil and unwanted visible particles, cut into small pieces and dried at room temperature. About 25 g of these finely incised leaves of plant were weighed and transferred into 250 mL beakers containing 150 mL distilled water and boiled for about 45 min. After cooling, the extracts then filtered through Whatman filter paper No. 1 to remove particulate matter and to get clear solutions. which were then refrigerated low tem. in 100 mL conical flasks for further experimental uses.

2.2 Silver nanoparticle (Ag NPs) synthesis

Silver Nanoparticles were prepared by using by MANJARI leaf extract as a Green reducing agent. 100 ml of MANJARI extract was added to 30 ml of 1 mM $AgNO_3$ doubly distilled water solution in the conical flask under constant stirring rate and incubated in water bath at 65^{O}C for 40 min for the reduction of Ag^+ ions. Green reduction was observed by color change dark brown. The formation of color occurred due to the excitation of surface Plasmon resonance of the silver nanoparticles [10]

Govindaraju et al.[11] reported the color change to brownish yellow while synthesizing silver nanoparticles using the leaf extract of Solanum torvum.

3. Characterization of silver nanoparticles

The UV-Vis spectrum of this solution was recorded with a UV/Vis spectrophotometer optimal analytical wavelength compared with doubly distilled water used as a blank solution. The reduced silver solution showed highly optical absorption band peak at 426 nm for MANJARI leaf extract (12). The slight variation in the values of absorbance signifies the changes due to variation in the particle size. Increasing the concentration of extract increases the intensity of absorbance. (13) UV–Vis spectrophotometer is one of the most notable features of the optical absorption spectrum of AgNPs in the Surface Plasmon Resonance (SPR).

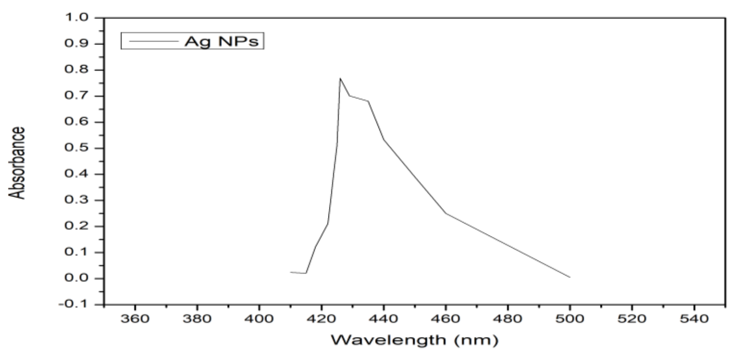

Fig. 2. Ultraviolet-visible (UV-vis) Spectra of Biosynthesis of silver nanoparticles

4. Result and Discussion

4.1 Photocatalytic activity of Ag NPS

A photocatalytic experiment was performed to establish that photocatalysis occurred, when light and a photocatalyst were involved. The experiment was performed with the sample of initial concentration of dye 10mg/L, Ag-NPs as a PC, and solution of pH 8.5. To investigate the photocatalyst adsorption, the dark run was also conducted with photocatalyst present but without light irradiation. Additionally, the photolysis run was performed with light irradiation rather than the presence of a photocatalyst. Photocatalyst and light irradiation were used to conduct the photocatalysis run.

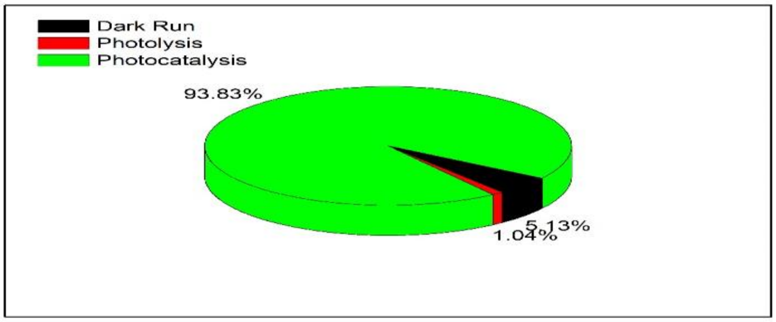

Fig.3: Photocatalytic activity of PC

4.2 Effect of the initial dye concentration

Experiment was carried out by varying the initial concentrations of the dye from 10 to 25 mg/L in order to assess the appropriate amount of catalyst dose. As the concentration of the dye was increased, the rate of photo decolorization decreased indicating for either to increase the catalyst dose or time span for the complete removal. Figures 6 at different concentrations of dye solutions (10–25 mg/L). The possible explanation for this behavior is that main aspects as the initial concentration of the dye increases, the path length of the photons entering the solution decreases and less transmission of light through the wastewater. (14-15) and in low concentration the reverse effect is observed, thereby increasing the number of photon absorption by the catalyst in lower concentration and In high dye concentrations, more active sites may be covered with dye ions.

