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Photocatalytic Studies of Medicinal Plants on Methylene Blue and Congo red dyes

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Abstract : *Natural products appears as an alternative to the use of chemical catalysts for water purification and treating the effluents from textile and dying industries. The Photo-catalytic activities of leaf extracts of S. nigrum, M. koenigii H. cannabinus L and M.arvensisw were studied using methylene blue and congo red dyes. The reactions were done both in presence and absence of light. in the aqueous solution under UV-lamp irradiation as a light source. On comparing the results of dye degradation of methylene blue and congo red with four different plant extracts Mentha arvensis showed maximum percent degradation and minimum degraded percent was observed in Hibiscus cannabinus.*

Keywords: *Congo red, methylene blue, photocatalytic, S. nigrum, M. koenigii, H. cannabinus L , M.arvensis*

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I. Introduction

Natural products are the basis of synthetic and traditional herbal medicine and are considered as the major health care system. The presence of various constituents present in plants made scientists to examine for their uses in treating certain infective diseases and management of chronic wounds. Medicinal plants are cheaper and more reachable to the most of the inhabitants in the world. Thus, there is necessity to encourage the use of medicinal plants as possible sources of new drugs. Natural products of plant origin have its own importance than the chemically synthesized drugs or developing new drugs to treat various diseases.

Dye contaminants from many other industries enter into water ecosystem and affect the survival of aquatic organism create lot of environmental and health hazard problems. Methylene blue and Congo red are the most common organic pollutants discharged from various industries directly or indirectly into water sources causing water pollution. Therefore, bleached dye after degradation is less toxic and harmless and the colorless water could then be used for some useful purposes like washing, cooling, irrigation and cleaning [1]. The photocatalytic treatment using plant extracts as catalysts are more viable and eco-friendly than the chemically synthesized photocatalysts. The use of plants or plant leaf extract as photocatalysts enables in waste water treatment, effluents from dying industries and so on.

Solanum nigrum, commonly known as Black Nightshade is a dicot weed belonging to Solanaceae family. The plant has been traditionally used as hepatoprotective agent in India[2-3]. olasodine, solasonine and solanidineare being present in Solanumnigrum as chemical constituents. Eltayeb et al. (1997) confirmed that the steroidal alkaloid solasodine was present maximum in the leaves [4]. M.koenigii is a plant with various significant uses in the traditional system of medicine as a stimulant, antidysentric and for management of diabetes mellitus in Eastern Asia [5]. The plant is highly valued for its leaves as an important ingredient in an Indian cuisine to promote appetite and digestion.Steam distillate of the leaves can be used as stomachic, purgative, febrifuge and antianemic8. Leaves are applied externally to bruises and eruption[6].

Kenaf (Hibiscus cannabinus L.), an herbaceous annual crop of the Malvaceae family grows in tropical and temperate climates and thrives with abundant solar radiation and high rainfall[7].Hibiscus species are are native to Southern Asia and West Africa.Leaves are used as vegetables in preparing salad and for cooking purpose.The genus Mentha belongs to the Lamiaceae family and comprises a large number of species, including M.arvensis[8]. The leaves are oval with toothed margins and are aromatic. Lower side of the leaves are minutely hairy and are used for medicinal purpose. Traditionally, M.arvensis has been used for both culinary as well as medicinal purposes.

II. Experimental

S. nigrum, M. koenigii H. cannabinus L and M.arvensis leaf powders were prepared with 10g of fresh leaves taken in each beaker. It was washed thoroughly with tap water and then with distilled water for at least 2 times and cut into small pieces. The chopped leaves were oven dried at 80^{o}C until the complete moisture is removed.

