Green synthesis of silver nanoparticles TULSE leaves and its photocatalytic activity for MB dye degradation

[1]Jagdeesh meena, [2]Munesh lal meena, [3]Preetem singh meena, [4]Hariom meena

[1,2,3,4]Assistant Professor
Department of Chemistry
Govt. PG College
Karauli (Rajasthan)-322241, INDIA

***Abstract*- Nanoparticles (NPs) are being widely used in different fields. Development of green nanotechnology is generating interest of researchers toward ecofriendly biosynthesis of nanoparticles. This study investigates an efficient and sustainable route of Green synthesis of stable silver nanoparticles (Ag NPs) was done using TULSE leaf extract and its photocatalytic degradation of MB dye. The effect of some parameters like amount of Nano catalyst, PH and dye concentration are also investigated. Ag NPs were synthesized by using leaf extract of TULSE and aqueous silver nitrate solution through a simple, cost effective and eco-friendly method. Then the developed silver nanoparticles were characterized by using UV-Vis spectrophotometer, and Fourier transforms infra-red (FTIR) spectroscopy.**

Keywords: **Green synthesis, silver nanoparticles, TULSE leaves, photocatalytic activity.**

1. INTRODUCTION

Clean drinking water is an essential global concern, as the demand for it continues to rise at an alarming rate. The increasing population, climate change, and rapid industrialization are major contributing factors to this crisis. Addressing this issue requires collective action from individuals, governments, and organizations. In recent year researchers angigantic interest has been developed to biosynthesis nanoparticle photocatalytic activity. industries release a large amount of effluents alone with organic dyes in to the water bodies. MB dyes are widely used as a colorant in various factory such as a paper, cosmetics, textile, pharmaceutical and plastic (1). These dye highly toxic, harmful, mortal and non-biodegradable can cause vital diseases like cancer, skin diseases, and some time these show allergic effect. The chemical structure of the dye molecule is show in Fig. 1. Many waste water Treatment techniques like co-aggulation-flocculation, ion exchange, membrane filtration, Adsorption, etc. (2). However these techniques are highly expensive and often transfer some harmfull toxic pollutents. there for urgent need to devlop an eco-friendly and cost-effective technique for degradation of an dye pollutant from industrial waste water. Nanoparticles have been synthesized from many sources of plants, animals and microorganisms (3). Green synthesised silver based nanoparticales have many applications in medicine, biology, and the environment. like as a photocatalytic activity, antimicrobial activities and Antibacterial activity (4-5). The interest in **TULSI** because large chemical composition in leaf extract are triterpens, flavonoids and eugenol. that may reduce properties silver ions to silver nanoparticles (6-8). In the current work, we have used TULSI leaves broth to synthesis the silver nanoparticles (Ag NPs). 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 TULSE leaf broth and studied its photocatalytic activities. TULSI 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.

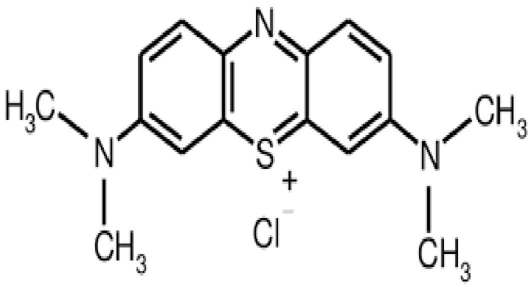


Fig. 1 chemical structure of the MB dye

Fig. 2 Fresh TULSE leaf collect from in local college campus

2. REAGENTS AND CHEMICALS

Silver nitrate ($AgN0_3$) was purchased from Merk (Germany). TULSI leaf was obtained from a local College campus. 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. Hcl and NaOH used to maintain to pH.

