Comparative Evaluation of Removal of Fast Green and Reactive Orange by Low-Cost Adsorbent

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Abstract- *The survival of human beings on earth is menaced by various environmental issues. The foremost modification from previous years to present, when the things started to change, was the invention of synthetic dyes. The characteristics of synthetic dyes are brighter, fast and easy to be applied on fabrics and cheaper to generate. Scientists have discovered many gorgeous colors and synthetic dyes which are useful for many applications. Synthetic dyes from wastewater cannot be removed by ordinary wastewater treatment systems because they are not degradable. Adsorption techniques have the high efficiency in decolorizing the industrial effluents. Bench scale studies were carried out to evaluate the color adsorption potential of banana pith under various experimental conditions viz Flow rate, Color intensity and pH. The removal potential sequence by Banana Pith was observed and is Fast Green < Reactive Orange, and the removal efficiencies were found to be 74.2% and 90.7% respectively, at optimum experimental conditions of pH-6, Co-25mg/l, flow rate-20ml/min and particle size of the adsorbent-150-300µ.*

Keywords- Adsorption, Banana Pith, Reactive Orange and Fast Green.

I. INTRODUCTION

Dyes and colors are frequently used in Industries. Specially the industries namely Textile, Leather, Paper, Ink and Cosmetic industries extensively use dyes and hence effluent from these industries is a topic of major concern for environmentalist today. Many a times these will be toxic to flora and fauna, these effluents escalated environmental problems mainly because of their non-biodegradable characteristics. Hence treatment of color effluents becomes environmentally important [1].

The various conventional methods available for treating the colored effluents will be biological, physical and chemical treatment methods and are namely precipitation, coagulation, flocculation, ion-exchange, biosorption, adsorption etc[2].

According to Literature survey Bench scale studies were carried out to evaluate the feasibility of treating colored samples using low-cost adsorbent under varied experimental conditions. Many researchers investigated number of adsorbents which are commercially available and low-cost such as carbonized coir pith, chitosan, zeolites, saw dust, fly ash, banana pith rice husk, neem husk, silk cotton hull, orange peel, egg shell banana peel, tea waste and tamarind fruit shell [3,4,5,6,7,8,9,10,11,12,13,14,15,16].

In order to make the treatment of dyeing wastewater economical, it is imperative to use low-cost adsorbent. Thus an attempt has been made in the present study to assess the potential of Low-Cost adsorbent to adsorb colors from the synthetic colored sample using Bench scale studies.

1.1 Objectives of the Present Work

The specific objectives includes

1. Identification of colors to be tried and their Preparation.
2. Selection of the adsorbent and its Preparation.
3. To carry out Bench scale studies to remove color from synthetic samples using low-cost adsorbent under varied Experimental conditions viz flow rate, intensity of colors, Color concentration, pH of the sample.

II. MATERIALS AND METHODOLOGY

2.1 Adsorbent used and its Preparation

It was prepared as per the procedure given by[8]. The waste Banana stems were cut into small pieces and washed several times in tap water. After washing, it was dried under sunlight for 96 hours to remove moisture. After drying process, the waste Banana pith was grinded and sieved through sieve having size 150-300µ. Then the adsorbent sieved was used for the experimentation.

2.2 Colors tried and their Preparation

Dyes namely Fast green and Reactive Orange were used for experimentation. Synthetic colored samples of predesigned intensities were prepared by dissolving calculated

amount of commercially available colors in distilled water. Initially the stock solutions were prepared by dissolving the colors in distilled water. Then the stock solutions were diluted to desired concentrations. The pH of the solution was adjusted to the required value using acid/alkali.

2.3 Variables considered

Variables considered for experimentation are as follows

2.3.1 pH

It was planned to conduct experimentation at pH 4, 6, 8 and 10. The pH's of the samples were adjusted using acid and alkali (H_2SO_4 and NaOH).

2.3.2 Dyes Color Concentrations

In order to evaluate the effect of concentration on removal efficiency, the different concentrations of colors were considered for the study and were 25 and 85mg/l.

2.3.3 Flow Rate

20, 35, 50 and 65 ml/min were the flow rates considered for the study.

2.4 Experimental Setup

The experimental setup consists of borosilicate glass column of internal diameter 3.1 cm and length of 24.5 cm(fig.1). Column was mounted on a stand and cotton was placed at the bottom of the column which acts as a supporting material for the adsorbent. Constant head was maintained using two aspiratory bottles which were placed at different heights for gravity and constant flow. Pinch cock was used to adjust the flow rate. Prior to each experiment distilled water was passed through the column to get rid of the column contaminations and air bubbles. Synthetic colored samples of known concentration at different pH were passed through two aspiratory bottles and then it was passed into the column containing for and the samples were collected in sample bottles at different flow rates. Then the collected samples were analyzed by using Spectrophotometer(Model: HACH DR 2700).

