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Removal of Eosin Y Dye using Activated Carbons from Modified Wood Dust Powder of *Dalbergia sisoo*

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Abstract

An agro-waste/wood-dust of Dalbergia sisoo (Sisau) derived activated carbons have been applied as a potential adsorbent to remove anionic dye "Eosin Y" from aqueous solution. The activated carbons were synthesized by carbonization technique. The chemical activation was done by impregnating with three different impregnating agents, i.e. acid, base and salt, namely phosphoric acid (H_3PO_4), potassium hydroxide (KOH) and sodium carbonate (Na_2CO_3). The prepared activated carbons were characterized by various instrumental techniques like TGA/DSC, XRD, Raman, FTIR, SEM and BET. The BET analysis gave the evidence of micropores and mesopores in the samples. The H_3PO_4 activated carbon sample revealed higher surface area than KOH and Na_2CO_3 activated samples. The amorphous nature of the sample was observed on the basis of XRD and Raman spectroscopy technique. The adsorption of dye was performed by varying the dye concentration, pH and sample dose. The maximum percent of dye removal by H_3PO_4 activated carbon (Dal-A) for Eosin Y was found to be 99.9 % at an aqueous solution of 20 ppm, pH 3.5, adsorbent dose of 30 mg and 5 min of time as compared to KOH and Na_2CO_3 activated carbons; Dal-B and Dal-C respectively. This study proved to be highly successful in addressing the local problem of wastewater pollution of garment and textile industrial effluents using locally available wood dust of Dalbergia sisoo. Acidic pH environment was found to be more conducive in the removal of Eosin Y dye.

Keywords*:* *Activated* carbon, chemical activation, Dalbergia sisoo, dye removal, adsorption

1. Introduction

Water pollution caused by dyes is one of the most escalating problems in the world nowadays. Even in Nepal, the garment and textile industries have become the most imperious and briskly developing industrial sector (Nagajyothi *et al.,* 2010). The garment and textile industries are spread in several parts of the country with its main cores at Kathmandu valley, Biratnagar, Bhairahawa, Nepalgunj and Pokhara. The dyeing industries

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*Dr. Shrestha is an assistant professor of Chemistry, Patan Multiple Campus, TU, Nepal consume a lot of synthetic dyes due to their superior dyeing properties, especially in terms of stronghold. These industries emit significant amounts of synthetic textile organic dye wastes amongst all industrial waste waters. It has been reported that, more than 10,000 different types of dyes and pigments are being manufactured worldwide annually. It is estimated that approximately 10% to 15% of the dye is lost in the effluent during the dyeing process (Kadirvelu *et al*., 2003). After the dyeing process, the waste water carries the residual and unspent dye substances which are usually discharged into the environment as such without being treated. This discharged effluent is toxic in nature, imparts color to the receiving water or soil and interferes with both terrestrial and aquatic plant and animal life (Kadirvelu *et al*., 2003).

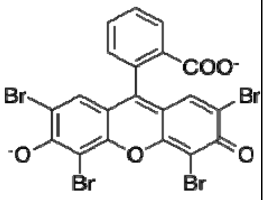
Among all the possible harmful chemicals and dyes present in industrial effluents, present study has focused on elimination of anionic dye, “Eosin Y” (EY)as garment and textile effluentfrom aqueous solution, using laboratory synthesized phosphoric acid (H_3PO_4), potassium hydroxide (KOH) and sodium carbonate activated carbon (Na_2CO_3). EY has been widely used in textile industry to dye fabrics and ink manufacturing as well. EY is a water soluble dye and is a reddish pink crystalline powder. Physically, EY causes the redness, swelling and pain while it contacts the sensitive parts of the human body like eye, skin, etc. but it may cause permanent damage of parts of eye like cornea and it is more harmful when EY enter inside the human body and may cause a series of adverse effects on vital organs like liver, lungs, kidney and gastrointestinal organs (Sasaki *et al*., 2002). EY is not permanent and fades rapidly in sunlight and it is hazardous for living beings. The proper treatment of effluent containing the dye is extremely necessary.

Various materials and methods have been studied as adsorbent to removeEY so far, such as multiwalled carbon nanotubes (CNTs) (Lawal, *et al.* 2019), chitosan (Du, et.al. 2008), and magnetite nanoparticles (Kumari, et.al. 2018), adsorption etc. Currently, more and more attention has been paid to the use of cheap agro-waste as an adsorbent by simple treatment (Xia *etal.*,2019), usingactivated carbons (ACs), which are being one promising choice. Activated carbon (AC) has been an ideal material for the separation of a variety of chemical pollutants including dyes from water.

In the present study, wood dust of *Dalbergia sisoo* (Sisau) has been used as a precursor material for the preparation of activated carbon (AC). Till date, no study has been reported on the preparation and comparative study of activated carbons from *Dalbergia sisoo* (Sisau), activating with three different chemical activating reagents; H_3PO_4, KOH and Na_2CO_3on removal of EY from industrial effluent.

