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RESEARCH ARTICLE OPEN ACCESS

Decolorization of Dyes from Synthetic Wastewaters Using Biosynthesized Silver Nano Particles

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Abstract:

The Present Experiment was carried out using agno3 nano particles for dye decolorization using Bauhinia Purpurea leaves by bio synthesis process.The variables effecting the decolorization process are contact time, pH, concentration, dosage and temperature. The characterization studies were carried out using FTIR and XRD.The dyes experimented in the present study are Methyl Orange(MO),Phenol Red(PR), Safarian Stain Powder(SSP) and Bromo Cresol Green(BCG).The optimum pH for PR-5,MO-4,SSP-3 and for BCG-6 were formed. The positive results confirmed that Bauhinia Purpurea leaves broth combined with silver dioxide solution formed silver nano particles and are capable of removing dyes.

Keywords — **Dyes, XRD, FTIR, PH, concentration, time, temperature.**

I. INTRODUCTION

THE APPLICATION OF NANO MATERIALS IS AN OUTSTANDING ACHIEVEMENT BY THE RESEARCHERS. NANOMATERIALS ARE THE KEY TO TECHNOLOGICAL AND ADVANCEMENT OF THE UNIVERSE [1-2]. ANY INDUSTRY BASICALLY USES DYES FOR PROCESSING THEIR RAW MATERIALS TO FINISHED PRODUCTS, IN TURN PRODUCING DYE WASTE IN AQUEOUS SOLUTION FORM. THE MAIN CONSUMPTIONS OF DYES WERE USED IN TEXTILE INDUSTRIES AND THE OUTLET FROM THE TEXTILE INDUSTRY IS BEING A POLLUTION FACTOR FOR THE ENVIRONMENT. THE DYES RELEASED FROM THE TEXTILE INDUSTRIES ARE TOXIC EVEN AT VERY LOW CONCENTRATIONS, MAY AFFECT THE AQUATIC LIFE [3-10]. MANY METHODS LIKE CHEMICAL, PHYSICAL AND BIOLOGICAL METHODS ARE USED FOR DECOLORIZATION OF TEXTILE WASTEWATER. AS SOME OF THEM ARE EXPENSIVE THEY ARE UNABLE OF USING THEM IN MANY COUNTRIES. DYE DECOLOURIZATION IS AN EFFECTIVE AND PRACTICAL METHOD FOR A REMOVAL OF DYES IN WASTEWATER.[1-8]. HENCE AN ATTEMPT IS MADE USING SILVER DIOXIDE NANOPARTICLES WITH BAUHINIA PURPUREA LEAVES.

II. MATERIAL AND METHODS

The present experimentation is carried out in batch process, for removal of dyes (Phenol Red–PR, Methyl Orange–MO, Saffrain Stain Powder–SSP, Bromo Cresol Green–BCG) from aqueous solutions by using Bauhinia Purpurea leaves broth with Silver nano particles (bp-Ag-nps).

Fig.1 Dyes

Fig.2 Dyes stock solutions (a) Phenol Red (b) Methyl Orange (c) Saffrain Stain Powder (d) Bromo Cresol Green

1. Reagents and materials:

Analytical grade chemicals were used for experimentation and need no further purification. Double distilled water is used to prepare all stock and synthetic solutions. From a stock solution containing 1000 mg of dyes in 1.0 litre, the synthetic solutions of dyes were made. By addition of O.l M HCl and O.l M NaOH solutions the pH of dyes solutions were adjusted to the desired values. .

2. Preparation of the Broth solutions and Nano particles formation:

2.1Preparation of Bauhinia Purpurea broth:

In this process 10 gm of fresh and cleaned leaves of BP are taken in a magnetic stirrer and to this 110 ml of distilled water is added and it is heated at 60°C for 30min.After that the solution is filtered in 250 ml conical flask using whatmann's filter paper and it is kept aside for further process. The broth obtained is in pale yellow colour.