Fig.1 Pictorial View of Experimental Setup

2.5 Calibration Curves

The percentage adsorptions for known concentrations of colors at defined wavelength were recorded by using Spectrophotometer. The wavelengths considered for colors Reactive orange and Fast green were respectively 410 and 620 nm. The graphs of color intensity versus percentage adsorption were drawn from fig.2 to fig.5. The colored samples to be analyzed were kept in Spectrophotometer and percentage adsorption was recorded. Corresponding to the percentage adsorption recorded the color intensity was read form calibration curve. Accordingly by knowing influent and effluent concentrations of colors, the removal efficiency was calculated.

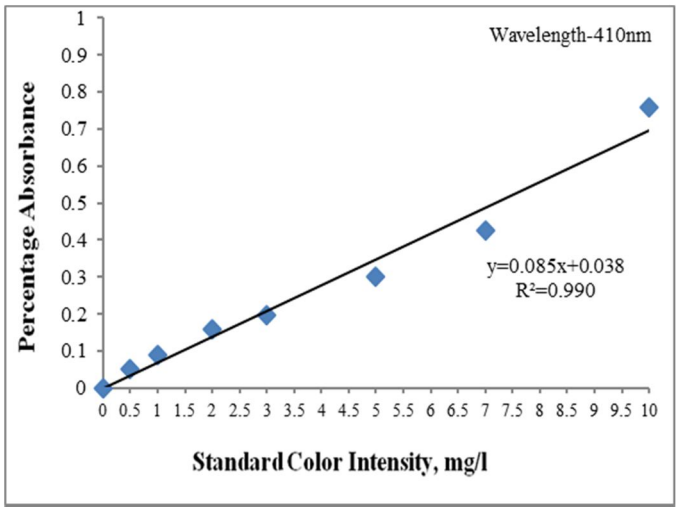

Fig.2 Calibration Curve for Reactive Orange
(Color Intensity: 0.5 to 10mg/l)

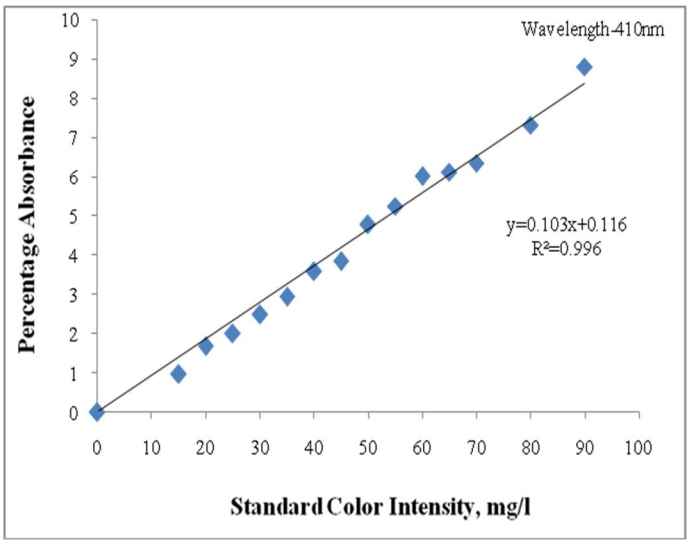

Fig.3 Calibration Curve for Reactive Orange
(Color Intensity: 15 to 120mg/l)

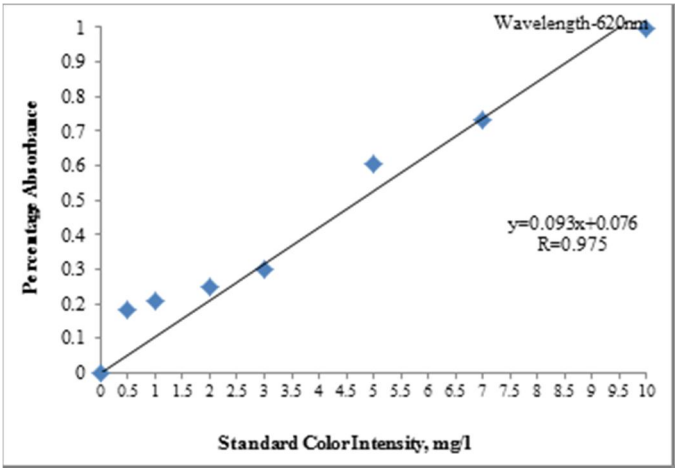

Fig. 4 Calibration Curve for Fast Green
(Color Intensity: 0.5 to 10mg/l)