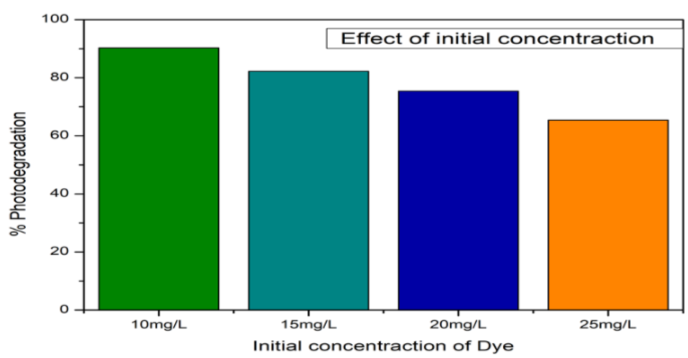

Fig.4: Variation in Photodegradation w/r/t Initial Concentration of Dye

4.3. Effect of Photocatalyst Loading:

It can be seen that initial slopes of the curves increase greatly by increasing catalyst loading from 0.5 mg to 1.5 mg/L for MB degradation. thereafter the rate of decolorization remains constant or decreases. Further increase in the dose of catalyst had no significant effect on decolorization of dyes. The photocatalytic destruction of other organic pollutants has also exhibited the same dependency on catalyst dose. Because the total active surface area of the catalyst rises with an increase in dosage, more active sites are available on the catalyst surface. (16)

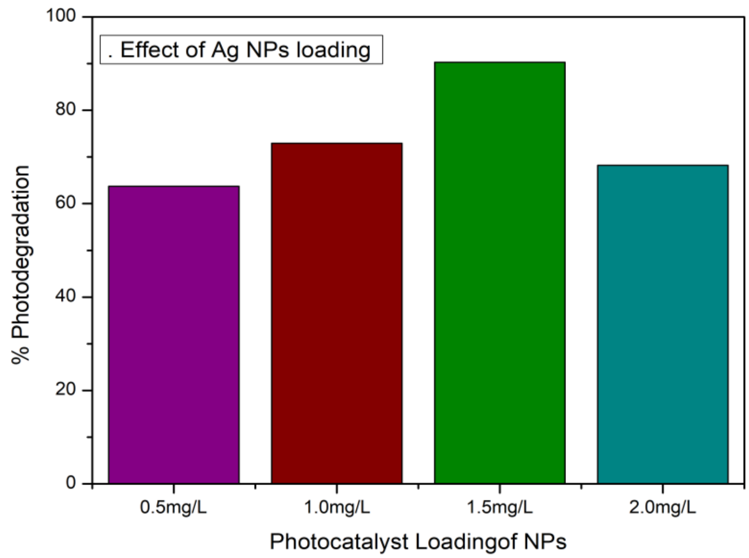

Fig. 5: Variation in % Photodegradation w/r/t Photocatalyst Loading

4.4 *Effect of Variation in pH*

Wastewater containing MB dyes is discharged at different ph. Experiments were conducted at different pH levels, ranging from 4.5 to 10.5 for constant dye concentration (10 mg/L) and catalyst loading (1.5 mg/L, respectively), in order to investigate the impact of pH on the decolorization efficiency. It has been found that the decolorization efficiency of MB dye rises with increasing pH, with the maximum rate of degradation occurring at pH 8.5. The difference in degradation results can be attributed to the different in type of used catalyst.

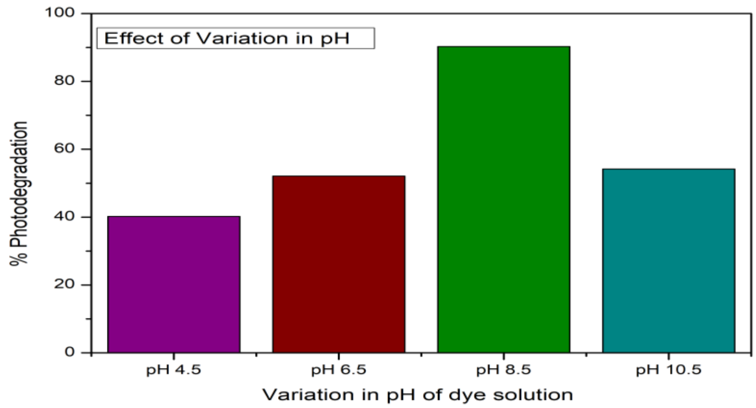

Fig. 6: Variation in % Photodegradation w/r/t pH of solution

5. Conclusion

In conclusion, MANJARI leaf extract was used to create silver nanoparticles by a straightforward, quick, and environmentally safe biological process. When exposed to the plant extracts, reduction of silver ions into metallic silver showed a colour shift. UV-Vis spectroscopy proved to be an effective approach for the examination of nanoparticles for their characterization. When exposed to sunshine, the nanoparticles were found to be effective and active catalysts for the breakdown of MB dye. According to the results, Ag NPs have a great potential for quickly degrading dyes; as a result, they may be employed extensively in the future to completely remove dangerous dyes from waste water.

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