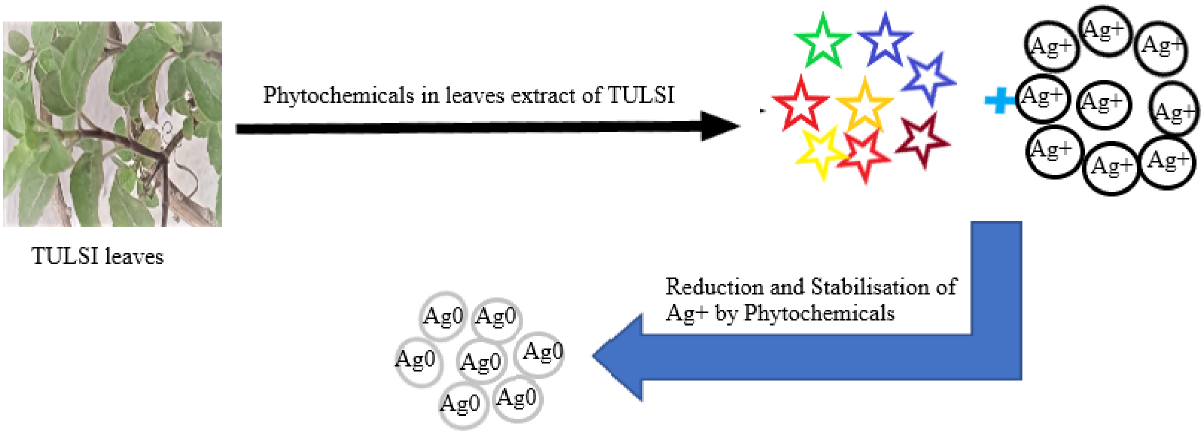
2.1 Preparation of the leaf extract

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 (25ºc) room temperature. About 20 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 40 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 (4°C) in 100 mL conical flasks for further experimental uses.

2.2 Silver nanoparticle (Ag NPs) synthesis

Silver Nanoparticles were prepared by using by TULSI leaf extract as a Green reducing agent. 150 ml of TULSE extract was added to 50 ml of 1 mM $AgNO_3$ doubly distilled water solution in the conical flask under constant stirring rate and incubated in water bath at 60^{O}C for 30 min for the reduction of Ag^+ ions. Green reduction was observed by color change from yellowish to dark brown. The formation of color occurred due to the excitation of surface Plasmon resonance of the silver nanoparticles [10] Similarly, Rao et al. [11] observed that the Svensonia hyderabadensis solution of the silver ion complex started to change the color from yellow to dark brown due to the reduction of silver ions.

Govindaraju et al.[12] reported the color change to brownish yellow while synthesizing silver nanoparticles using the leaf extract of Solanum torvum. Shani Raj et.al (13) reported the colour change to added Terminalia arjuna leaf extract After few minutes, solution was turned into reddish-brown color which indicates the reduction of AgNO3 into AgNPs. N N Bonnia et.al (14) also reported Appearance of brown colour while using silver nanoparticles synthesized from imperata cylindrica aqueous extract. The solution was centrifuged at 10,000 rpm for 30 min and pellet obtained was washed dual with double distilled water and one time with absolute ethanol. The Ag NPs solution was poured into the dishes and left in the heating oven for drying at 250°C for 24 hours.



3. CHARACTERIZATION OF SILVER NANOPARTICLES

The UV-Vis spectrum of this solution was recorded with a UV/Vis spectrophotometer (SIMADZOS UV 2101 PC) at 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 TULSE leaf extract (15). 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. (16) UV–Vis spectrophotometer is one of the most notable features of the optical absorption spectrum of AgNPs in the Surface Plasmon Resonance (SPR).