Fig.3. Bauhinia Purpurea Leaves

2.2 Preparation of Nano Particles:

In this process 70 ml of broth solution is taken and to that 230 ml of 1mM $AgNO_3$ is added in a 500 ml conical flask and is kept in an oven for about 10 min at 60°C to obtain nano particles. The nano particles formation is noticed when the pale yellow color is changed to dark brown color. This solution is used for various dyes degradation process of different concentrations and different dosages.

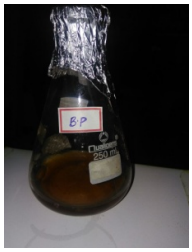

Fig. 4 Nano particles solutions of Bauhinia Purpurea

3. Preparation of 1000 mg/L dyes stock solutions:

Fig. 5 (a) Chemicals and (b) Broth solutions

4. Characterization Studies:

The Characterization studies were carried in XRD and FTIR

Fig. 6. Centrifuge samples for drying and Characterization analysis (FTIR & XRD)

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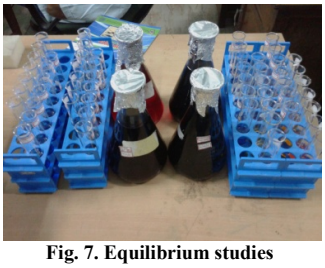

Fig. 7. Equilibrium studies

III RESULTS AND DISCUSSION

1. CHARACTERIZATION

1.1 FTIR Spectrum

FTIR is a type of spectroscopy that measures absorption, emission and and photoconductivity of solids, liquids and gases. The peaks visible in the FTIR graph are due to the amide linkages between amino acid residues in the proteins.

The FTIR spectrum of Agno3 nanoparticles is shown in Figure 8. FTIR measurement showed the presence of the following functional groups. The fundamental mode of vibration at 3207.76which correspond to the Amine N-H Stretch, 3062.13which correspond to the Alkenyl C-H Stretch, 3031.26 which corresponds to Alkenyl C-H Stretch, carboxlic acid, ether and ester confirmed. 2954.11 correspond to Carboxylic Acid O-H Stretch. Carboxylic Acid O-H Stretch at 2917.46 is observed. 2848.98 which correspond to Carboxylic Acid O-H Stretch present. 1614.49 which correspond to Alkenyl C=C Stretch. 1383.98 which correspond to C-O single bond band. 1321.30 which correspond to C-O single bond band. 1240.28 which corresponds to C-O absorption of medium intensity . 1067.65 which corresponds to C-O absorption of medium intensity. 1033.89 which corresponds to C-O absorption of medium intensity. The bond at 916.23 is due to the Aromatic C-H Bending. The bond at 780.24 is due to Aromatic C-H Bending .The peak 519.indicates the C-H stretch vibrations of Agno3 nano particle which is consistent with that reported before. The FTIR measurements were carried out to identify the potential functional groups of the biomolecules in the leaf extract of Bauhinia Purpurea which are responsible for the reduction of the silver ions into silver nanoparticles shows a strong absorption peak at 2954.11 cm−1 which indicates presence of carboxylic groups. This functional group was modified in synthesized silver nanoparticles. The broad absorption band was observed between 2954.11 and 2848.98 cm−1 due to the O–H stretching and H- bonded alcohols and phenol groups . A weak band was observed at 3207.76 cm−1 corresponding to N–H bending primary amines. It was modified into 1614.49 cm−1 indicating presence of C=O stretching vibrations of carbonyls groups, respectively. New narrow bands were formed in the synthesized silver nanoparticles at 1383.98 cm−1 and 1321.30 cm−1 owing to the C–O single bond band. New narrow bands were formed in the synthesized silver nanoparticles at 1240.28cm−1,1067.65cm−1, 1067.65cm-1

and 1033.89cm-1 owing to the C-O absorption of medium intensity .The two weak bands at 916.23 cm−1 and 780.24 cm−1 owing to the Aromatic C-H Bending. A small peak was formed at 519.84 cm−1 due to the occurrence of C-H stretch. Moreover, the functional biomolecules are hydroxyl, carboxylic, phenol, and amine groups in Bauhinia Purpurea leaf extract involved in the reduction of silver ions which was confirmed by FTIR spectrum reported that the aliphatic amine, aliphatic alkenes of alkaloids, synthesized AgNPs [**11-15**].