General information of Eosin Y dye is tabulated in **Table 1.**

Table 1. Physical and chemical characteristics of Eosin Y dye

Dye	**IUPAC name**	**Chemical formula**	**Chemical structure**	**Mol.wt. ($gmol^{-1}$)**	**Appearance**	**λ_{max} nm**
Eosin Y	Disodium;2-(2,4,5,7-tetrabromo-3-oxido-6-oxoxanthen-9-yl) benzoate	$C_{20}H_6Br_4Na_2O_5$		691.85	Reddish Pink powder	524

2. Materials and Methods

2.1. Reagents

All the chemicals used in this study were of analytical grade and were used without further purification. Phosphoric acid (85%) was obtained from Fischer Scientific, India. Similarly, Eosin yellow (EY, 95%) from SIGMA-ALDRICH. Hydrochloric acid, extra pure grade, was obtained from DUKSAN reagents and Aqueous NH_3 (30%) from Baker Analysed A. C. S. reagent. Distilled water has been used throughout the experimental work. Wood dust of *Dalbergia sisoo* (Sisau)was collected from local carpentry, Kathmandu, Nepal.

2.2. Methods

2.2.1. Preparation of wood dust powder

Wood dust of *Dalbergia sisoo* (Sisau) was sun-dried for a few days. Then a few preliminary stages have been performed such as crushing, grinding and sieving through 150 µm sized sieve. Thus fine wood dust powder was obtained and was used as a precursor for the preparation of AC.

2.2.2. Preparation of activated carbon by carbonization method

Thus obtained fine powder precursor was preheated for 2 h separately in order to remove all volatile matters. Then the fine powdered precursor was divided into three parts. The first part was impregnated with H_3PO_4, thesecond partwas impregnated with KOH and the third part with Na_2CO_3. The ratio of precursor to activating agent was taken 1:1 (w/w) of precursor to activating agent. The impregnation ratio was determined as the ratio of the weight of H_3PO_4, KOH and Na_2CO_3 to the weight of the wood dust powder of *Dalbergia sisoo* (Sisau). They were left for 24 h at room temperature for proper soaking, and then evaporated to dry at 110^0C in an oven. The weighed amount of samples was inserted into the horizontal electric tubular furnace and carbonized at 400^0C for 3 h in an inert atmosphere of N_2. Continuous flow of pure N_2 was used to create an inert atmosphere. The carbonized samples were then cooled to room temperature maintaining an inert atmosphere of nitrogen and were washed with distilled water for several times until the pH of the washed water became neutral and were dried in an oven at 110^0C. Finally, as prepared adsorbents or ACswere named as '**Dal-A**' for H_3PO_4 activated carbon, '**Dal-B** for KOH activated carbon, and '**Dal-C**' for Na_2CO_3 activated carbon. Thus prepared samples were stored in an air-tight container until further use in adsorption experiments.

The description and preparation condition of three different ACs were tabulated in **Table 2**.

Table 2. Description and preparation condition of three different ACs

Sample name	Activating agent	Preheating hour	Preheating temperature (^{o}C)	Carbonization temp (^{o}C)	Carbonization time (h)	Atmosphere
Dal-A	H_3PO_4	2	110	400	3	N_2
Dal-B	KOH	2	110	400	3	N_2
Dal-C	Na_2CO_3	2	110	400	3	N_2

2.3. Adsorption process

20 ppm stock solution of EYdye was prepared by dissolving 20 mg of the dye per liter of double distilled water. At first 100 ml EY dye solution was taken in 250-mL Erlenmeyer flasks and 20 mg of as prepared AC (**Dal-A**) was added and agitated for 5 minutes at 400 rpm at neutral pH on the magnetic stirrer at room temperature. During the agitation period, about 3 ml of the mixture solution was taken in a micro centrifuge tube in every single minute time interval (5 times). All the 5 micro centrifuge tubes were then centrifuged for 5 minutes to separate the insoluble particles. The agitation speed was kept constant at 400 rpm. The same process was repeated for the samples **Dal-B**and **Dal-C.**

Finally, the clear solution wasanalyzed for the final concentration of dyes and **s**ubjected to UV-vis spectrophotometer (SCINCO, Mega-2100, Double beam, UV-VIS spectroscopy) and absorbance was noted.

The adsorption of dye molecules is affected by various factors:

1. Adsorbent dose
2. Solution pH
3. Initial dye concentration
4. Contact time

Optimization of these parameters will greatly help in the research work and mainly in the development of industrial scale treatment processesfor the dye removal.

The same experimental process was repeated for; (a) two dosage of carbon-samples (25 mg and 30 mg), (b) **Dal-B** and **Dal-C**samples and (c) solution of different pH values, varying from pH 3.5 to 8.5. The percentage removal of dye is defined as the difference in dye concentration before and after adsorption, and was calculated by using the Equation (1):

$$\% \text{ Removal} = \frac{(Co-Ce)}{Co} \times 100\% \ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where Co is the initial concentration, while Ce is the final concentration of dyes, prior and after adsorption.

