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Feasibility Studies to Evaluate Color Removal Potential of Banana Pith

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Abstract. *A first obvious change from past to present, where the things began to change, was the discovery of synthetic dyes. Cheaper to produce, brighter, more colors—fast and easy to apply to fabric are some of the characteristic of these new dyes. Due to increasingly stringent restrictions on the organic content of industrial effluents, it is necessary to eliminate dyes from wastewater before it is discharged. Many of these dyes are also toxic, and even carcinogenic, and this poses a serious hazard to aquatic living organisms. Synthetic dyes from wastewater cannot be removed by ordinary wastewater treatment systems because they are not degradable. But wastewater can be decolorized by biological, chemical and physical processes such as ultra filtration, electro-chemical adsorption, coagulation and photo oxidation. Adsorption techniques have the high efficiency in decolorizing the industrial effluents. Many scientists across the world completed studies to assess the potential of many low-cost adsorbents in decolorizing the industrial wastewater. Inspite of work carried out by researchers across the globe to treat colored wastewaters, one should note that, the treatment is color specific, adsorbent specific and depends on varied operational conditions. Thus the experimentation was carried out to evaluate the color (Sunset Yellow) adsorption potential of banana pith using Bench scale studies, under different experimental conditions viz Flow rate, Color intensity, Particle size of the adsorbent and pH.*

Key Words: Adsorption, Banana Pith, Sunset Yellow.

1. INTRODUCTION

Industrialization is generally believed to be the universal remedy for the economical backwardness. Mounting Pressure on industrialization to withstand in the context of advancement towards economic stability is constantly degrading all the spheres of environment today. Specially water pollution due to color from dye stuff industries has become a topic of major concern for environmentalists/scientists.

Industries are not permitted to discharge the effluent into the receiving body without treatment due to stringent restrictions since they are carcinogenic, toxic, and objectionable from aesthetic view, affect photosynthetic activity and causes hazardous effect on living organisms and aquatic life. Due to the non-biodegradable characteristics of color bearing effluent from industries, pose series of environmental problems. Hence it is essential to treat the colored effluent before discharging into receiving water body[1].

The various conventional methods for treating the colored effluent include biological, physical and chemical treatment methods[2]. Each of these methods has their own merits and demerits. Moreover the suitability of any treatment option is color specific and should be techno economically feasible.

Indepth literature survey has been carried out to take stock of work carried out by researchers across the globe in treating colors wastewaters. Based on the literature survey the gap has been identified in this area. Based on this, it was planned to carryout Bench scale studies 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 India around 80% of the population is depending on land for living and the utilization of agricultural waste has a greater significance where it plays a vital role in national economy. India is the second largest banana producer after Brazil[8]. Banana pith is the white middle portion of the banana stem. These stems are useful for ethanol production, bio-gas generation and paper making etc. After cutting the bunch large amount of residue is either used as manure, simply thrown or burnt off to decrease the volume of residue. Inorder to make the treatment of dyeing wastewater economical, it is imperative to use low-cost adsorbent. Thus in the present study an attempt has been made to evaluate adsorption potential of Banana Pith in treating Sunset Yellow color from the synthetic samples.

1.1 Objectives of the Present Work

The specific objectives includes

1. Selection of the adsorbent and its Preparation.
2. Fabrication of experimental setup.
3.To evaluate color (Synthetic colored samples), removal potential of color, adsorbent selected under varied experimental conditions viz flow rate, intensity of color,

particle size of the adsorbent, Color concentration, pH of the sample.

2. Materials and Methodology

2.1 Adsorbent used and its Preparation

Banana Pith is the white middle portion of the banana stem and is used as adsorbent in the present study. Banana stems were collected from a local farm of Hassan District. 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 sieves having size 150-300µ and 500-1000µ. Adsorbent collected after sieving was used for the experimentation [8].

2.2 Color tried and its Preparation

Synthetic colored samples of predesigned intensities were prepared by dissolving calculated amount of Sunset Yellow color in distilled water. Initially the stock solution was prepared by dissolving the color in distilled water. The solution was diluted to desired concentration for experimentation. 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 (diluted H_2SO_4) and alkali (NaOH).

2.3.2 Dyes 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 65mg/l.

2.3.2 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 adsorbent and the samples were collected in sample bottles for different flow rates. Then the collected samples were analyzed by using Spectrophotometer(Model: HACH DR 2700).