2.1 Photocatalytic studies

The photo degradation studies were carried out using a multi UV lamp photoreactor [Heber HML – COMPACT- LP-MP88] fitted with six numbers of 8W mercury vapor lamps (Sankyo denki,Japan) emitting wavelengths with maximum spectral intensity at 365 nm. The Photo-catalytic activities of leaf extracts of S. nigrum, M. koenigii H. cannabinus L and M.arvensiswere evaluated by measuring the degradation of methylene blue and congo red dyes in the aqueous solution under UV-lamp irradiation as a light source. In this experiment, 100mg of photo-catalyst was dispersed in 25ppm of 100 ml dye solutions. The solutions were aerated continuously, which served as the oxygen source for the thorough mixing of the solution. Primary reactions were done to observe the variations in dark and later under uv-lamp irradiation. The degradation studies were done for about 180 minutes and the samples were drawn for every 30 minutes, centrifuged and the absorbance was measured using UV-Visible spectrophotometer.

III. Results And Discussion

The photocatalytic degradation of four different plant extracts were studied on two dyes namely methylene blue and congo red. The photocatalytic studies were performed in presence and absence of UV-lamp irradiation. The UV-lamp irradiation was carried out for every 30 minutes for three hours (0, 30, 60, 90, 120, 150 and 180 minutes). These irradiated solutions containing dye and the photocatalysts(plant extracts) were analyzed using UV-Visible spectrometer after every 30^{th} minute. The spectra of congo red and methylene blue along with the photocatalysts are represented in fig.

The maximum absorption band for methylene blue and congo red was obtained at 665 and 496nm respectively. The percentage degradation of the maximum absorption band of dyes with S. nigrum, M. koenigii, H. cannabinus and M.arvensis leaf extracts were studied and analyzed for both dark and light reactions.

The percentage degradation of the dyes with photocatalysts was calculated using the formula

% Degradation = $C_O - C_t$

In the dark C_O showed higher degradation activity and Solanum nigrum had shown minimum photocatalytic activity where as exhibited maximum degradation and Hibiscus cannabinus showed minimum activity with methylene blue dye. Since, the absorption property was observed more, the amount of dye degraded was found to be higher with 63.17% and 67.54% in Hibiscus cannabinus with congo red dye and Mentha arvensis with methylene blue dye (TABLE.1).

Table.1 Photodegradation studies of leaf extracts in dark

Name of the leaf extract	Percent degraded with Congo red dye in dark	Percent degraded with Methylene blue dye in dark
Murrayakoenigii	61%	64.61%
Mentha arvensis	18.49%	67.54%
Hibiscus cannabinus	63.17%	4.08%
Solanumnigrum	20.11%	9.31%

On UV-lamp irradiation with congo red dye(TABLE.2- TABLE.9), Solanumnigrum had shown maximum degradation with 44.34% and minimum degradation was found to be in Hibiscus cannabinus with 27.66%. Murrayakoenigii and Mentha arvensis leaves were intermediate with 2% difference between Hibiscus cannabinus and Solanumnigrum leaves.Upon UV-lamp irradiation with methylene blue dye solution, leaves of Mentha arvensis exhibited maximum photodegradation activity with 64.83% and the minimum percentage degraded was observed in Hibiscus cannabinus with 24.41%. Murraya koenigii and Solanumnigrum leaves were found to remain intermediate with 52.92% and 45.39% respectively.Therefore, in the presence of light, leaves of Solanumnigrum with Congo red dye (Fig.1) and Menthaarvensis with methylene blue dye showed maximum percentage degradation due to higher absorption property whereas Hibiscus cannabinus leaves showed minimum percentage degradation due to lower absorption property(Fig.2).