2.4. Characterization technique of activated carbon samples

The pyrolytic behaviors of the raw wood dust powder were investigated by TGA/DSC (SDT Q600 V20.9 Build 20). The morphology of the prepared samples was determined by Scanning Electron Microscope (SEM, Nanoeye, Korea). Phase state was evaluated by using X-ray Diffraction (XRD, Rigaku RINT 2000 Diffractometer). Similarly, Surface carbon-oxygen functional groups present in samples were identified performing FTIR measurements using FT-IR instrument (Bruker, Vertex 70, Germany). The % transmission of samples was recorded over 4000-400 cm^{-1}. The presence the amorphous carbon samples was confirmed by Raman signal [labRAM HR800 (JOBIN YVON)]. The surface area, pore size and pore volume of the carbon samples were measured by BET **(**Micromeritics ASAP 2020 system. As prepared AC samples have been applied efficiently in adsorption of EY dye. Then absorbance was noted using Spectroscopy (SCINCO, Mega-2100, Double beam, UV-VIS spectroscopy).

3. Results and Discussion

3.1. TGA/ DSC Analysis:

Thermogravimetric analysis (TGA) was carried out to know the pyrolytic behavior of the raw wood dust powder of *Dalbergia sisoo* (**Dal-Raw**).

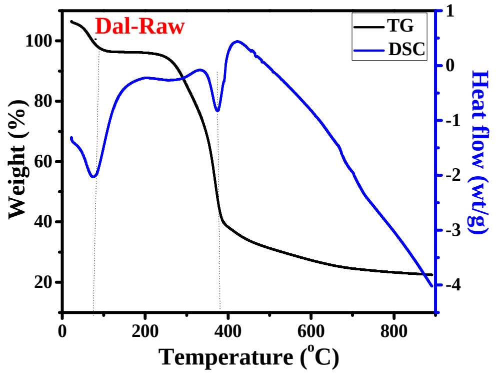
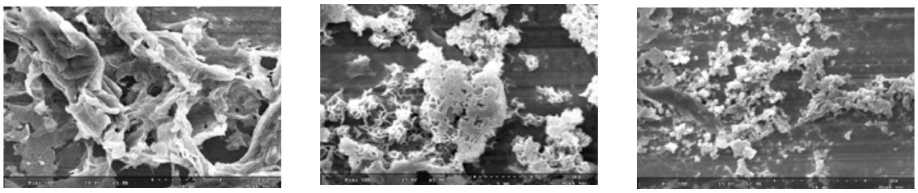


Fig.1. TGA/DSC measurement of raw wood dust powder of *Dalbergia sisoo* (**Dal-Raw**)

Fig.1 illustrates the TG and DSC curves of raw wood dust powder of *Dalbergia sisoo* (**Dal-Raw**). It was observed that, in TG curve (a black line), a slight weight loss occurred from 60-100 ^{0}C which was due to dehydration. This was confirmed by a sharp endothermic peak at 100°C from DSC measurement. A shallow peak at around 200- 300°C, slight weight loss was clearly observed in DSC curve, which might be due to decomposition of hemicellulose which was substantially completed at 300-310°C (Karthikeyan, *et al.*, 2014). However, it is not clear in TG plot. A significant weight loss was observed between 300-400°C from TG, which isconfirmed by a sharp endothermic peak at around 400°C of DSC. This is due to the breakdown of cellulose into carboxyl, lactone, and lacto, carbonyl due to the desorption of CO_2 and CO by converting cellulose into organic volatile matters present in sawdust. It showed that, extreme of weight loss occurs around 400°C (Molina-Sabio and Rodriguez-Reinoso, 2004). Samples are more stable beyond 400°C. Therefore, 400°C is an appropriate temperature for the carbonization process (Wu *et al.*, 2015).

3.2 Scanning Electron Microscopy (SEM) analysis

The morphology and pore size of as prepared ACs (**Dal-A, Dal-B and Dal-C**) were investigated by SEM.



Dal-A **Dal-B** **Dal-C**

Fig. 2. SEM micrographs of **Dal-A, Dal-B** and **Dal-C** samples

In**Fig. 2a, b** and **c.** the pore development on the surfaces of the ACs might be due to the evaporation of activating agents H_3PO_4, KOH and Na_2CO_3 during carbonization process, leaving space, which were previously occupied by the activating agents (Xie *et al.*, 2018). Among them, H_3PO_4 activated carbon (**Dal-A**), exhibited very fine internal structure with well-developed pores. Among the three activating agents, H_3PO_4 is considered as the best dehydrating agent whereas in the case of **Dal-B** and **Dal-C**, pores seemed to be somewhat less developed. It is probably due to incomplete carbonization at 400°C (Lokhande *et al.*, 2007).Due to well-developed pores in **Dal-A**, it possessed higher BET surface area than other two prepared ACs (**Dal-B** and **Dal-C**).

3.3. N_2 Adsorption/desorption isotherm / Brunauer Emmett Teller (BET) surface area measurement

Figure 3 shows the N_2 adsorption/desorption isotherms at 77 K for all as prepared activated carbon samples.

