ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Treatment of Textile Dyeing Industry Effluent Using Activated Carbon Prepared From Agriculture Waste (Sawdust)

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ABSTRACT

Dyes are colouring compounds being extensively used in textile industries and the indiscriminate disposal of dye wastewater poses one of the major problems on the environment. This effluent contains a variety of contaminants viz. nature of acidic, caustic, dissolved solids and toxic compounds like organic, inorganic or heavy metallic. The micro toxins are developed due to colouring agents by forming chelating under suitable chemical environment. Methods for treating textile dye wastewaters consist of various chemical, physical and biological processes. Among many decolourisation procedures the adsorption technique gives good results because it can be used for the removal of various types of colored matter. Commercial systems use mostly activated carbon as the sorbent for decolourisation of wastewaters because of its excellent adsorption ability. Although activated carbon has an advantage as a sorbent, its massive employment is restricted due to its high price. Activated carbon is the most widely used adsorbent because it has excellent adsorption efficiency. Nevertheless, commercially available activated carbon is very expensive. In this study activated carbon prepared from agricultural waste (saw dust) is used to treat three different textile dyeing industry effluents and studied the effect of variables like adsorbent dosage, RPM, pH and time.

Keywords: Adsorption, Dye effluent, Dosage, RPM, pH, Time.

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INTRODUCTION

Dyes usually have complex aromatic molecular structures which make them more stable and difficult to biodegradable. Furthermore, many dyes are toxic to some microorganisms and may cause direct destruction or inhibition of their catalytic capabilities [1].

Textile industries use dyes and pigments to color their products they are more than one lakh commercially available dyes with over 735 tons of dyes stuff are produced manually. Many types of dyes represent acute problems to ecological system as they considered toxic and have carcinogenic properties, which make the water inhibitory to aquatic life. Due to their chemical structure, dyes possess a high potential to the resist fading on exposure to light and water. The main sources of water generated by the textile industry originate from the washing and bleaching of natural fibers and from the dyeing and finishing steps. Given the great variety of fibers dyes and process aids, these processes generate wastewater of great mechanical complexity and diversity, which are not adequately treated in conventional waste water treatment plant [2, 3].

Recognition of color as a priority pollutants and promulgation of environmental regulations limiting effluent color levels have prompted several investigators to orient their research efforts towards color removal studies. Unfortunately, there are many variables to be considered for effective color removal and recognition of this fact is of primary importance for development of effective treatment technology [4, 5].

MATERIALS AND METHODS

Treatment of Dye Effluent

Methods for treating textile dye wastewaters consist of various chemical, physical and biological processes. These include adsorption, nanofiltration, colloidal gas aprons, ultrasonic decomposition, electro coagulation, precipitation, photo-oxidation, predispersed solvent extraction, ozonation, supported liquid membrane and liquid-liquid extraction. Natural materials that are available in abundance or certain waste products from industrial or agricultural operations may have great potential as an inexpensive sorbents. Due to their low cost, after these materials have been expended, they can be disposed off without expensive regeneration. The abundance and availability of agricultural by-products make them good sources of raw materials for activated carbons. Many carbonaceous materials such as bark, coal, lignite, coconut shells, wood, dead biomass, seaweed, and peat are used in the production of commercial activated carbons [6, 7].

Physical Treatment-Adsorption

Adsorption is the process of transferring material from a fluid phase to a solid phase. The adsorption process has been widely used for color removal. Adsorption is one of the processes, which besides being widely used for dye removal also has wide applicability in wastewater treatment. This process being very low cost method and most simple method for containing these pollutants is being used in this study. Adsorption results in the removal of solutes from solution and their concentration at a surface, until the amount of solute remaining in solution is in equilibrium with that at the surface [8, 9].

Experimental Procedure

Activated carbon is prepared from saw dust. Experiments were conducted to treat effluent-1 (green colored dye), effluent-2 (blue colored dye) and effluent-3 (red colored dye) using activated carbon prepared form agriculture waste (saw dust).

Test dye solution of 100 mg/l was prepared from effluent solution and this solution is taken in the reagent bottles, varying doses of adsorbents were added to study feasibility of color removal and the PH of the test mixture was adjusted when required. A number of such reagent bottles containing the test mixture depending upon the requirement were employed.