Fig. 4 UV/Vis spectrophotometer

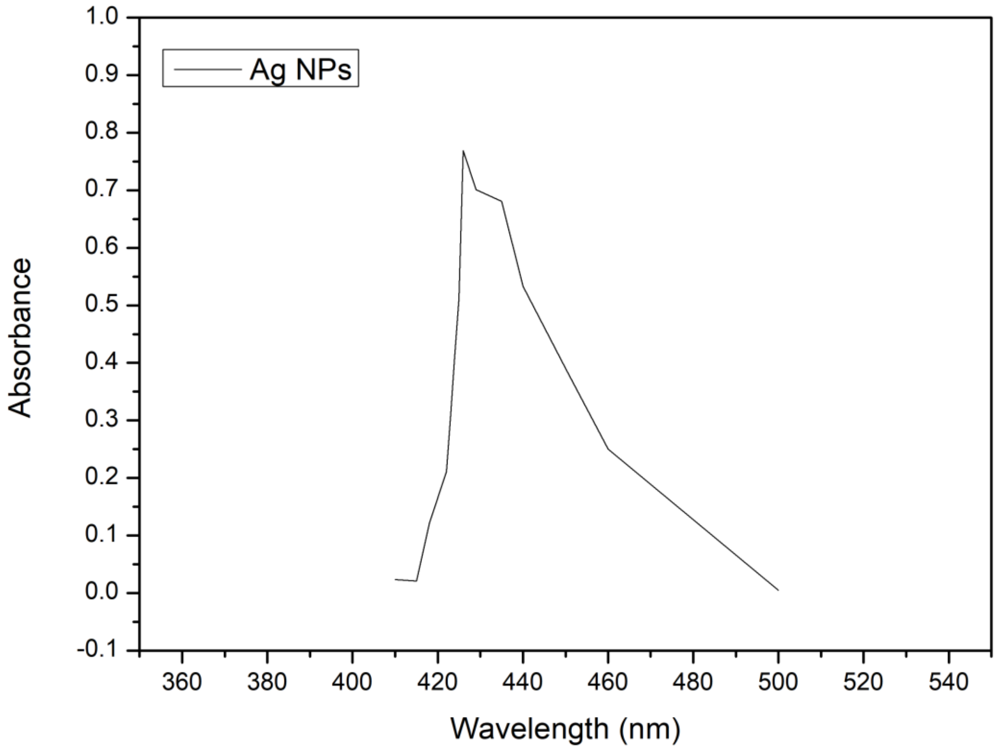
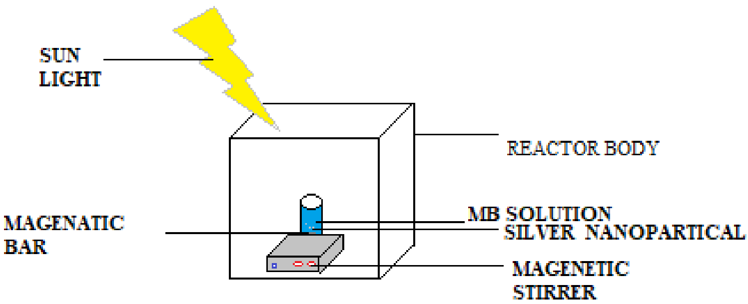


Fig. 5. Ultraviolet-visible (UV-vis) Spectra of Green synthesis of silver nanoparticles

4.**EXPERIMENTEL PROCEDURE AND ANALYSIS**

Typically, 1000mL of double distilled water was used as the stock solution and 10,15,20,25 g of methylene blue dye was added. 100mL of methylene blue solution received 0.5,1.0,1.5,2.0 gm of Green synthesized silver nanoparticles. Additionally, a control was kept going without the inclusion of silver nanoparticles. The reaction suspension was thoroughly mixed by being magnetically stirred for 40 minutes prior to being exposed to radiation in order to plainly establish the working solution's equilibrium. The dispersion was then exposed to sunshine and observed from dawn until dusk every day. Aliquots of the 5 mL solution were with draw and filtered used to assess the dye's photocatalytic degradation at 15 min. intervals. A (SIMADZOS UV 2101 PC) UV-Vis spectrophotometer was then used to determine the absorbance spectrum of the supernatant at various wavelengths. controlled experiment is also carried out to conform that reaction. Concentration of dye during degradation was calculated by the absorbance value at 650 nm. respectively, due to the n–π* transition and the azo linkage. (17-18)



. Fig. 6 PHOTOCHEMICAL REACTOR

The degradation efficiency % is given by following formula:

%Degradation = C_0-C/C_O X100

Where is C_O is the initial dye concentration and C is the dye concentration after degradation. In the absence of biosynthesized nano catalyst, the reduction process is negligible (dye degradation 1.-2. %). But after that Addition of green synthesized silver nanoparticles improved the reduction process (dye degradation up to 90.06% within 72 hours).