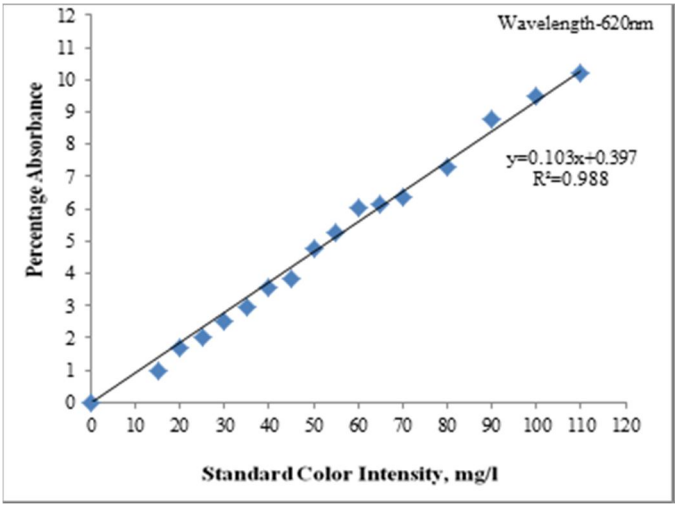

Fig.5 Calibration Curve for Fast Green
(Color Intensity: 15 to 120mg/l)

III. RESULTS AND DISCUSSIONS

The results of experimentation carried out to evaluate the performance of Bench Scale studies in removing colors selected namely Reactive Orange and Fat Green by the adsorbent Banana Pith under varied experimental conditions are presented in tables 1 and 2 and fig.6 to 9. Based on the experimental observations, the discussions were made and thereby inferences were drawn.

Removal efficiencies recorded for two initial concentrations of colors studied indicated that better removal can be achieved at lower initial concentrations. Further the results exhibited the reduction in removal efficiency with increase in flow rate from 20 to 65ml/min. Thus it is inferred that better removal can be achieved at higher contact time. Interestingly it was observed that with increase in pH from 4 to 6 efficiency increases but with further increase in pH decrease in efficiency was observed. Therefore within the limits of experimentation variables studied. It is inferred that Banana Pith can adsorb the Reactive Orange more efficiently compared to Fast Green at optimum conditions of Co-25mg/l, pH-6, Flow Rate-20ml/min. the removal efficiencies of Reactive Orange and Fast Green were found to be respectively 90.7% and 74.2%.

Table.1 Results of Column Studies on Reactive Orange

Initial Concentration Co (mg/l)	Flow Rate (ml/min)	Final Concentration (Ce) mg/l, at stated pH			
		4	6	8	10
25	20	5.05	2.32	5.0	6.87
	35	6.65	3.67	6.37	8.72
	50	9.22	5.25	9.35	11.5
	65	10.22	6.20	9.95	12.67
85	20	32.72	23.55	34.68	44.20
	35	40.37	28.22	38.16	46.49
	50	43.94	31.36	48.25	53.04
	65	50.06	42.28	53.29	55.01

Table.2 Results of Column Studies on Fast Green

Initial Concentration Co (mg/l)	Flow Rate (ml/min)	Final Concentration (Ce) mg/l, at stated pH			
		4	6	8	10
25	20	8.62	6.45	9.8	12.42
	35	11.05	8.12	12.32	14.45
	50	12.67	9.87	13.7	16.07
	65	13.67	11.12	14.97	17.3
85	20	41.14	38.84	48.87	57.29
	35	50.57	45.22	58.99	65.28
	50	59.48	52.36	60.69	69.27
	65	61.88	56.44	65.96	73.18

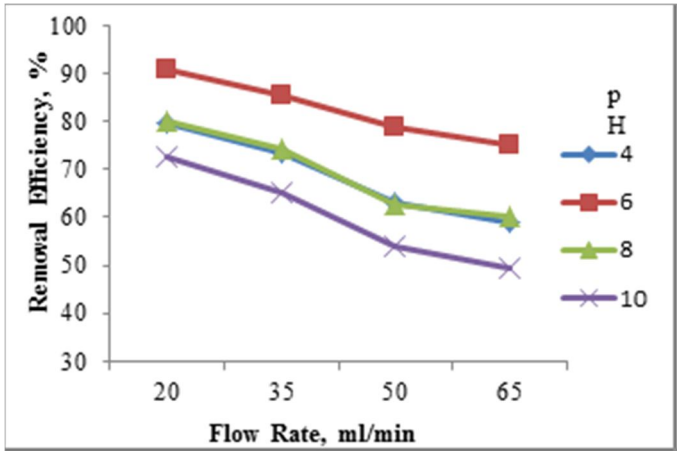

Fig.6 Effect of Flow Rate on Removal Efficiency of Reactive Orange (Co: 25mg/l)

