STATISTICAL MODELING STEADINESS AND DYNAMICS OF DIRECT RED 83 ESTABLISHMENT AQUEOUS SOLUTION BY Balsamodendron caudatum WOOD WASTE ACTIVATED NANOPOROUS CARBON

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ABSTRACT
Adsorption ability of Balsamodendron caudatum wood squander is efficient to remove Direct Red 83 in textile squander water association. Balsamodendron caudatum wood waste activated nanoporous carbon material (BANC) and was treated with phosphoric acid to pick and choose up adsorption competence for the elimination of Direct Red 83(C.I. No 15418-16-3). The treatment (BANC) with phosphoric acid was analyzed by XRD, SEM, FT-IR, and TGA-DTA examination. The present study deals with the use of BANC waste as adsorbent for the removal of Direct Red 83 dye from its solution. The studies illustrate that sorption is motorized by the first dye concentration. Dye solution pH and sorption temperature have been investigated in the present study. A Kinetic study of Direct Red 83 followed the pseudo-first-order, pseudo-second-order, and Elovich models respectively. Up attempt points out that the pseudo-first-order kinetic model was created to evaluate the new data well.

Keywords: Sorption, Direct Red 83, Kinetics, Low-Cost Sorbents, Aqueous Solution.

INTRODUCTION
Imprecise persistence of organic/inorganic pollutants (heavy metals and dyes) causes pollution of air, soil, and water which seems to be the major environmental concern. The continuous increase in surface and groundwater pollution in recent years has become a major face and a great cause of concern for both governments and industrialists all over the world. Several factors have been linked to these rising pollution levels and they include growth in global population, rapid industrialization, and industrial growth, excessive exploitation of natural resources as well as persistent droughts. Nowadays the industry creates artificial dyes. The manufacture of dyes is anticipated at 700,000 tons each year world wide.¹The dyes are unsaturated and aromatic organic compounds. Their essential complexion is mostly due to the incidence of unsaturated substance groups called chromophores. The dyes must be able to penetrate the material to be colored and be durably fixed. Certain chemical radicals such as auxochromes efficiently fix the desired dye on the material. However, in observation of the high cost and related problems of regeneration, there is a regular search for alternate low-cost adsorbents. Such types of adsorbents comprise pine tree leaves², rice husk ash³, (Arundodonax) seeds⁴, red mud⁵, TiO2 nanocomposites⁶, oryza Sativa husk⁷,green adsorbent⁸,Hildegardia barter activated carbon⁹,e-waste derived adsorbent resin¹⁰and Multi walled Carbon Nano tubes and Poly (Acrylonitrile-styrene) Impregnated with Activated Carbon.¹¹

EXPERIMENTAL
Adsorbent
Balsamodendron caudatum wood waste was obtained from a variety of areas of Nilgiris District, Tamil Nadu, and India. The knowledge of Balsamodendron caudatum wood dissipate substance is used as the sorbent and it is conventional to be low-cost, environmental, economically protected and it has a
reasonable proposal. To increase sorbents, the fabric was first positioned and washed with water and then
dried up. The shriveled material thus obtained was treated with H$_2$O$_2$ (50w/v) at normal room temperature
for about 24 hrs to oxidize the adhering ordinary substance. The resultant material was meticulously
washed with double-distilled water and then subjected to the temperature of 120°C for moisture removal.
One division of the above substance was enclosed with water well with phosphoric acid for 24 hours, then
the materials were placed in the muffle heating system carbonized at 120-130°C. The dried materials
were flattened and activated in a muffle furnace kept at 800°C for 60 minutes. After instigation, the
obtained carbon was washed rightfully with an enormous quantity of water to remove free acid. Then the
obtained substance was washed with a large amount of water to eliminate the surplus of acid, then dried
to the preferred constituent part size. The resulting carbon material is named BANC.

Grounding of Aqueous Dye Solution
The store solution of the dye (1000 ppm) was prepared by dissolving 1g of dye in one liter of water
without any further accomplishment. For the collection study, an aqueous solution of this dye was
arranged from stock solutions in deionized water.

| Table-1: Uniqueness of the Dye Used |
|-------------------------------------|
| Group | Model | Common Name | C.I. No. | M wt |
| Direct | RD 83 | Direct Red 83 | 15418-16-3 | 992.77 |

Fig.-1: Configuration of Direct Red 83

Pseudo First–Order Equation
The pseudo first - order equation is normally uttered as follows:

\[
\frac{dq_t}{dt} = k_1(q_e - q_t)
\]  

(1)

q$_e$ and q$_t$ are the sorption ability at symmetry and at time t, correspondingly (mg g$^{-1}$), k$_1$ is the rate
invariable of pseudo-first –order sorption (l min$^{-1}$).

Pseudo Second–Order Equation
The pseudo-second-order sorption kinetic rate equation is articulated as$^{12}$

\[
\frac{dq_t}{dt} = k_2(q_e - q_t)^2
\]  

(2)

k$_2$ is the rate invariable of pseudo-second order sorption (g. mg$^{-1}$. min$^{-1}$).k$_2$ is the rate invariable of
pseudo-second order sorption (g. mg$^{-1}$. min$^{-1}$). If the first sorption rate h (mg g$^{-1}$ min$^{-1}$) is

\[
h = k_2q_e^2
\]  

(3)

Elovich Equation
The Elovich model is normally expressed$^{13}$as:

\[
\frac{dq_t}{dt} = \alpha \exp(- \beta q_t)
\]  

(4)

$\alpha$ is the initial sorption rate (mg.g$^{-1}$ min$^{-1}$), $\beta$ is the sorption invariable (gmg$^{-1}$) through any one conduct
test.
RESULTS AND DISCUSSION

Characterization of Sorbent
The external area of the BANC was premeditated all through N₂ sorption at 77K by a NOVA1000, Quanta chrome company. The pH of BANC was measured by a PHS-3C pH meter. The pH of zero charge (pHpzc) of the samples was using the pH drift method. The surface area of the BANC obtained from the N₂ equilibrium sorption isotherms was found to be 760 m²/g. The outcome of the “pH drift” test, from which the pHpzc of BANC was calculated in this test, was found to be 4.2. The better color removal of the dye, Direct Red 83, was notified at a pH of 6.5.