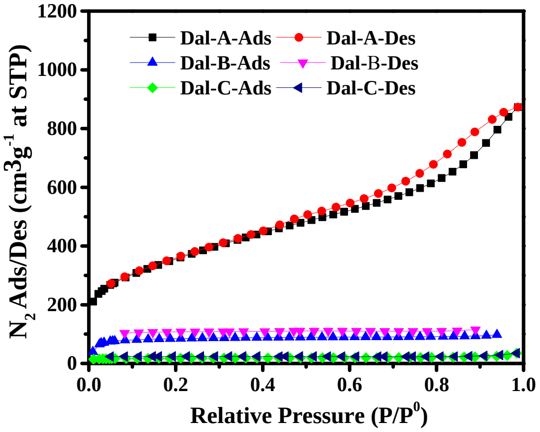


Figure 3. N_2 adsorption/desorption isotherms at 77 K for 3 ACs (**Dal-A, Dal-B** and **Dal-C**)

As can be seen in **Fig. 3**, at lower relative pressure region ($P/P^0 < 0.1$), the isotherms showed a drastic uptake indicating the presence of micropores in all the ACs. The uptake in lower relative pressure seems to decrease in **Dal-B** and **Dal-C**; however, at high relative pressure, the plateau was reached. It indicates that, these ACs namely **Dal-B** and **Dal-C** consisted of micropores. In **Dal-A**, at $P/P^0 = 0.5$, the amount of nitrogen uptake has increased significantly showing hysteresis loop during adsorption and desorption of nitrogen. The widely opened knees and the slight hysteresis loops at the relative pressure of 0.5 to 1.0 indicated the presence of a considerable amount of small mesopores in **Dal-A**.

Such hysteresis loop did not exist in the adsorption –desorption curve for **Dal-B** and **Dal-C**. This highlights the presence of microporous structure.

The surface area was measured by Brunauer–Emmett–Teller (BET) method. Among three ACs, $H_3PO_{4\ AC}$ (**Dal-A**) showed highest surface area of 1362 m^2/g, pore size of 5.0 nm and pore volume 1.2 cm^3g^{-1} in comparison to KOH (**Dal-B**) and Na_2CO_3 (**Dal-C**) ACs which were 281 m^2/g, pore size of 3.5 nm and pore volume 0.7 cm^3g^{-1} and 59.2 m^2/g pore size of 3.7 nm and pore volume 0.8 cm^3g^{-1} respectively. It might be due to the presence of innumerable mesoporosity along with microporosity in the case of phosphoric acid activated carbon (**Dal-A**) (Molina-Sabio and Rodriguez-Reinoso, 2004). This is also supported by SEM images **Fig. 2. (a)** of **Dal-A** sample, containing fine internal structure with extensive porosity.

Table 3: BET specific surface area, pore size and pore volume of **Dal-A**, **Dal-B** and **Dal-C**

Name of Sample	**Specific Surface Area (m^2g^{-1})**	**Pore size (nm)**	**Pore volume (cm^3g^{-1})**
Dal-A	1362	5.0	1.2
Dal-B	281.0	3.5	0.7
Dal-C	59.2	3.7	0.8

3.4. XRD analysis

To identify the phase state of carbon samples, XRD technique was carried out. **Fig. 4** shows the XRD pattern of prepared ACs.

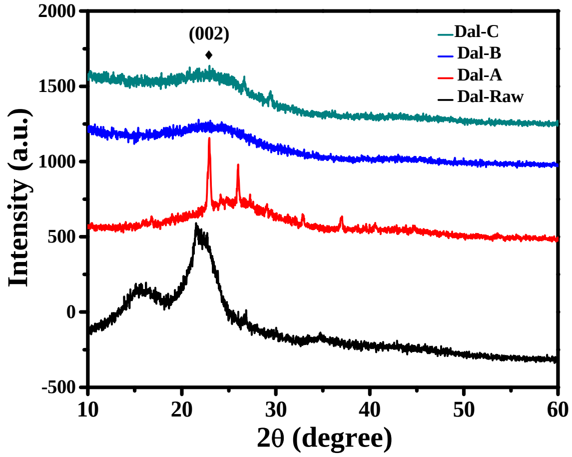


Figure 4. XRD pattern of3 ACs (**Dal-A**, **Dal-B** and **Dal-C**) and **Dal-Raw**

The XRD pattern of **Dal-Raw** showed peaks at around 16 and 23, 2θdegree (Bragg's angle), whereas in chemically activated carbonized samples; **Dal-A**, **Dal-B** and **Dal-C**,those two sharp peaks were found to be completely missing. But a broad peak was seen at around 27, 2θ degrees corresponding to (002) diffraction of the disordered stacking of the microstructures. Since no higher and sharper peak at (002) plane was seen, which confirms the absence of degree of graphitization (Sivakumar et al., 2012). The broad peaks at around 20 to 30, 2θ degree indicates the presence of amorphous nature of carbon (Sivakumar et al., 2012). Besides this, no other peaks have been visualized in XRD pattern which revealed that there is no any other effect of activating agents like H_3PO_4, KOH, Na_2CO_3.

3.5. Raman Spectroscopy

It is a technique to identify the graphitic nature of the activated carbons.