Then the reagent bottles containing test mixture was placed in an orbital shaker operating at 200 RPM, to facilitate effective mixing and precipitates formation. Then the reagent bottles containing reaction mixture were kept under undisturbed for 1 hr for settlement of precipitation formed. The settled precipitate is separated from the mixture by filtration with the help of a filter paper. The filtrate is analyzed for % colour removal by using the calibration curve prepared. The effect of parameters like time, speed, dosage and pH are studied [10, 11].

RESULTS AND DISCUSSION

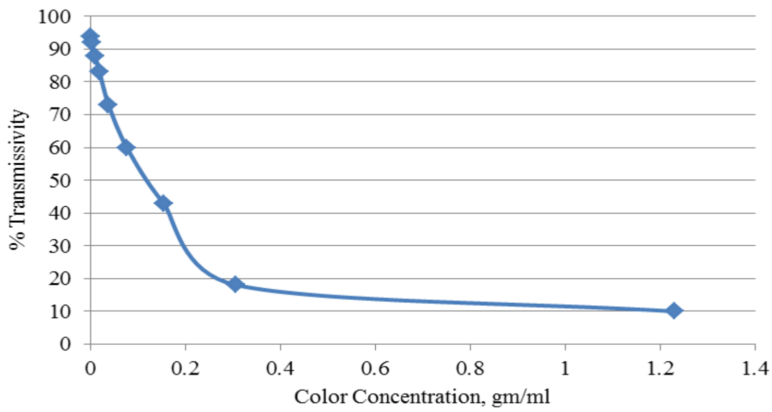
Treatment of Effluent-1

Calibration Curve

Calibration details for effluent-1 in given in Table 1 and Graph 1.

Table 1: Calibration data for effluent-1

Color Concentration, gm/ml	% Transmissivity
0.001215	94
0.00241	92
0.009609	88
0.0192	83
0.0384	73
0.0768	60
0.15375	43
0.3075	18
1.23	10



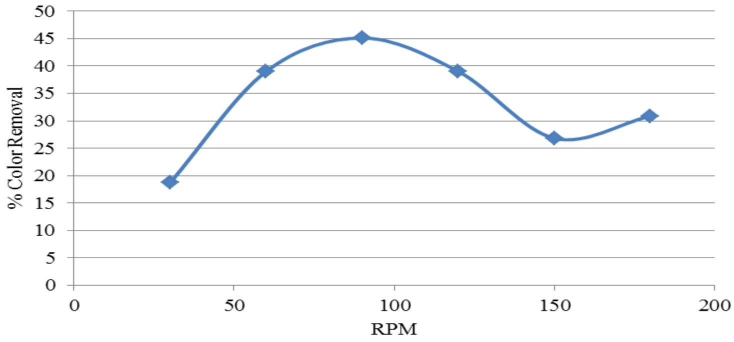
Graph 1: Calibration curve for effluent-1

Effect of RPM on % Color Removal

Variation of color removal with RPM for effluent-1 (green colored dye) is given in Table 2 and Graph 2. Maximum color removal of 45.12 % occurs at optimum RPM of 90.

Table 2: RPM vs. % Color Removal

RPM	% Transmissivity	% Color Removal
30	10	18.69
60	15	39.02
90	**16**	**45.12**
120	15	39.02
150	12	26.82
180	13	30.89



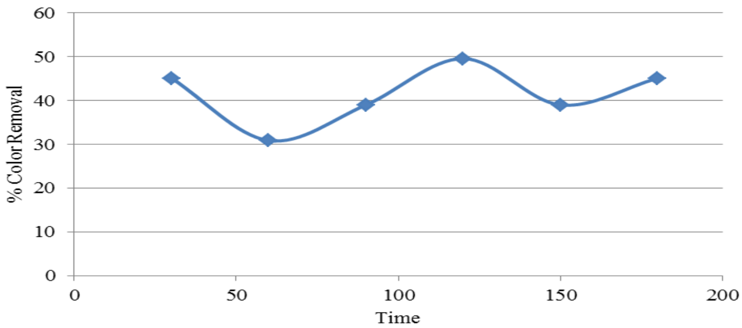
Graph 2: RPM vs. % Color Removal

Effect of Time on % Color Removal

Variation of color removal with time at optimum RPM of 90 for effluent-1 (green colored dye) is given in Table 3 and Graph 3. Maximum color removal of 49.59 % occurs at optimum time of 120 min.

