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Comparative between Syzgium Aromaticum Flower Bud (SAFB) and Activated (SAFB) for the Removal Reactive Green Dye from Aqueous Solution

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Abstract

The need to develop a more efficient adsorbent, comparable to the commercially available adsorbent, is attracting important interest as a promising adsorbent for wastewater treatment. In this study, the potential of Syzgium Aromaticum Flower Bud (SAFB) and Activated (SAFB) for the removal of reactive green dye (RG) of the aqueous solution was reported. Has been widely utilized as a highly effective adsorbent for RG dye because of its large specific surface area, high porosity, and favorable pore size distribution. Maximum adsorption of removal percentage 68.21% of (SAFB) and 94.23% of ACTIVE-SAFB was reported for dye, which influenced process variables (initial RG concentration, PH and adsorbent mass) on the removal of RG solution were investigated. The data appear isotherm Freundlich gave the better fit and adsorption efficiency of 38.05 mg/g of (SAFB) and 101.142 mg/g of ACTIVE-SAFB was obtained for dye at solution pH value of 6.2, adsorbent quantity at 0.05 g of (SAFB), ACTIVE-SAFB and equilibrium time of 2 hr.

Keyword: Adsorption, Activated carbons, pollutants, Reactive green dye, Isotherm

Introduction

Over the last decades, the incidence of pollutants in the aquatic environment has become a global worry problem. Pollutants, too called contaminants emerging, consist of many substances of anthropic or natural source, having dye, pharmaceuticals, steroid hormones, phenol, and personal care products, and agrochemicals. These substances are usually found in water resources at few concentrations that contract their detection and analysis and remove water drinking and wastewater handling (Banerjee and Chattopadhyaya 2017; Aseel M Aljeboree 2019; WALEED K. ABDULSAHIB 2020). The latest problem is an insufficiency of most allowable concentrations of these complexes. Thus, no or very few reservations and control actions are taken to ensure that these complex, specifically micro-range contaminants, are not disposed of the surface waters (A. M. El-Shamy ; Alkaim 2016; Kamil 2016). Activated carbons are useful adsorbents. Their properties adsorptive are due to their excellent surface area, a microporous structure, and a great degree of surface reactivity (Daguerre, Guillot and Stoeckli 2001; Aljeboree 2019; Aljeboree 2019). Thus, they are utilized to cleanse, dechlorinate, deodorize, decolorize, distinct, and concentrate on permitting retrieval and filtering, eliminating, or modifying the harmful constituents from gases and liquid solutions. Therefore, activated carbon adsorption is of interest to several financial sectors and concern areas as diverse as food, pharmaceutical, nuclear, petroleum, chemical, automobile, and vacuum industries in addition to for the handling of water drinking, industrial and urban wastewater, and industrial flue gases (A. M. El-Shamy ; Nadher D. Radhy 2019).

Materials and Methods

Preparation of absorbents

The surface of Syzgium aromaticum flower bud in powder forms was washed via excessive quantities of D.W; many items of washing were was performed to remove dust and soluble materials. The wash-away surface was then dry under sunlight and in an oven at 110 o C for 2hr. and kept in airtight containers. The particle size of 50 µm was utilized for the surface in all experiments of this work.

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Activated carbons

Syzgium Aromaticum Flower Bud (SAFB), was air-dried and crushed to obtain a fraction mean size range from 63µm to 2.5mm. About 100g were impregnated with 4 % H_2SO_4 then dried at 80˚C for 24h. Activation was conducted by hot air at 300˚C for 2h. The carbonized material was washed with distilled water until the pH reach by reached 6.6–6.8 then dried at 110˚C. The material was grounded to a fine powder .

Batch adsorption experiment

Adsorption studies were carried out in batch mode to study the influence of the experimental parameter (weight of absorbent, solution pH and primary of RG concentration) on the adsorption of dye on (SAFB) and ACTIVE-SAFB. The effect of experimental factors such as mass (0.01–0.2 gm), dye concentration (10–100 mg. L-1), and pH (3-10), was studied employing one parameter one-time approach. Dye experimental solutions (V = 100 mL) were taken in conical flasks (100 mL), and mixed with a known quantity of (SAFB) and ACTIVE-SAFB at predefined experimental conditions. The solution was then gently agitated in an isothermal shaker water bath to achieve the equilibrium among absorbance dye suspensions. Afterward, the suspensions were centrifuged two times. to eliminate absorbance particles. After equilibrium, the final dye concentrations in the flasks were determined utilizing UV–VIS spectrophotometer at 625 for RG dye. Removal percentage (E %), and adsorption efficiency (qe) was calculated as followed:

$$Qe=(Co-Ce)/W*V \quad (1)$$

$$E\%=(Co-Ce)/Co*100 \quad (2)$$

Co (mg. L–1) the primary concentration of dye and Ce (mg. L–1) is the dye equilibrium concentration at time t (min), W (g) is the adsorbent weight , V (L) is the volume of dye solution