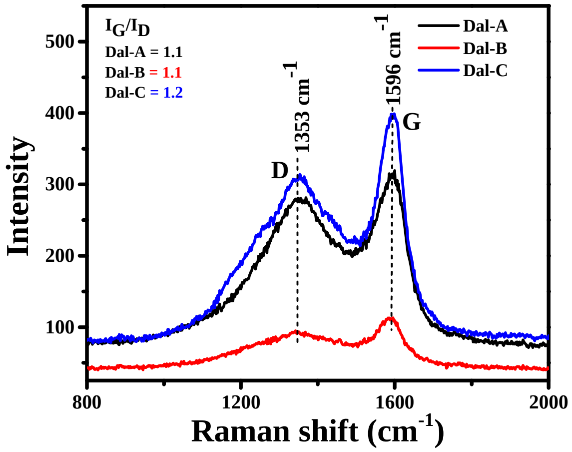


Fig.5. Raman spectra of3 ACs (**Dal-A**, **Dal-B** and **Dal-C**)

Figure 5presents the Raman spectra of as prepared ACs. Raman spectra of all the three ACs demonstrated strong D and G bands approximately at 1353 cm^{-1} and 1596 cm^{-1} respectively. Here D band at 1353 cm^{-1} indicated disordered carbon in all the three ACs (**Dal-A**, **Dal-B** and **Dal-C**) prepared in the laboratory. Similarly, G band was obvious in sample **Dal-A** and **Dal-C** while in **Dal-B**, it was found to be small. The relative peak intensity ratio of D band to G band [I(D)/ I(G)] provides semi quantitative information of crystallization degree of graphitic carbon in all as prepared ACs. The ratio I(D)/I(G) for **Dal-A**, **Dal-B** and **Dal-C**was found to be 1.1. 1.1 and 1.2 respectively. The ratio I(D)/I(G) was found to be almost 1 in all the three ACs showing the formation of amorphous carbon (Shimodaira and Masui, 2002). The identical result has been established by XRD pattern.

3.6. FT-IR analysis

The FTIR spectra of **Dal-A**, **Dal-B** and **Dal-C** were examined to study the effect of activating agents in the production of surface functional groups, and the possible interaction between functional groups and metal ions are presented in **Fig.6**. The percentage transmittance of the ACs was recorded over 4000-400 cm^{-1}.

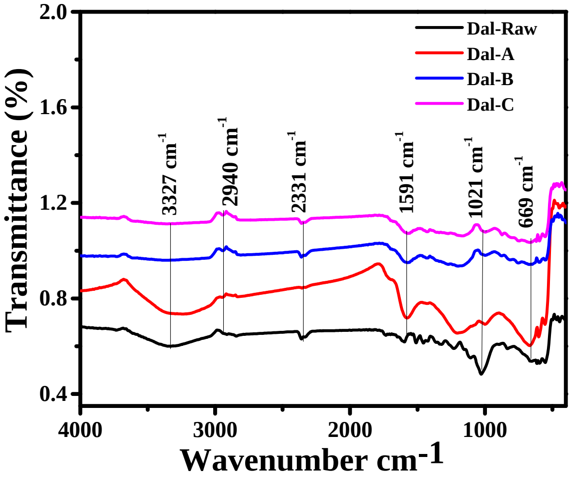


Fig.6.FTIR spectra of3 ACs (**Dal-A**, **Dal-B** and **Dal-C**) and **Dal-Raw**

FT-IR spectra of **Dal-Raw** showed the adsorption band at around 3327cm^{-1} which was attributed to –OH stretching of carboxyl, phenol and alcohol vibration and adsorbed water. This band was found to be vanished in chemically activated carbon samples, except in **Dal-A**, which indicated the dehydration of carbon samples due to carbonization. It is also supported from thermal analysis (TGA/DSC). The TGA/DSC curve (**Fig.1)** clearly shows mass loss at around 100°C, indicating evaporation of water molecules. The band at around 2940 cm^{-1} is assigned to aliphatic C-H stretching adsorption. The band at around 2331cm^{-1} (2330-2359 cm^{-1}) is assigned for CH_3 of alkane. The band at 1591 cm^{-1} (in the region 1500 - 1900 cm^{-1}) is due to C–C vibrations in aromatic rings. Similarly, the broad band observed in the region 1021 cm^{-1} is usually focused with oxidized carbon and has been assigned to C–O stretching in acids, alcohols, phenols, ethers and/or esters groups. This point is also supported by TGA/DSC curve [**Fig.1**], which clearly shows significant mass loss between 300°C to 400°C. This is due to the breakdown of cellulose into carboxyl, lactone andlacto groups, which is due to desorption of CO_2 and CO, converting cellulose into organic volatile matters present in the sawdust (Prahas *et al.*, 2008). These results are in good agreement with the findings of many researchers. The FTIR analysis shows that all the three the ACs were fully functionalized with oxygen containing functional groups: carboxylic, phenolic, lactonic, ethers groups by the activating agents used in this study.

3.7. Adsorption studies

3.7.1. Effect of variable parameters

3.7.1.1. Doses of adsorbent

The effectiveness of various adsorbent doses on anionic dyes adsorption/removal is reported by many researchers to determine the most economical minimum dosage**.** In general, the dye removal percentage increases with the increase of the adsorbent dosage (Dawood *et al.,* 2014). The amount of adsorbent represents an important parameter due to its strong effect on the capacity of an adsorbent at a given initial concentration of the adsorbate (100 mg/L). The percentage removal capacity of activated carbon is due to their porous structure and pore size distribution and it depends on the polarity, solubility and molecular size of the adsorbate. From adsorption spectra, it was observed that the optimum dose of adsorbents (**Dal-A, Dal-B and Dal-C)** for the removal of **EY** from aqueous solution is 30 mg/100ml.