Table 3: Time vs. % Color Removal

Time	% Transmissivity	% Color Removal
30	16	45.12
60	13	30.89
90	15	39.02
120	**18**	**49.59**
150	15	39.02
180	16	45.12



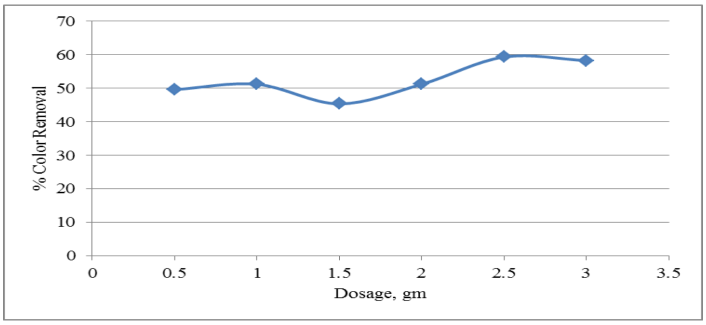
Graph 3: Time vs. % Color Removal

Effect of Dosage on % Color Removal

Variation of color removal with dosage at optimum RPM of 90 and optimum time of 120 min for effluent-1 (green colored dye) is given in Table 4 and Graph 4. Maximum color removal of 59.34 % occurs at optimum dosage of 2.5 gm.

Table 4: Dosage vs. % Color Removal

Dosage, gm	% Transmissivity	**% Color Removal**
0.5	18	**49.59**
1.0	19	**51.21**
1.5	17	**45.36**
2.0	19	**51.21**
2.5	**22**	**59.34**
3.0	21	**58.28**



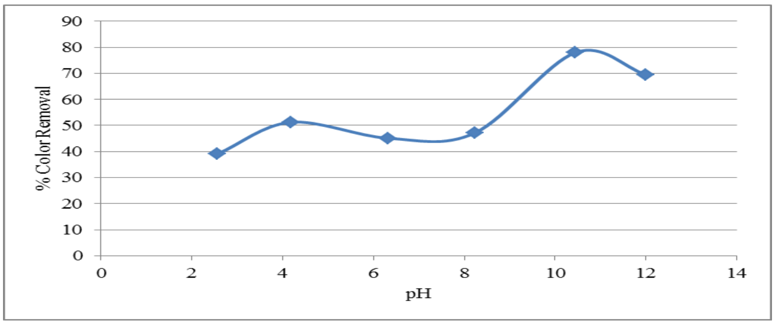
Graph 4: Dosage vs. % Color Removal

Effect of pH on % Color Removal

Variation of color removal with pH at optimum RPM of 90, optimum time of 120 min and at optimum dosage of 2.5 gm for effluent-1 (green colored dye) is given in Table 5 and Graph 5. Maximum color removal of 78.04 % occurs at an optimum pH of 10.45.

Table 5: pH vs. % Color Removal

pH	% Transmissivity	% Color Removal
2.56	15	39.02
4.17	19	51.21
6.32	17	45.12
8.23	18	47.15
10.45	**32**	**78.04**
11.99	24	69.56



Graph 5: pH vs. % Color Removal

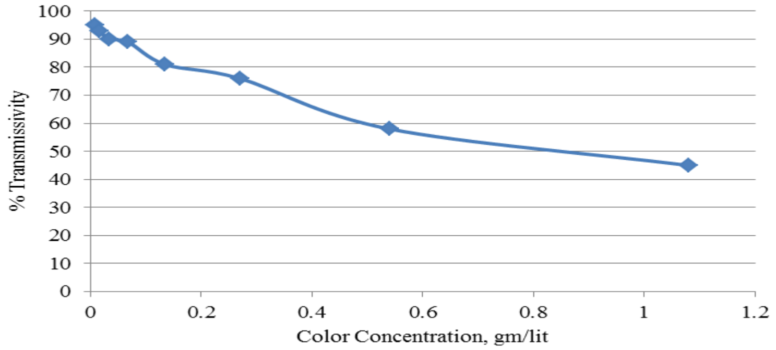
Treatment of Effluent-2

Calibration Curve

Calibration details for effluent-2 in given in Table 6 and Graph 6.