5. RESULT AND DISCUSSION

5.1 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 7 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. (19-20) 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.

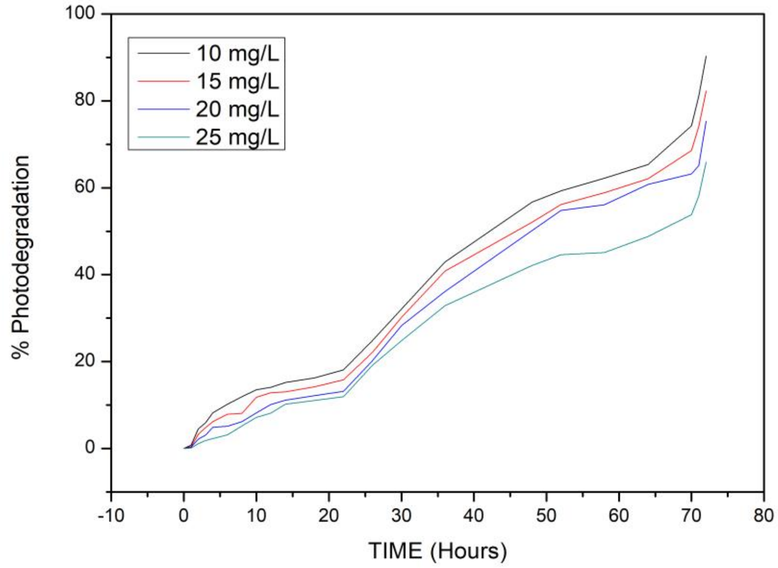


Fig. 7: Variation in Photodegradation w/r/t Initial Concentration of Dye

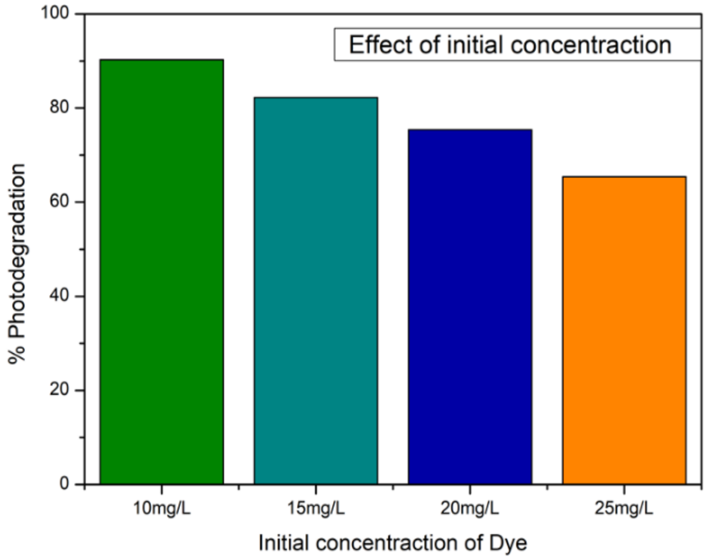


Fig.8: Variation in Photodegradation w/r/t Initial Concentration of Dye

5.2. 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. (21) But At the same time, due to an increase in turbidity of the suspension with high dose of photocatalyst, there will be decrease in penetration of UV light and hence photoactivated volume of suspension decreases. (22-24)

At higher catalyst loading may be due to the deactivation of activated molecules by collision with ground state catalysts, thus reducing the rate of reaction. (25-26) At the same time, we measured the quality of the catalyst by checking the recyclability of the catalyst. After completion of the run, the SILVER NPs were recovered by simple filtration and were washed repeatedly with water and dried at 80 °C in a hot air oven. it was found that they occurred without appreciable loss of catalytic activity (Fig. 11). A small difference in the efficiency of the catalyst was observed among the four step due to some loss of the catalyst during filtration.