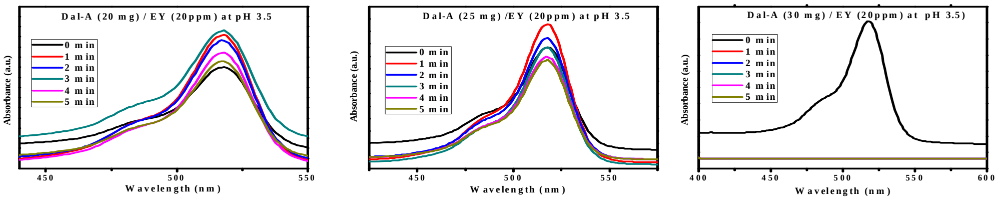


Fig.7. Eosin Y Dye adsorption at three different masses of 20, 25 and 30 mg of **Dal-A**

The percentage removal of the dyes increased from 62.2%, 74.3 % to 99.9% of **EY** adsorption by **Dal-A**, along with the increase of dose of ACsfrom 20 mg, 25 mg to 30 mg. When the dose is increased, free sorption surface and adsorption sites also increase and thus more dye molecules will be adsorbed (Chen *et al.,* 2011). When AC was increased to 35 mg/100ml (figure not shown), there was no significant difference in percentage removal of dyes from the dose of 30 mg and therefore 30 mg is suitable for adsorption of dyes in this study. The percentage removal of dyes by **Dal-B and Dal-C** aresummarized in**Table 4.**

Table 4: Details of comparison of % Removal of Eosin Y dye using different doses of AC (**Dal-A**, **Dal-B**, **Dal-C**)

S. No	**Name of samples**	**% of dye adsorbed**		
		Amount of sample taken		
		20 mg	**25 mg**	**30 mg**
E. Y. (Eosin Yellowish)				
	Dal-A	**62.2**	**94.3**	**99.9**

	Dal-B	**15.3**	**13.4**	**10.7**
	Dal-C	**0**	**0**	**3.3**

Here, the various doses of adsorbents (**Dal-A, Dal-B and Dal-C**) were mixed separately with dye solutions and the mixture was agitated in a mechanical shaker. The adsorption capacities for different doses were determined at every single minute interval for 5 times by keeping all other factors constant.

The percentage of removal increased with the increase in doses of the adsorbent **(Fig 5)**, which are shown in **Table 4.** This is attributed to increased surface area and availability of more adsorption site (Namasivayam *et al.,* 2001).

3.7.1.2. pH of dye solution

The change in solution pH is an important parameter for dye adsorption. Generally, low pH solution results in an increase in the percentage of anionic dye removal because of the electrostatic attraction between anionic dye and the positive surface charge of the adsorbent (Sallesh *et al.*, 2011). At higher solution pH, electrostatic repulsion is found between the negatively charged surface and dye molecules, thus decreasing the adsorption capacity and percentage removal of anionic dyes.

The effects of pH on the percentage removal of EY dye solution having concentration 0.020g/L (20 ppm) were investigated by varying the pH from 3.5 to 8.5.

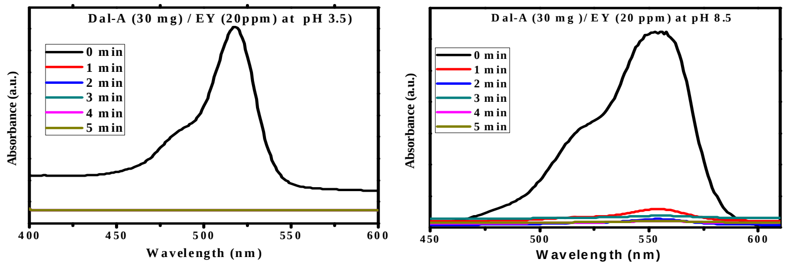


Fig.8. Adsorption spectra of EY dye by **Dal-A**at pH 3.5 and 8.5 at different times containing 30 mg of **Dal-A**

As can be seen in **Fig.8**, EY dye has been completely adsorbed (removed) by **Dal-A** within a single minute at pH 3.5. Whereas, at pH 8.5, even after 5 minutes, no significant adsorption took place.

In the case of **Dal-B** (**Fig.9**), adsorption of EY was not so good at both pH 3.5 and 8.5.