Table 6: Calibration data for effluent-2

Color Concentration, gm/ml	% Transmissivity
0.008	95
0.017	93
0.034	90
0.068	89
0.135	81
0.27	76
0.54	58
1.08	45



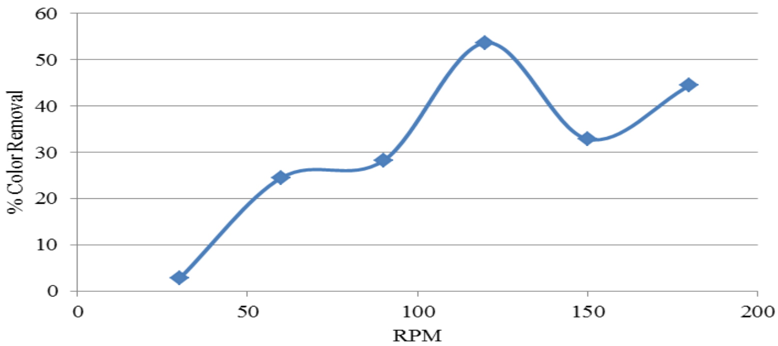
Graph 6: Calibration curve for effluent-2

Effect of RPM on % Color Removal

Variation of color removal with RPM for effluent-2 (blue colored dye) is given in Table 7 and Graph 7. Maximum color removal of 53.70 % occurs at optimum RPM of 120.

Table 7: RPM vs. % Color Removal

RPM	% Transmissivity	% Color Removal
30	38	2.77
60	49	24.53
90	50	28.24
120	**62**	**53.70**
150	51	32.87
180	56	44.44



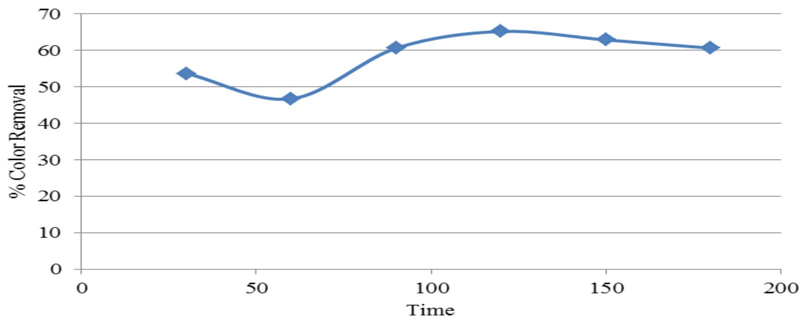
Graph 7: RPM vs. % Color Removal

Effect of Time on % Color Removal

Variation of color removal with time at optimum RPM of 120 for effluent-2 (blue colored dye) is given in Table 8 and Graph 8. Maximum color removal of 65.22 % occurs at optimum time of 120 min.

Table 8: Time vs. % Color Removal

Time	% Transmissivity	% Color Removal
30	62	53.70
60	57	46.75
90	65	60.64
120	**67**	**65.22**
150	66	62.90
180	65	60.64



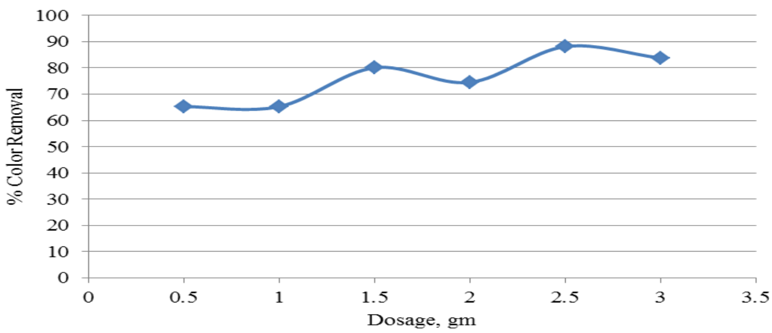
Graph 8: Time vs. % Color Removal

Effect of Dosage on % Color Removal

Variation of color removal with dosage at optimum RPM of 120 and optimum time of 120 min for effluent-2 (blue colored dye) is given in Table 9 and Graph 9. Maximum color removal of 88.14 % occurs at optimum dosage of 2.5 gm.