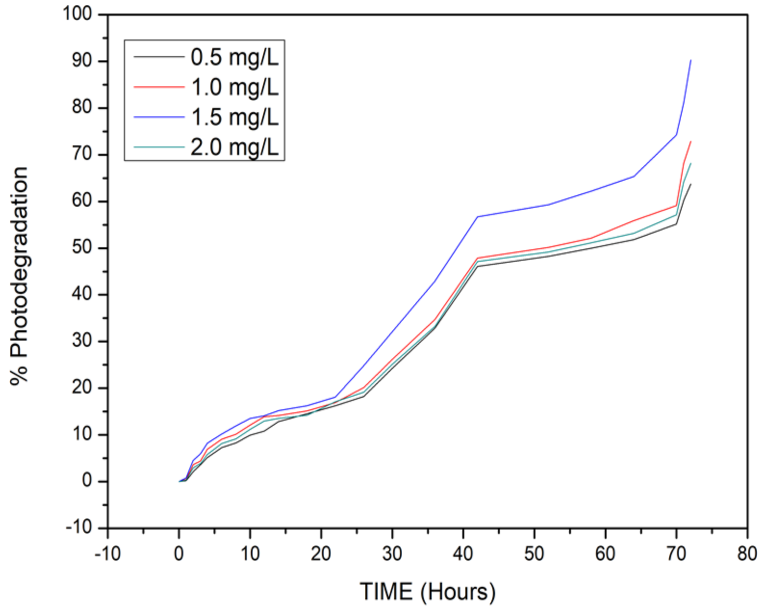


Fig.9 : Variation in % Photodegradation w/r/t Photocatalyst Loading

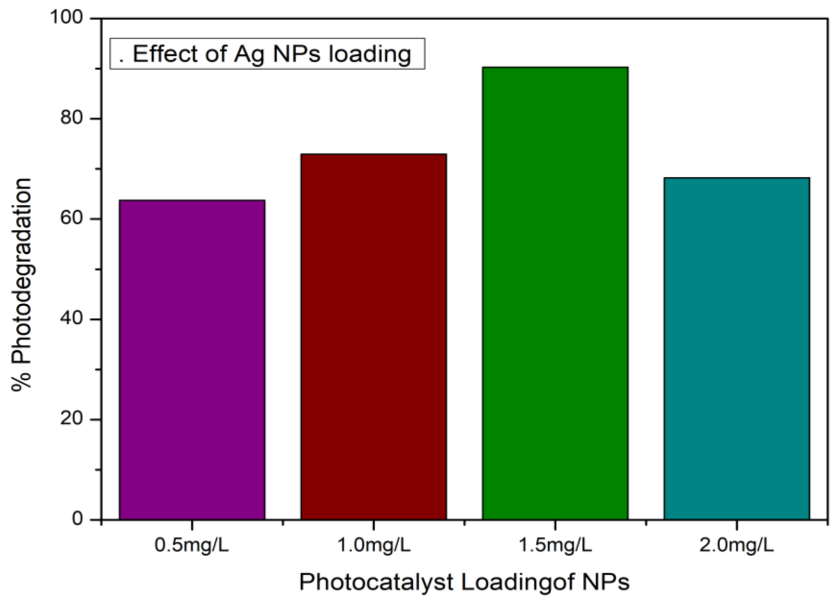


Fig. 10: Variation in % Photodegradation w/r/t Photocatalyst Loading

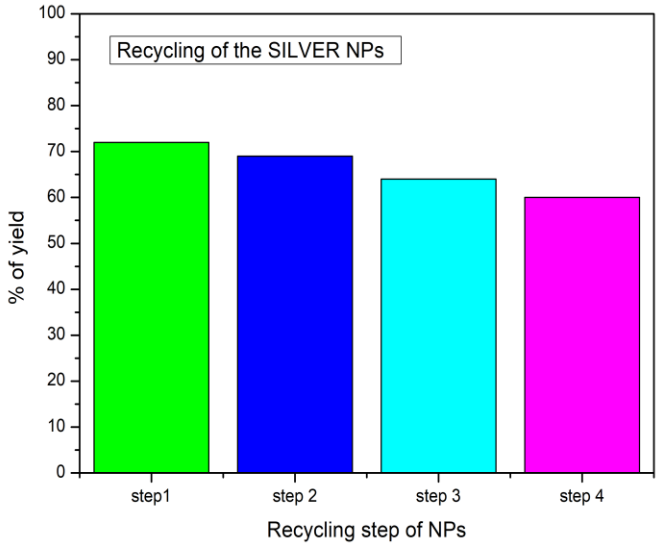


Fig.11: Recycling of the SILVER NPs in the MB degradation process.

5.3 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.