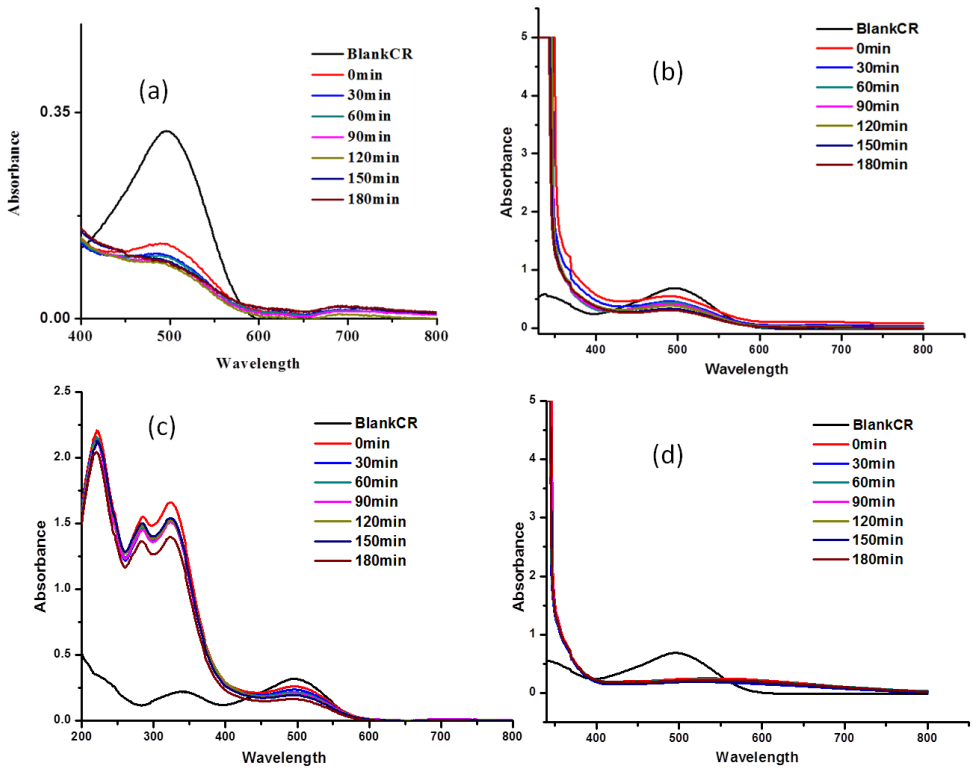

Fig.1 Photocatalytic studies of congo red dye with a) Murraya koenigii b) Solanumnigrum c) Mentha arvensis d) Hibiscus cannabinus

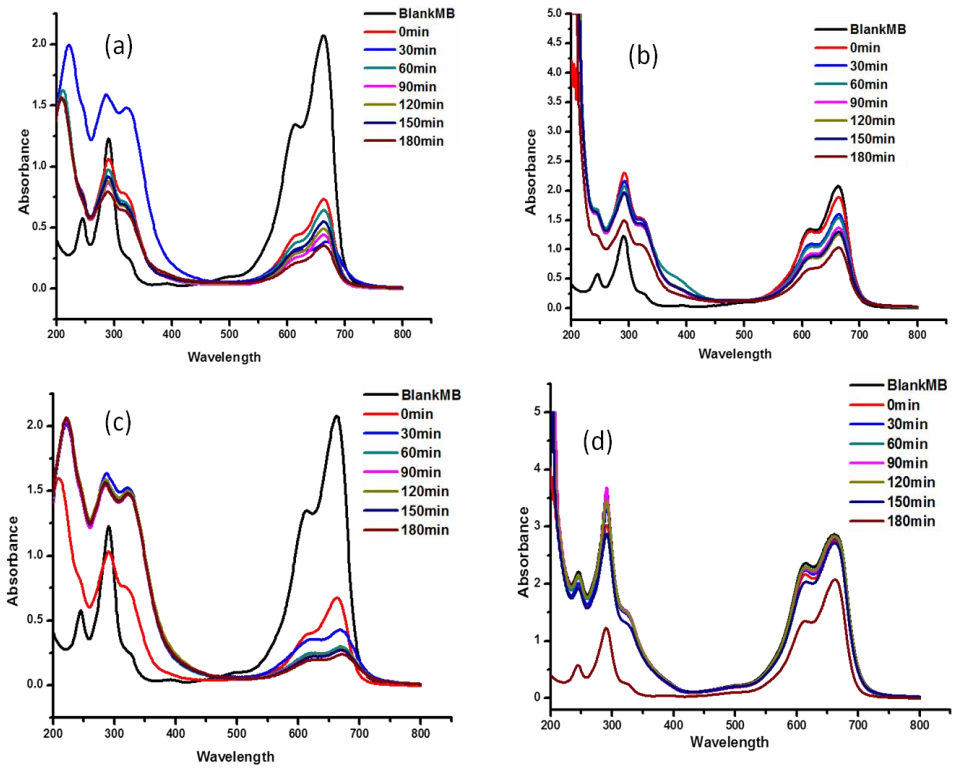

Fig.2 Photocatalytic studies of methylene blue dye with) Murraya koenigii b) Solanumnigrum c) Mentha arvensis d) Hibiscus cannabinus