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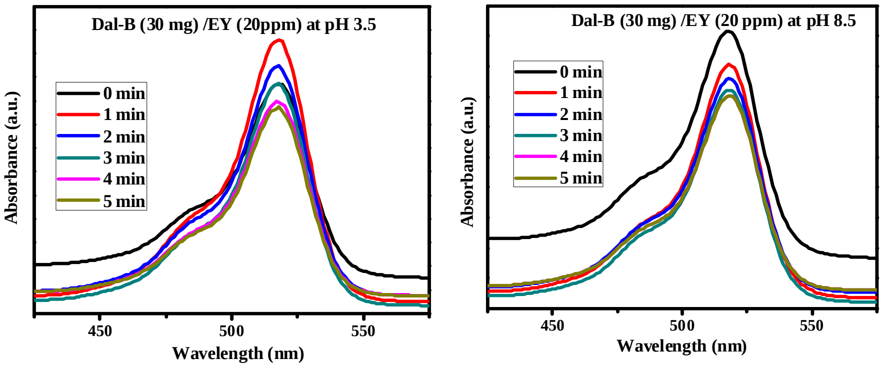

Fig. 9. Adsorption spectra of EY dye by **Dal-B** at pH 3.5 and 8.5 at different times containing 30 mg of **Dal-B**

In the case of **Dal-C (Fig. 10)**, almost no adsorption occurred at both pH 3.5 and 8.5

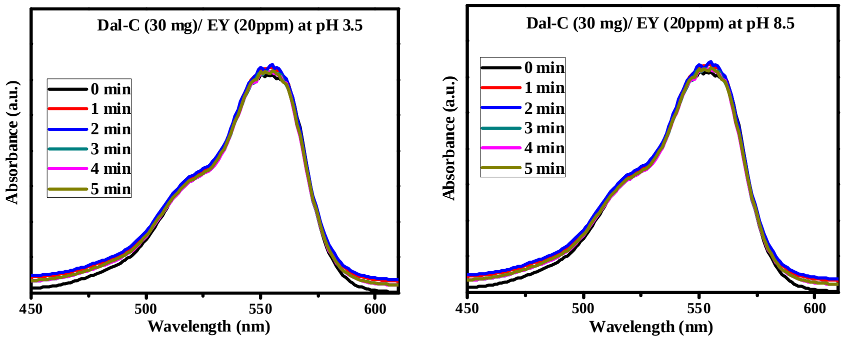

Fig.10. Adsorption spectra of EY dye by **Dal-C** at pH 3.5 and 8.5 at different times containing 30 mg of **Dal-C**

In the case of **Eosin Y (EY),** the pH of 3.5 was found to be very effective. The adsorption capacity is expected to be increased, because in acidic medium, the excess of hydrogen ion concentration would increase the adsorption of the negatively charged anionic dyes like MO and EY. This is because of the increase in the force of attraction between adsorbent (carbon-samples) and adsorbate (dye molecules) (Dawood and Sen, 2014).

3.7.1.3. Contact time

Contact time refers to the amount of time the adsorbent is in contact with the dye solution. For a 20ppm (0.02g/L) concentration of EY dye and 20mg, 25mg and 30mg mass threeas prepared ACs (**Dal-A, Dal-B and Dal-C),** the retention of the dyes increased with increasing contact time which are shown in adsorption spectra of **Fig.8, 9 and 10.** It was observed that the initial removal percentage of dyes is quite rapid. Almost 99.9 % of the dyes were adsorbed within a single minute. Then the adsorption process was more or less constant up to 5 minutes in the case of H_3PO_4 activated carbon *i.e.* **Dal-A**. This is probably due to high surface area of 1362 m^2g^{-1} and very fineinternal structure with extensive mesoporosity in **Dal-A**. Highly developed mesoporous ACs are favorable for the adsorption of larger molecules such as dyes (Stavropoulos and Zabaniotou, 2005). This might be due to the fact that initially all the sites of the ACs were vacant and available for dye molecules to get occupied. Later the percentage removal rate of dye was decreased significantly resulted from saturation of ACs surfaces with dye molecules. But **Dal-B and Dal-C**did not exhibit significant adsorption behavior of the EY dye. Both these sample were found to have relatively low surface area and less developed porosity. When the result of the H_3PO_4 activated carbon *i.e.* **Dal-A,** was compared with commercial carbon, **Dal-A** was found to have even far better adsorption capacity than commercial carbon, which has been shown in **Table** 5.

Table 5. The comparison of surface area and adsorption capacity of laboratory prepared **Dal-A** and**commercial carbon**at identical pH, initial concentration and time

Surfactant	Surface area (m^2/g)	Dye	pH	Initial conc. (ppm)	Time (min)	Adsorption capacity (%)
Dal-A	**1362**	**EY**	**3.5**	**20**	**5**	**62.2** **74.3** **99.9**
Com. C	**876.02**	**EY**	**3.5**	**20**	**5**	**0** **0** **10.8**

4. Conclusion

From the result of present investigation, novel Activated Carbons can be conventionally and economically prepared from wood dust, the waste biomass. Surface morphology (porosity) and surface area of ACs, play a major role in the selected adsorbent-adsorbate system. By comparing the characteristics of ACs prepared by different activating agents (H_3PO_4, KOH and Na_2CO_3), the H_3PO_4 activated carbon *i.e.* **Dal-A** was found to have best adsorption capacity, which is much better than commercial carbon. Results revealed that, laboratory prepared H_3PO_4activated carbon (Dal-A), prepared from *Dalbergia sisoo*has the greatest potential to remove an anionic dye like Eosin Y (EY) from industrial effluents within a few minutes.

5. Conflict of interest

The author declares no conflict of interest.

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7. References

Chen Y., Zhu Y., Wang Z., Li Y., Wang L., Ding L., Gao X., Ma Y. and Guo Y. (2011). *Application studies of activated carbon derived from rice husks produced by chemical-thermal process--A review.* Adv. Colloid Interfac., 103(1): 39- 52.