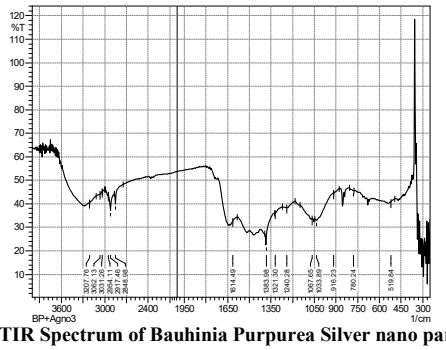

Fig.8. FTIR Spectrum of Bauhinia Purpurea Silver nano particles

XRD :

Fig. 9(a) and Fig. 9(b) shows the XRD for the Silver nanoparticles.

The data howsdiffractionpeaks at 2θ=0.5189, 0.5205, 0.3723, 0.4857, 0.4344 which can be indexed planes [cu Kα=1.541874A] at d = 3.0948, 1.9246, 2.0482, 1.9021, 1.6920 of pure silver. It confirmed that the main composition of the nanoparticles was silver [**16-20**].

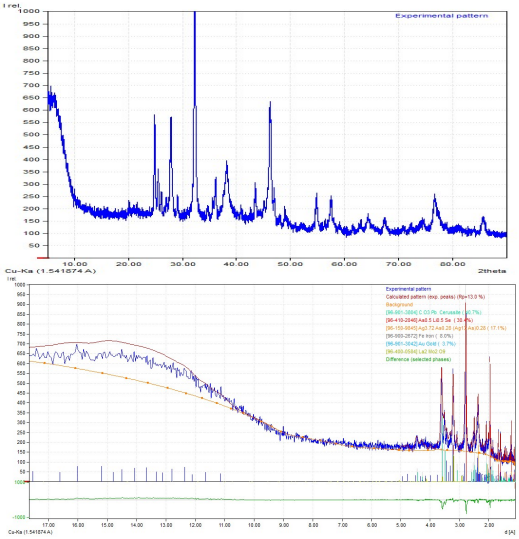

Fig.9(a) &(b)XRD analysis for Bauhinia Purpurea leaves

Effect of contact time

The Decolourization of Dyes (Phenol Red–PR, Methyl Orange–MO, Saffrain Stain Powder–SSP, Bromo Cresol Green–BCG)was studied as a function of contact time at Room temperature. 20 ml of 20 mg/L Dye solution was taken with 5 ml of Bauhinia Purpurea broth Silver nano particles (bp-Ag-nps) solution at different time intervals ranging from 1 min to 72 hrs. At the start, the ions adsorbed and occupied selectively the active sites on the bp-Ag-nps solution. As the contact time increased the active sites on the bp-Ag-nps were filled. The rate of adsorption becamegradually slower and reached an exhaust stage, resulting constant value. The results obtained are shown in figure 10 (a) and (b). As a result of the experiment, the highest % Removed for the Dyes (PR, MO, SSP, BCG) was 52%, 54%, 50%, 49% at the time of 30 min, 25 min, 40 min,. The dye uptake capacities were shown in fig. 5.6 and 5.8.The rapid uptake of the dye indicates that the sorption process could be ionic in nature where the anionic dye molecules bind to the various positively charged organic functional groups present on the surface of the bp-Ag-nps [**21-25**].