Table.2 Percentage degradation studies of Mentha arvensis with congo red dye

Time	Absorbance	% Degradation
0	0.260	18.49
30	0.236	9.23
60	0.217	16.53
90	0.208	20
120	0.199	23.46
150	0.196	24.61
180	0.165	36.53

Table.3 Percentage degradation studies of Hibiscus cannabinus with congo red dye

Time	Absorbance	% Degradation
0	0.253	63.17
30	0.229	9.48
60	0.226	10.67
90	0.212	16.20
120	0.211	16.60
150	0.195	22.92
180	0.183	27.66

Table.4 Percentage degradation studies of Solanumnigrumwith congo red dye

Time	Absorbance	% Degradation
0	0.548	20.11
30	0.458	16.42
60	0.444	18.97
90	0.418	23.72
120	0.386	29.56
150	0.336	38.68
180	0.305	44.34

Table.5 Percentage degradation studies of Murrayakoenigiiwith congo red dye

Time	Absorbance	%Degradation
0	0.124	61
30	0.11	11.29
60	0.106	14.51
90	0.1	19.35
120	0.099	20.16
150	0.090	27.41
180	0.081	34.67

Table.6 Percentage degradation studies of Mentha arvensis with methylene blue dye

Time	Absorbance	%Degradation
0	0.674	67.54
30	0.428	36.49
60	0.297	55.93
90	0.28	58.45
120	0.271	59.79
150	0.267	60.38
180	0.237	64.83

Table.7 Percentage degradation studies of Hibiscus cannabinus with methylene blue dye

Time	Absorbance	% Degradation
0	2.748	4.08
30	2.799	1.85
60	2.762	0.509
90	2.754	0.21
120	2.731	0.61
150	2.707	1.49
180	2.077	24.41

Table.8 Percentage degradation studies of Solanumnigrum with methylene blue dye

Time	Absorbance	%Degradation
0	1.879	9.31
30	1.589	15.43
60	1.530	18.57
90	1.364	27.40
120	1.297	30.97
150	1.252	33.36
180	1.026	45.39

Table.9 Percentage degradation studies of Murrayakoenigiiwith methylene blue dye

Name of the leaf extract	Percent degraded with Congo red dye in light	Percent degraded with Methylene blue dye in light
Murrayakoenigii	34.67%	52.92%
Mentha arvensis	36.53%	64.83%
Hibiscus cannabinus	27.66%	24.41%
Solanumnigrum	44.34%	45.39%

On comparing the results of dye degradation of methylene blue and congo red with four different plant extracts in presence and absence of light, Mentha arvensis showed maximum percent degradation and minimum degraded percent was observed in Hibiscus cannabinus (TABLE.10).

Table.10 Photodegradation studies of leaf extracts under UV-Lamp irradiation

Time	Absorbance	%Degradation
0	0.735	64.61
30	0.646	12.10
60	0.550	25.17
90	0.493	32.92
120	0.444	39.59
150	0.385	47.61
180	0.346	52.92

Therefore, Hibiscus cannabinus leaves has got lower absorption property when compared to other leaf extracts and hence it shows lower percentage degradation.

IV. Conclusion

The eco-friendly green catalystshas been shown to be effective methods for removing organic pollutants from wastewater as a complete mineralization of dyes in to CO_2 and H_2O. The photocatalytic degradation of methylene blue dye depends on the concentration of the dye, amount of catalyst and light intensity. On comparing the results of degradation of dyes with methylene blue and congo red with four different plant extracts both in presence and absence of light, Mentha arvensis exhibited maximum percent degradation and Hibiscus cannabinus showed minimum percent degradation. From the current study, it has been concluded that Hibiscus cannabinus leaves has got lower absorption property and hence it shows lower percentage degradation than the other leaf extracts.

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