Table 9: Dosage vs. % Color Removal

Dosage, gm	% Transmissivity	% Color Removal
0.5	67	65.27
1.0	67	65.27
1.5	77	80.09
2.0	75	74.53
2.5	**82**	**88.14**
3.0	80	83.79



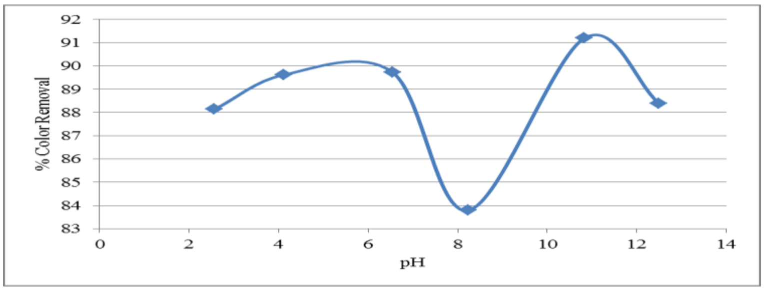
Graph 9: Dosage vs. % Color Removal

Effect of pH on % Color Removal

Variation of color removal with pH at optimum RPM of 120, optimum time of 120 min and at optimum dosage of 2.5 gm for effluent-2 (blue colored dye) is given in Table 10 and Graph 10. Maximum color removal of 91.20 % occurs at optimum pH of 10.83.

Table 10: pH vs. % Color Removal

pH	% Transmissivity	% Color Removal
2.57	82	88.14
4.12	84	89.62
6.54	85	89.73
8.23	80	83.79
10.83	**86**	**91.20**
12.49	83	88.39



Graph 10: pH vs. % Color Removal

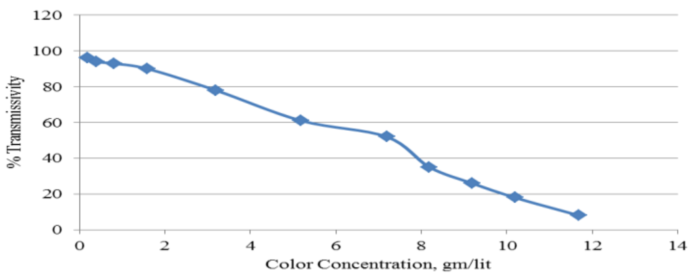
Treatment of Effluent-3

Calibration Curve

Calibration details for effluent-3 in given in Table 11 and Graph 11.

Table 11: Calibration data for effluent-3

Color Concentration, gm/ml	% Transmissivity
0.19973	96
0.39875	94
0.7975	93
1.595	90
3.190	78
5.190	61
7.190	52
8.190	35
9.190	26
10.190	18
11.690	8



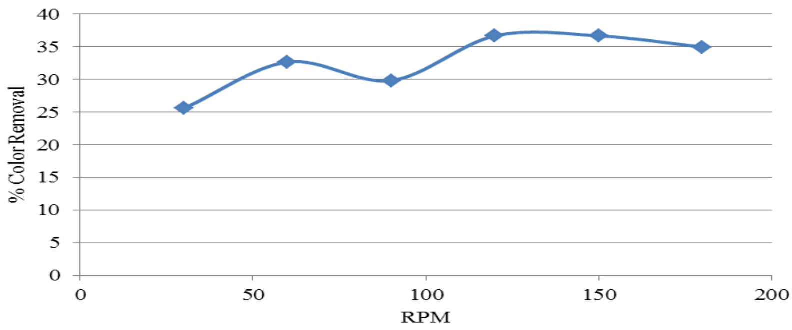
Graph 11: Calibration curve for effluent-3

Effect of RPM on % Color Removal

Variation of color removal with RPM for effluent-3 (red colored dye) is given in Table 12 and Graph 12. Maximum color removal of 36.69 % occurs at optimum RPM of 120.

Table 12: RPM vs. % Color Removal

RPM	% Transmissivity	% Color Removal
30	31	25.57
60	39	32.67
90	36	29.85
120	**43**	**36.69**
150	43	36.69
180	41	34.98



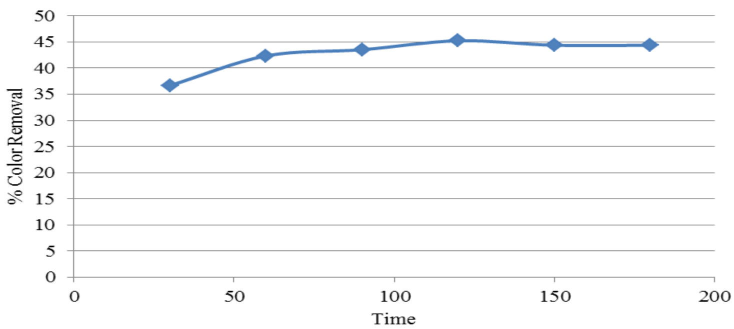
Graph 12: RPM vs. % Color Removal

Effect of Time on % Color Removal

Variation of color removal with time at optimum RPM of 120 for effluent-3 (red colored dye) is given in Table 13 and Graph 13. Maximum color removal of 45.25 % occurs at optimum time of 120 min.