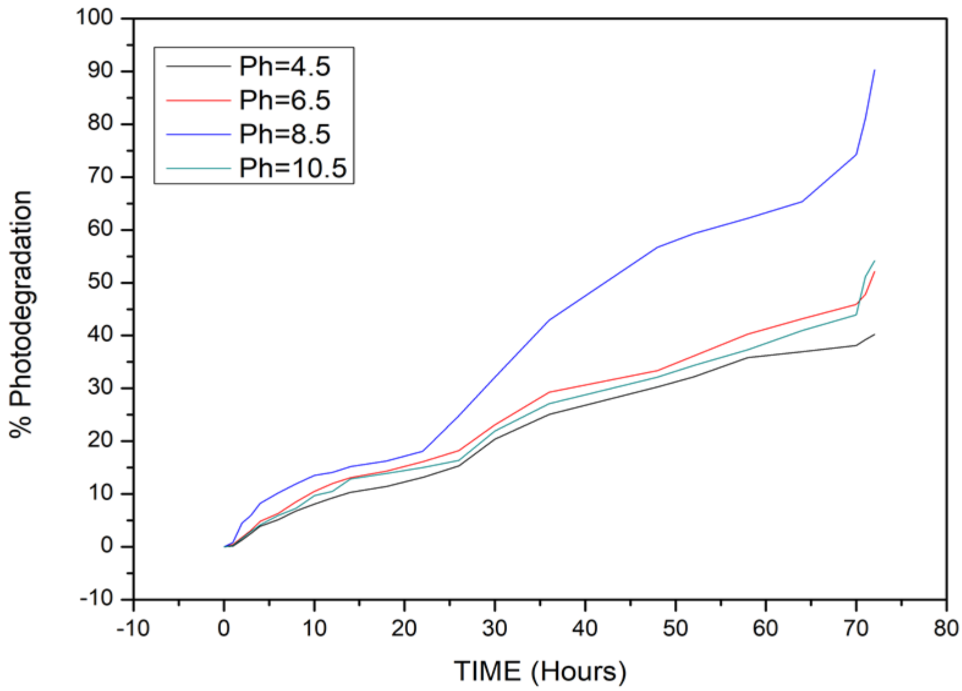


Fig. 12: Variation in % Photodegradation w/r/t pH of solution

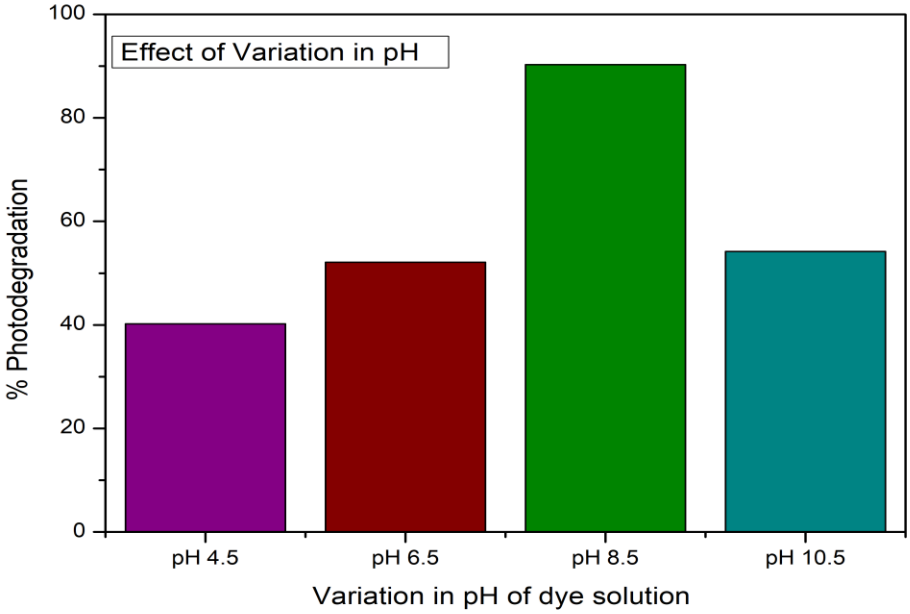


Fig. 13: Variation in % Photodegradation w/r/t pH of solution

6.VISUAL OBSERVATION

Green synthesised silver nanoparticles under sun light, methylene blue was photocatalytically degraded. Colour shifts were used to detect dye degradation at first. After being incubated with silver nanoparticles for 1 hour while being exposed to sun light, the dye's initial deep blue hue transformed to a light blue hue (Figure 14). Light green then replaced light blue after that. The reaction mixture's colour changing to colourless at 72 hours signified the end of the degradation process.

In optimum status Visual observation of color change from blue to colorless indicates degradation of methylene blue dye at different time intervals ((A) initial, (B) 1 h, (C) 4 h, (D) 36 h, (E) 48 h, and (F) 72 h).

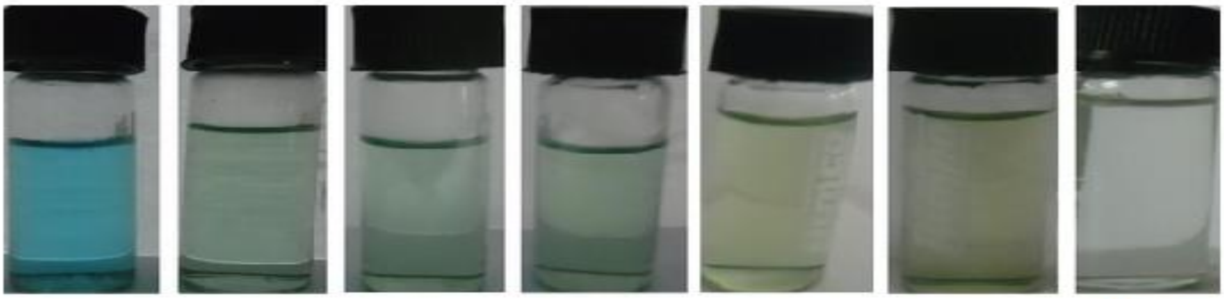


Fig.14 Visual observation of color change from blue to colorless indicates degradation of methylene blue dye at different time intervals ((A) initial, (B) 1 h, (C) 4 h, (D) 36 h, (E) 48 h, and (F) 72 h).

7. **CONCLUSION**

conclusion a simple, fast and eco-friendly biological procedure introduced to synthesize silver nanoparticles using TULSI leaf extract. Reduction of silver ions into metallic silver when exposed to the plant extracts depicted a color change. For characterisation of the nanoparticles, UV-Vis spectroscopy substantiated to be a suitable technique for the analysis of nanoparticles. The nanoparticles were applied as catalyst and found to be efficient and active in degradation of MB dye in the presence of sunlight. The results suggested that Ag NPs have a strong potential for fast dye degradation therefore, these Ag NPs can be used in future on large scale for complete degradation of hazardous dyes from waste water.

ACKNOWLEDGMENTS

The authors would like to thank principal Govt. PG College, Karauli (Rajasthan)- Indiafor providing the opportunity to carry out this research work.

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