Effect of pH
The understanding of observation was conducted to find the effect of pH on sorption. It was experimental that pH influences BANC surface dye important sites and the dye chemistry in water. In this testing, the initial dye concentration was fixed at 20 ppm. From the vibrate flask experiments, improved color removal of the dye, Direct Red 83, was observed at a pH of 6.5. The uptake of Direct Red 83 was established to be best at pH 6.5 with a maximum dye uptake of 95%. As the peripheral charge density decreases with an increase in the solution pH, the electrostatic repulsion between the positively charged dye and the surface of a sorbent is condensed surface. This causes more sorption.

Effect of concentration
The collection sorption experiments were carried out using three varied concentrations of dye viz. 20mg/L, 40mg/L and 60mg/L at pH 6.5. The reaction temperature of 30 °C was selected for sorbent. The rate of confrontation was maintained constant at 250 rpm. The color fall profiles were obtained by means of the sorbent BANC.

SEM Study
The SEM of the sorbent exposed in Fig.-3 releases the elements that are extremely permeable in the environment. It was originated that there are indistinguishable holes and grotto group openings on the front altitude of the model that would entirely have greater than previous to the surface area.14
XRD Analysis
Figure-4 shows the extensive point-of-view XRD example for nanoporous carbon illustration. The XRD analysis of nano-spongy carbon proved that the carbon equipped with acid performance shows the X-ray diffraction viewpoint $2\theta = 22$. It is comparable to the reported graphitization clump squander.

FT-IR Examination
The FT-IR range of the waste activated nanoporous carbon equipped by a range of behavior processes shown in Fig.-5 exposes that the carbons evaluated enclose four modules of exterior groups: carboxyls, lactones, phenols, and carbonyls. Shifts in sorption location may be caused by factors such as intra-molecular and intermolecular hydrogen bonding, steric implication, and number of-conjugation.\textsuperscript{15}

TGA-DTA Exploration
The thermal dependability of the carbon sources organized by phosphoric acid was analyzed by the TG and DTA given away in Fig.-6. The curvature detectably exemplifies that the carbon samples begin to drop weight at about $60^\circ$C due to the volatilization of tiny molecules and it is in progress to lose weight intensively higher than $600^\circ$C could be due to the crumbling of polymeric molecules formed from the beginning to end the carbonization progression.

Effect of the Temperature on Kinetic Rate invariable and Rate Parameters
The sorption test was accepted with a fixed initial dye concentration (20mg/L) at pH 6.5 and at a diversity of temperatures viz. 30 °C, 45 °C, and 60 °C. The examination of the data in (Table-2) reveals that the manipulation of the temperature of the dye has very little control over the pseudo-second-order rate
constants. Table-2 also reveals that the influence of the temperature of dye on Elovich and pseudo-first-order rate constant is neither significant nor little. It is apparent that the sorption of dye on the BANC waste-activated carbon is best described by a first-order rate equation with a regression coefficient value greater than 0.99.

Table-2: The sorption kinetic Representation Speed Constants for BANC a Variety of Temperature

| Sorbent | Initial Temperature | Pseudo First order | Pseudo Second-order | Elorich Model |
|---------|---------------------|--------------------|---------------------|--------------|
|         |                     | \( k_1 \) \text{lim}^{-1} | \( r^2 \) | \( k_2 \) \text{g mg}^{-1} \text{min}^{-1} | \( h \) \text{mg g}^{-1} \text{min}^{-1} | \( r^2 \) | \( \beta \) \text{g min}^{-1} | \( \alpha \) \text{mg g}^{-1} \text{min}^{-1} | \( r^2 \) |
| BANC    | 30°C                | 0.0225             | 0.9348             | 0.0067       | 0.5437       | 0.9436       | 0.1543       | 0.5765       | 0.9654       |
|         | 45°C                | 0.0085             | 0.8246             | 0.0567       | 5.4675       | 0.5432       | 0.1876       | 0.6435       | 0.9987       |
|         | 60°C                | 0.0445             | 0.7677             | 0.0377       | 0.2256       | 0.6654       | 0.4564       | 0.4548       | 0.9765       |

CONCLUSION

Sorption of Direct Red 83 dye on the BANC was determined to be dependent on the pH, (The most favorable pH of Direct Red 83 was 6.5), temperature, and concentration of sorbent. Sorption stability was reached within 220 min of contact time for Direct Red 83 dye used in the carrying out tests. The privilege saturation was found to be almost 95% for the BANC in the identical way. The kinetics of Direct Red 83 sorption on sorbent was found to follow a pseudo-first-order rate equation. The sorbent was employed to adsorb Direct Red 83 from aqueous solution explicitly and showed high removal ability at fitting conditions, indicating that the secondary sorption was an efficient and low-priced way of recycling of the used sorbents.

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