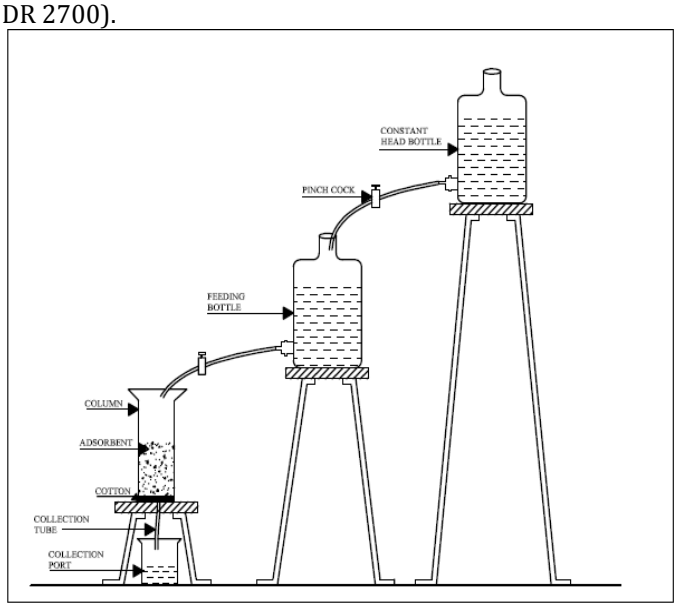

fig.1 Line Diagram of Experimental Setup

2.5 Calibration Curves

The percentage adsorptions for known concentrations of colors at defined wavelength were recorded by using Spectrophotometer. The wavelength considered for color Sunset yellow was 490nm. The graphs of color intensity versus percentage adsorption were drawn(fig.2 and fig.3). 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.

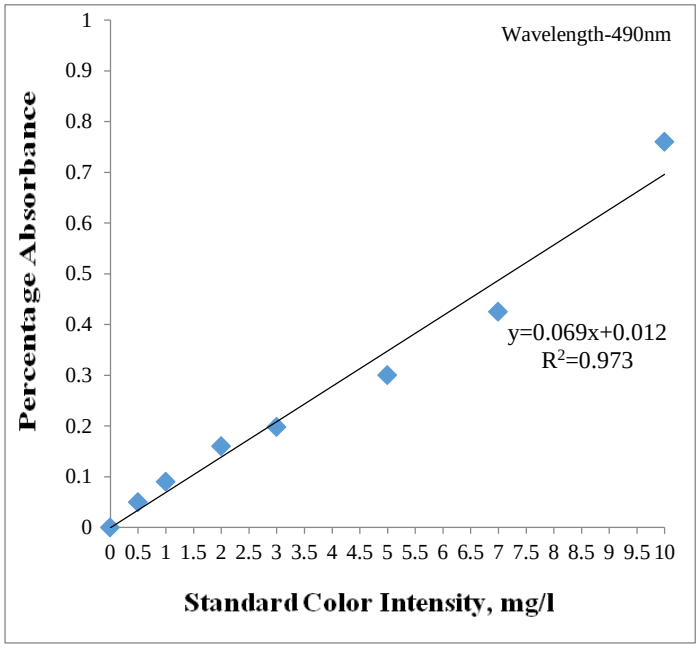

fig.2 Calibration Curve for Sunset Yellow (0.5 to 10mg/l)

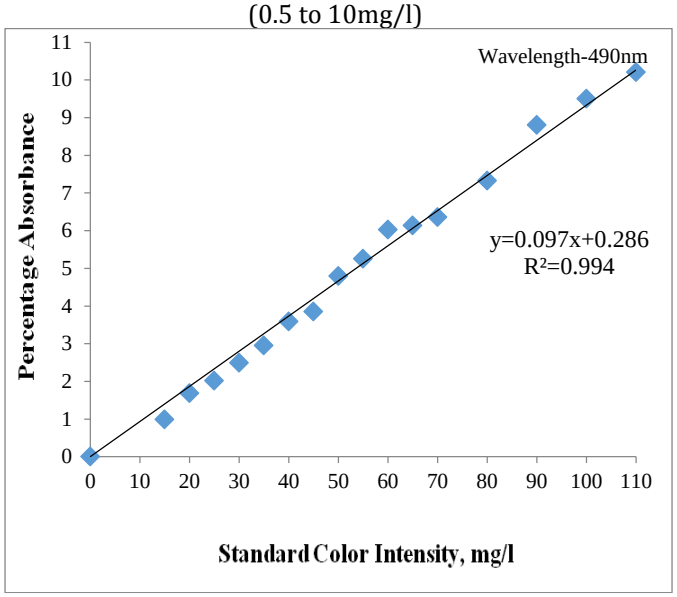

fig.3 Calibration Curve for Sunset Yellow (15 to 110mg/l)