Dawood S., Sen T. K. (2014). *Review on Dye Removal from Its Aqueous Solution into Alternative Cost Effective and Non-Conventional Adsorbents*. J. Chem Proc Eng (1): 104.

Du, W. L., Xu, Z. R., Han, X. Y., Xu, Y. L., & Miao, Z. G. (2008). *Preparation, Characterization and Adsorption Properties of Chitosan Nanoparticles for Eosin Y as a Model Anionic Dye*. Journal of Hazardous Materials, 153(1): 152–156.

Kadirvelu, K., Kavipriya, M., Karthika, C., Radhika, M., Vennilamani, N;, Pattabhi, S.,(2003). *Utilization of Various Agricultural Wastes for Activated Carbon Preparation and Application for the Removal of Dyes and Metal Ions from Aqueous Solutions.* Department of Environmental Science, PSG College of Arts and Science Coimbatore, Tamil Nadu, *Bioresource Technology*, 87(1): 129- 132.

Karthikeyan, K.; Amaresh, S.; Lee, S. N. (2014). *Construction of High-Energy-Density Supercapacitors from Pine-Cone-Derived High-Surface-Area Carbons.* Chem. Sus. Chem.,7(5):1435–1442.

Kumari, P., Shekhar, & Parashara, H. (2018). *β-Cyclodextrin Modified Magnetite Nanoparticles for Efficient Removal of Eosin and Phloxine Dyes from Aqueous Solution*. Materials Today: Proceedings, 5(7, Part, 2): 15473–15480.

Lawal, I. A., Dolla, T. H., Pruessner, K., & Ndungu, P. (2019). *Synthesis and Characterization of Deep Eutectic Solvent Functionalized CNT/ZnCo2O4 Nanostructure: Kinetics, Isotherm and Regenerative Studies on Eosin Y Adsorption*. Journal of Environmental Chemical Engineering, 7(1):102877.

Lokhande, C.D.; Gujar, T. P.; Shinde, V. R. (2007). *Electrochemical Supercapacitor Application of Pervoskite Thin Films*. Electrochem. Com., 9:1805–1809.

Molina-Sabio, M., Rodriguez-Reinoso, F. (2004). *Role of Chemical Activation in the Development of Carbon Porosity*. J. Coll. and Surf. Physicochem. Eng., 241: 15-25.

Nagajyothi P.C., Prasad T.N., Dinakar N., Suresh S. and Damodharam T. (2010). *Impact of Dyeing Unit Effluent on Nutrient Content of Index Leaf of Arachis hypogea L. and Sacchrum officinarum L*. Thai J. Agric. Sci. 43: 55-59.

Namasivayam C., Radhika R. and Suba S. (2001). *Uptake of Dyes by a Promising Locally Available Agricultural Aolid Waste: Coir Pith.* Waste Manage, 21: 381–387.

Prahas D, Kartika Y, Indraswati N, Ismadji S. (2008). *Activated Carbon from Jackfruit Peel Waste by H3PO4 Chemical Activation: Pore Structure and Surface Chemistry Characterization.* Chem Eng J,140: 32–42.

Salleh MAM, Mahmoud DK, Karim WAWA, Idris A, (2011). *Cationic and Anionic Dye Adsorption by Agricultural Solid Aastes: A Comprehensive Review*. Desalination 280: 1–13.

Sasaki, Y. F., Kawaguchi, S., Kamaya, A., Ohshita, M., Kabasawa, K., Iwama, K., Taniguch, K., Tsuda, S. (2002). *The Comet Assay with 8 Mouse Organs: Results with 39 Currently Used Food Additives.* Mutation Research, 519(1–2): 103–119

Shimodaira, N., Masui, A. (2002). *Raman Spectroscopic Investigations of Activated Carbon Materials*. J. Appl. Phys, 92: 902

Sivakumar, B., C.Kannan, & Karthikeyan, S. (2012). *Preparation and Characterization of Activated Carbon Prepared from Balsamodendron caudatum Wood Waste through Various Activation Processes.* Rasayan Journal Chemistry*,* 5*:* 321-327

Stavropoulos G.G., Zabaniotou A.A., (2005). *Production and Characterization of Activated Carbons from Olive-seed Waste Residue*. Microporous Mesoporous Mater. 82 (1): 79-85.

Wu, X., Jiang, L., Long, C., and Fan, Z. (2015). *From Flour to Honeycomb-like Carbon Foam: Carbon Makes Room for High Energy Density Supercapacitors*. Nano Energy 13: 527–536

Xia, L., Li, C., Zhou, S., Fu, Z., Wang, Y., Lyu, P., Zhang, J, Liu, X., Zhang, C., Xu, W. (2019). *Utilization of Waste Leather Powders for Highly Effective Removal of Dyes from Water*. *Polymers, 11(11):* 1786.

Xie, K., Zhang, K., Yang, Y., Zho, L., Qu, W. (2018). *Synthesis and Supercapacitor Performance of Polyaniline/Nitrogen-doped Ordered Mesoporous Carbon Composites.* Nanoscale Res. Lett. 13:163.