Table 13: Time vs. % Color Removal

Time	% Transmissivity	% Color Removal
30	43	36.69
60	48	42.36
90	50	43.54
120	**53**	**45.25**
150	49	44.39
180	49	44.39



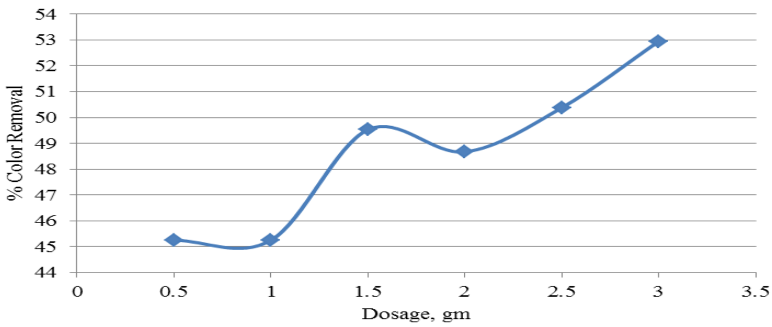
Graph 13: Time vs. % Color Removal

Effect of Dosage on % Color Removal

Variation of color removal with dosage at optimum RPM of 120 and optimum time of 120 min for effluent-3 (red colored dye) is given in Table 14 and Graph 14. Maximum color removal of 52.95 % occurs at optimum dosage of 3 gm.

Table 14: Dosage vs. % Color Removal

Dosage, gm	% Transmissivity	% Color Removal
0.5	53	45.25
1.0	53	45.25
1.5	56	49.53
2.0	55	48.67
2.5	58	50.38
3.0	**59**	**52.95**



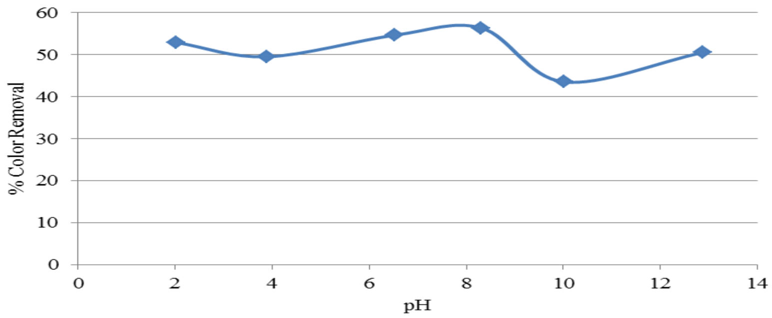
Graph 14: Dosage vs. % Color Removal

Effect of pH on % Color Removal

Variation of color removal with pH at optimum RPM of 120, optimum time of 120 min and at optimum dosage of 3.0 gm for effluent-3 (red colored dye) is given in Table 15 and Graph 15. Maximum color removal of 56.37 % occurs at optimum pH of 8.31.

Table 15: pH vs. % Color Removal

pH	% Transmissivity	% Color Removal
2.01	59	52.95
3.89	56	49.53
6.52	60	54.66
8.31	**62**	**56.37**
10.01	55	43.54
12.88	57	50.58



Graph 15: pH vs. % Color Removal

CONCLUSION

Maximum percentage of color removal for each of the textile dyeing industry effluent and optimum values of variables is given in the following table.

Effluent	Optimum Values of Variables				Maximum % Color Removal
	RPM	Time, min	Dosage, gm	pH	
1	90	120	2.5	10.45	78.04
2	120	120	2.5	10.83	91.20
3	120	120	3.0	8.31	56.37

From the above studies, it is concluded that dyes are amenable for their color removal and show positive response for treatment by the process of adsorption.

ISSN: 0975-8585

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