3. Results and Discussions

The results of experimentation carried out to evaluate the performance of Bench Scale studies in removing color(Sunset Yellow) by the adsorbent Banana Pith under varied experimental conditions are presented in table 1 and 2 and by graphs(fig.4 to 7). Based on the experimental observations, the discussions were made and thereby inferences were drawn.

Removal efficiencies recorded for two initial concentrations of Sunset Yellow 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. Again at lower particle size of adsorbent where in surface area will be maximum, better removal efficiency was observed. 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 Sunset Yellow under the optimum condition of pH-6, Co-25mg/l, Flow Rate-20ml/min and Particle size-150-300µ.

Table.1 Results of Column Studies on Sunset Yellow (Particle Size of Adsorbent : 150-300µ)

Initial Concentration Co (mg/l)	Flow Rate (ml/min)	Final Concentration (Ce) mg/l, at stated pH			
		4	6	8	10
25	20	13.0	9.48	11.35	12.83
	35	14.43	10.63	10.95	14.35
	50	16.2	11.93	13.98	15.53
	65	17.48	13.2	14.98	17.2
65	20	41.41	32.44	38.89	40.37
	35	44.79	37.51	42.71	47.0
	50	47.78	39.91	44.66	48.30
	65	51.09	43.81	49.08	51.94

Table.2 Results of Column Studies on Sunset Yellow (Particle Size of Adsorbent: 500-1000µ)

Initial Concentration Co (mg/l)	Flow Rate (ml/min)	Final Concentration (Ce) mg/l, at stated pH			
		4	6	8	10
25	20	14.93	11.30	12.35	13.73
	35	15.68	12.48	14.81	15.70
	50	17.55	14.63	16.48	17.93
	65	18.73	15.95	17.7	19.08
65	20	44.72	38.61	43.23	44.92
	35	45.31	40.56	45.05	49.99
	50	51.29	45.11	48.95	53.24
	65	52.07	48.62	51.94	54.8

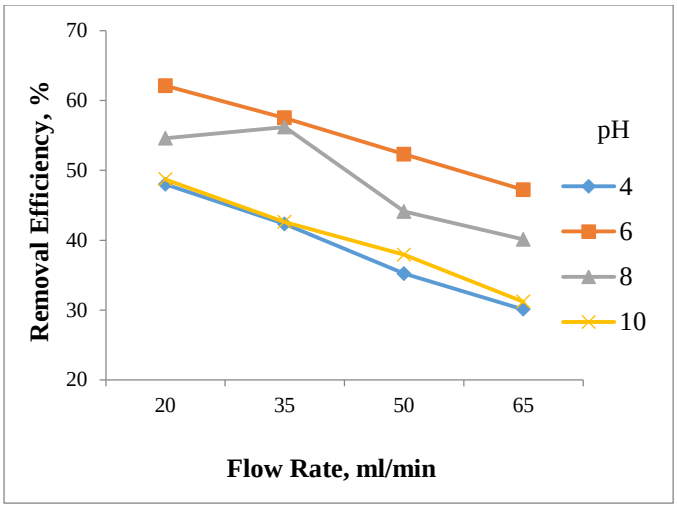

fig.4 Effect of Flow Rate on Removal Efficiency of Sunset Yellow(Co: 25mg/l, Particle Size of Adsorbent: 150-300µ)