Results and discussion

Characterization of FT-IR

The (SAFB)and ACTIVE-SAFB, was characterized via FT-IR spectroscopy. Spectra F.T-IR was collected in the mid -IR range from 4000 to 400 cm-1 with a resolution of 1 cm-1. The spectra F.T-IR of (SAFB) and ACTIVE-SAFB, before and after Reactive green dye adsorption, are appeared in Figures (1a) and (b). The F.T-IR pattern appears reduced in the intensity of bands next to the adsorption, also there is a difference real between (SAFB) and ACTIVE-SAFB , before and after interaction via dye that has been suggested a phy-sorption phenomenon happens as a data of forces attractive among the (SAFB) , ACTIVE-SAFB surface and dye under investigation (Liu ; A. M. El-Shamy).

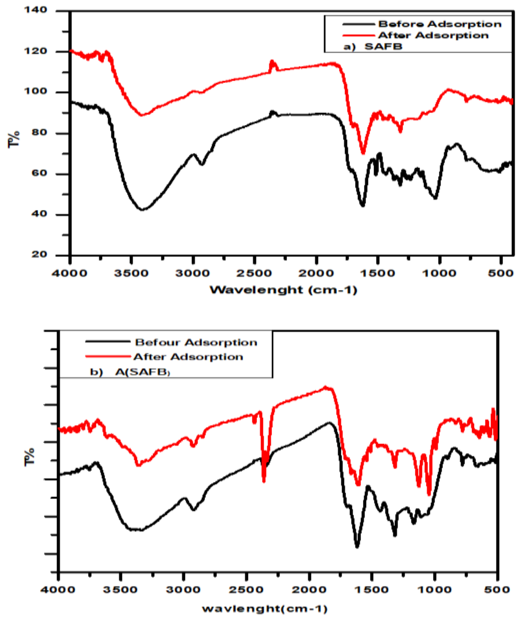

Fig. (1): FT-IR spectra of: a- (SAFB) and b-ACTIVE-SAFB surface before and after adsorption of reactive green RG dye.

Field Emission Scanning Electron

(FE-SEM) has been a primary tool for characterizing morphology of the surface and fundamental physical properties of the adsorbent. FESEM material of the adsorbent were taken before and after treated on (SAFB)and ACTIVE-SAFB surfaces (Figure (2a) and (ab)). The FESEM pictures of adsorbed samples appear very distinguished dark spots that in use as a sign for effective acid treatment (AYAD F. ALKAIM 2013).

Effect of concentration reactive green RG dye

The dye's initial concentration considers such a significant driving force to overcome wholly quantity resistances transfer of full molecules among the solid and aqueous phases (Y.S. Ho 2005). The concentrations of dye were altered, and intervals were assessed until no adsorption of adsorbate on (SAFB) and ACTIVE-SAFB took place. Fig. 3 seems the effects of agitation time on the amount of RG adsorbed by (SAFB)and ACTIVE-SAFB under different dye concentrations. As it appears, the adsorption rises through increasing primary RG concentration . The percentage (%) of RG through adsorption onto

(SAFB)and ACTIVE-SAFB was fast at the original period of agitation time and then decreased via increasing agitation time. This was made occur via forces attractive between of molecule dye(RG) and the adsorbent like forces Vander-Waals and attractions electrostatic(Domᶦ-nguez, Gonz‹ᶦlez, Palo and Cuerda-Correa ; C.-H.Weng 154-162; Doll 2004; M.ALJEBOREE 2019).