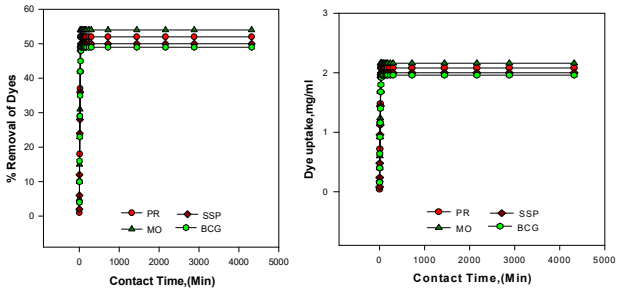

Fig.10(a)&(b) Effect of Equilibrium time for Bauhinia Purpurea leaves

Effect of pH

The pH parameter has been identified as one of the most important parameter that is effective on Dye decolourization.In order to find the effect of pH on Dye Decolourization using the Bauhinia Purpurea, experiments have been carried out at various initial pH values and results are given in figure 11 (a & b).The removal was increased from 30 % to 63 % as pH was increased from 2 to 8, The pH is varied for every dye used with the broth solution Bauhinia Purpurea whereas further increase in pH had a negative effect. The maximum % removal was found to be 49 % at pH 5 for PR Dye. The maximum % removal was found to be 63% at pH 4 for MO dye. The maximum % removal was found to be 62% at pH 3 for SSP dye. The maximum % removal was found to be 52% at pH 6 for BCG dye. Therefore, the remaining all experiments were carried out at this pH value[**26-30**].

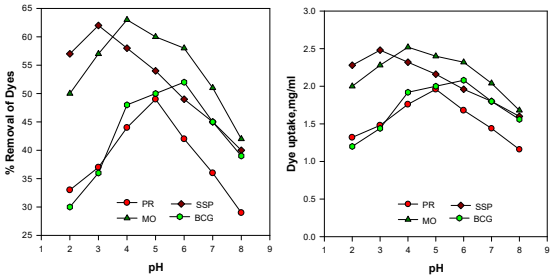

Fig. 11(a)&(b) Effect of pH for Bauhinia Purpurea leaves

Effect of initial concentration of dyes

The percentage Removal of dyes at various initial concentrations is depicted in Fig. 12 (a & b). At concentration of Dye solution (20 mg/L), maximum %removal is obtained and is different for every Dye using Broth Bauhinia Purpurea and on further increase in concentration (200 mg/L), %removal has been decreased. The capacity of % removal is increased up to concentration 20 mg/L. This is due to higher interaction between Bauhinia Purpurea Broth and the Dye solution. The maximum removal of PR Dye is 72%. The maximum removal of MO dye is 76%. The maximum removal of SSP dye is 70%. The maximum removal of BCG dye is 60 %. This was confirmed by other investigators and they attributed this phenomenon to the increase in the driving force of the concentration gradient, with the increase of the initial dye concentration. Hence a higher initial concentration of the dye will enhance the adsorption process. % removal capacity increased as a result of increasing initial dye concentration because the initial dye concentration favors a driving force to accomplish the mass transfer resistance between the solid and aqueous phases [**30-31**].

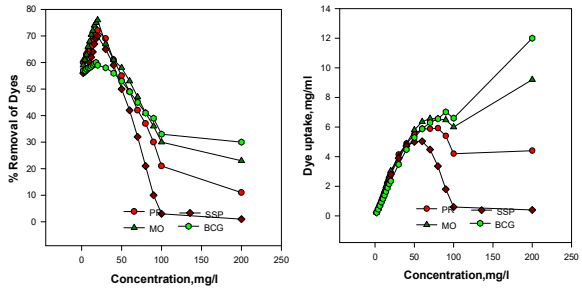

Fig 12(a)&(b) Effect of Concentration for Bauhinia Purpurea leaves

Effect of dosage

The variation of % removal of Dyes(PR, MO, SSP, BCG) was studied using different dosages of the broth Bauhinia Purpurea. Results from the fig 13 (a & b) showed that % removal of Dyes(PR, MO, SSP, BCG) increased and uptake decreased with increase in dosage. The maximum % removal is attained at 10 ml andwas almost constant at higher dosages. This trend could be explained as a consequence of partial aggregation .Therefore, the optimum dosage was selected as 5ml for further experiments. The maximum % removal of PR dye is 88% .The maximum % removal of MO dye is 83%. The maximum % removal of SSP dye is 80%,. The maximum % removal of BCG dye is 71% [**36-40**].