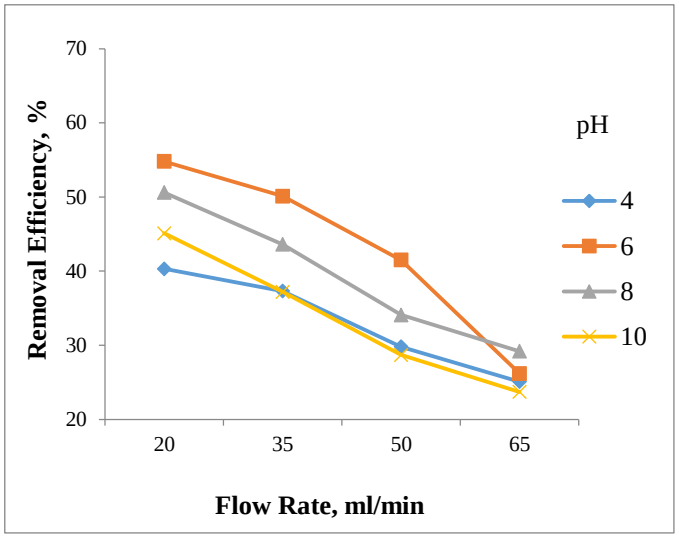

fig.5 Effect of Flow Rate on Removal Efficiency of Sunset Yellow(Co: 25mg/l, Particle Size of Adsorbent: 500-1000µ)

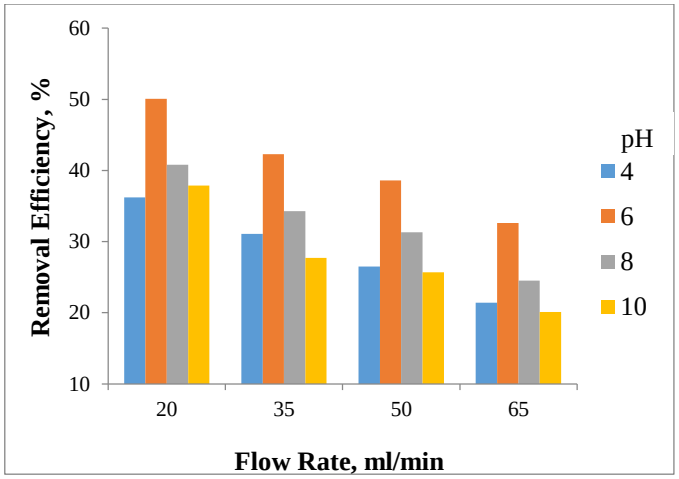

fig.6 Effect of Flow Rate on Removal Efficiency of Sunset Yellow(Co: 65mg/l, Particle Size of Adsorbent: 150-300µ)

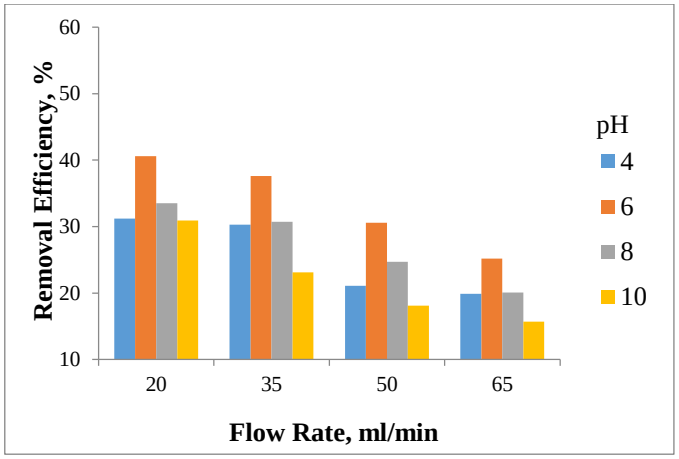

fig.7 Effect of Flow Rate on Removal Efficiency of Sunset Yellow(Co: 65mg/l, Particle Size of Adsorbent: 500-1000μ)

4. 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 particle size of the adsorbent has good bearing on the removal efficiencies and exhibited inverse relation in the present work.
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 of 25mg/l, flow rate of 20ml/min and adsorbent particle size of 150-300 μ.
4. It is concluded that the maximum dye removal efficiency of Banana Pith in removal of Sunset Yellow dye under optimum condition will be 62.1%.

4.1 Limitations of Present Study

The comparison of results of present study with those of other researchers could not be carried out, since the studies of other researchers are on batch experiments and present study is on column experiments. Further the batch experiments of other researchers are also not matching with the adsorbent/dyes variables studied in the present work. These issues can be considered under scope for further work.

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