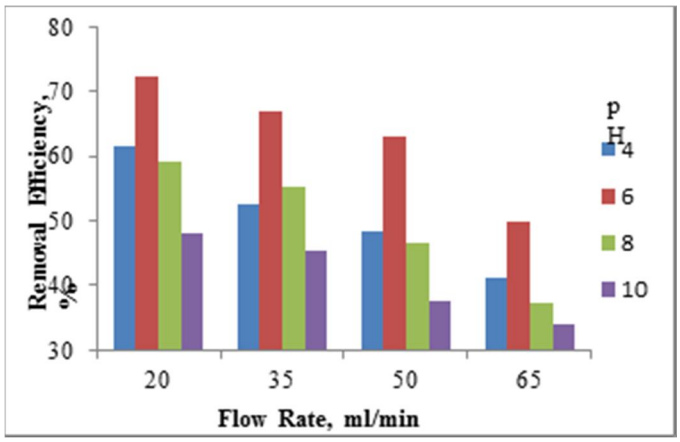

Fig.7 Effect of Flow Rate on Removal Efficiency of Reactive Orange (Co: 85mg/l)

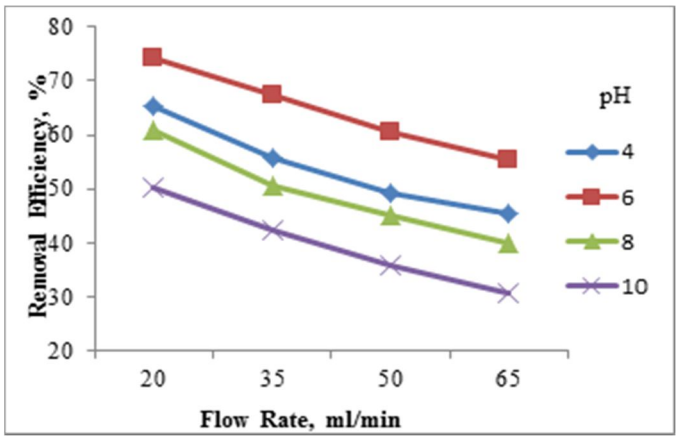

Fig.8 Effect of Flow Rate on Removal Efficiency of Fast Green (Co: 25mg/l)

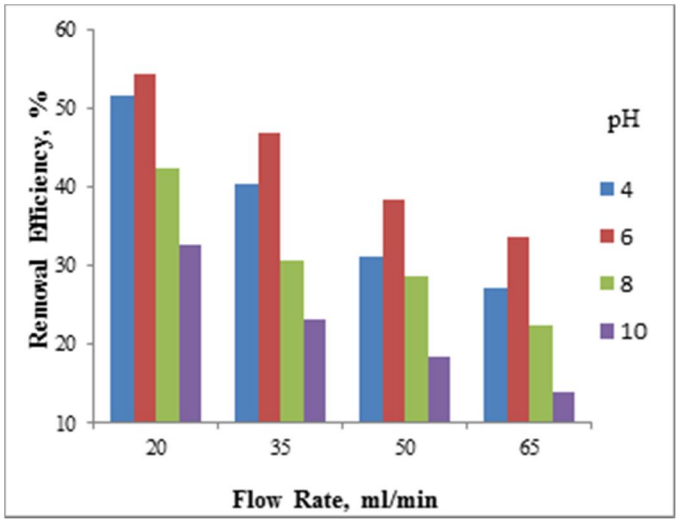

Fig.9 Effect of Flow Rate on Removal Efficiency of Fast Green (Co: 85mg/l)

IV. CONCLUSIONS

Based on the performance evaluation of the system studied in the present work, the following conclusions have been drawn.

1. It is concluded that the increase in pH of Synthetic sample, initial concentration of dyes beyond certain limit, the removal efficiency of all the dyes to adsorption will decrease.
2. It is concluded that the removal efficiency decreases with increase in flow rate.
3. It is concluded that the maximum dyes removal by the adsorbent can be achieved at pH of 6, Co 25mg/l, flow rate of 20ml/min.
4. It is concluded that, the adsorbents will be best in removal of Reactive Orange followed by Fast Green.
5. It is concluded that under optimum conditions of experimentation, Banana Pith will be able to absorb

maximum of 90.7% and 74.2% of Reactive Orange and Fast Green respectively.

4.1 Limitations of Present Study

The following are the limitations of present study

- The studies were carried out for selected range of variables and conclusions/inferences are drawn considering the best out of these variables. However the refined optimization of variables of experimentation is the limitation of present setup.
- Generally Textile industry effluent will be containing many colors at a time. Therefore, in a practical sense potential of adsorbent in treating actual effluent is to be studied, for optimum conditions established in the present work for individual colored samples. But such a lab work could not be carried out because of non availability of industrial effluent with colors studied and because of time constraint.

4.2 Scope for Further Study

- The issue covered in the limitations above can be considered as subject matter for further study.
- The removal efficiency in removing other dyes by the adsorbent studied in the present work can be considered for further study.
- The removal efficiency of the dyes studies in the present work by the other adsorbent can be considered for further study.

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