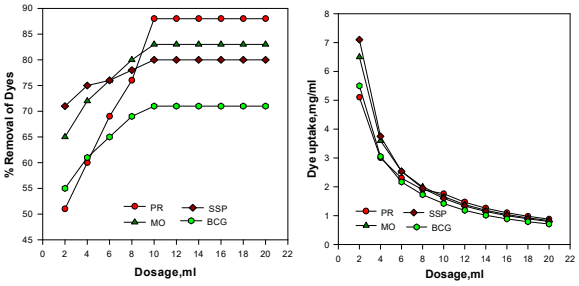

Fig 13(a)&(b) Effect of Dosage for Bauhinia Purpurea leaves

Effect of temperature

The dependence of temperature on the % removal of dyes is investigated at different temperatures as given in fig. 5.9. Results from fig 14 (a & b) showed that %removal of Dyes (PR, MO, SSP, BCG) increased from 66% to 80% with increase in temperature from 283 K to 323 K. This indicates that the % removal of Dyes using Broth Bauhinia Purpurea was controlled by an endothermic process. The increase in removal with temperature may be attributed to either increase in the number of active surface sites available for interaction on the Dyes. The maximum % removal of PR dye is 92 %, The maximum % removal of MO dye is 91%, the maximum % removal of SSP dye is 88 %, The maximum % removal of BCG is 89[**41-45**].

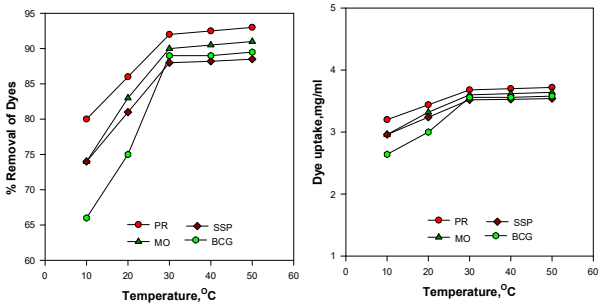

Fig 14(a)&(b) Effect of Temperature for Bauhinia Purpurea leaves

CONCLUSIONS

A) REMOVAL OF PHENOL RED WITH BAUHINIA PURPUREA BROTH NANO SOLUTION

The maximum dye decolorization obtained when the processing parameters are set as: t = 30 min, pH = 5, w = 10ml, Co = 20 mg/ml and T = 303 K is 92 % onto BP-Ag-npswas observed.

B) Removal of Methyl Orange with Bauhinia purpurea broth nano solution

The maximum dye decolorization obtained when the processing parameters are set as: t = 30 min, pH = 4, w = 5 mg/ml, Co = 20 mg/ml and T = 303 K is 90 % onto BP-Ag-npswas observed.

C) Removal of Saffrain Stain Powder with Bauhinia Purpurea broth silver nano solution

The maximum dye decolorization obtained when the processing parameters are set as: t = 30 min, pH = 3, w = 5 mg/ml, Co = 20 mg/ml and T = 303 K is 88 % onto BP-Ag-npswas observed.

D)Removal of Bromo Cresol Green with Bauhinia Purpurea broth silver nano solution

The maximum dye decolorization obtained when the processing parameters are set as: t = 30 min, pH = 6, w = 5 mg/ml, Co = 20 mg/ml and T = 303 K is 89 % onto PP-zn-nps was observed.

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