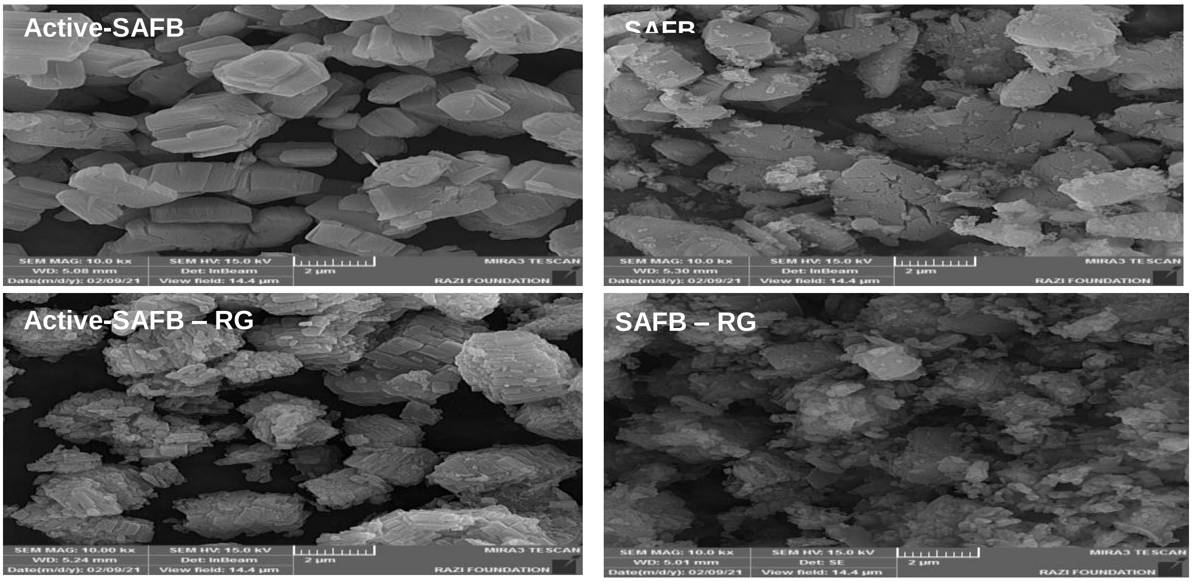

Fig. 2: FESEM image of (SAFB) (a) and ACTIVE-SAFB(b) after and before adsorption of RG dye

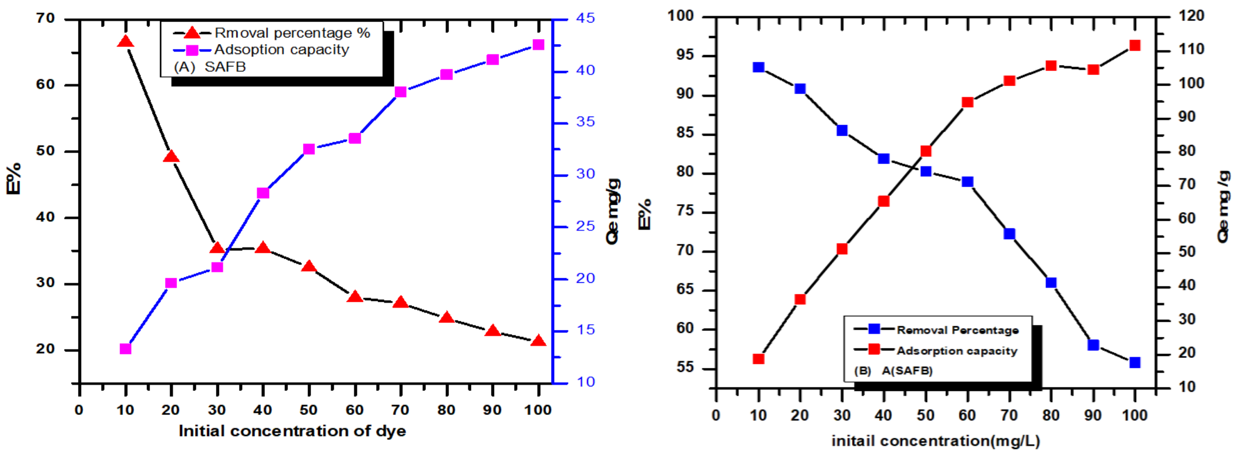

Fig. 3: initial concentration of Reactive green dye adsorption using (A) (SAFB)and (B)ACTIVE-SAFB (mass dosage 0.05 g/L, 20 oC and pH 6.2).

Effect of absorbance dosage:

The influence mass of adsorbent on the removal percentage (%) of dye (50 mg/L) has been appeared in Figure (4). The increase of adsorbent amount about rang 0.008 - 0.15g, the percentage removal of RG improved from 29.9 - 68.8% of (SAFB) and 48.1 to 89.5 % of ACTIVE-SAFB about 2h of adsorption time. This data is attributed to increasing the number of active sites caused via increasing mass of adsorbent (M. F. Shehata ; Adeyemo, Adeoye and Bello 2017; Aljeboree 2019).

Effect of solution pH

The effect of the initial pH of the (SAFB) and ACTIVE-SAFB on the quantity of RG adsorbed was investigated via varying the primary pH (3-10) at constant method factors (Aseel M Aljeboree 2019). A rise in primary pH increases the quantity of dye adsorbed, as indicated from data in Fig. (5). The RG dye adsorption quantity on the surface of (SAFB) and ACTIVE-SAFB is rise as the pH value decline as shown in Figure (5); this is due to the increment in the positive charge of dye that lead to an increase in the adoption of dye to the negative charge of the (SAFB) and ACTIVE-SAFB. But basic pH media help to remove the dye (negatively charged) that lead to repulsion between (SAFB) and ACTIVE-SAFB surface active sites and dye layer (A.E.N.M. Saad ; Hayder Obaid Jamel 2017; Altaa, Alshamsi and Al-Hayder 2018)

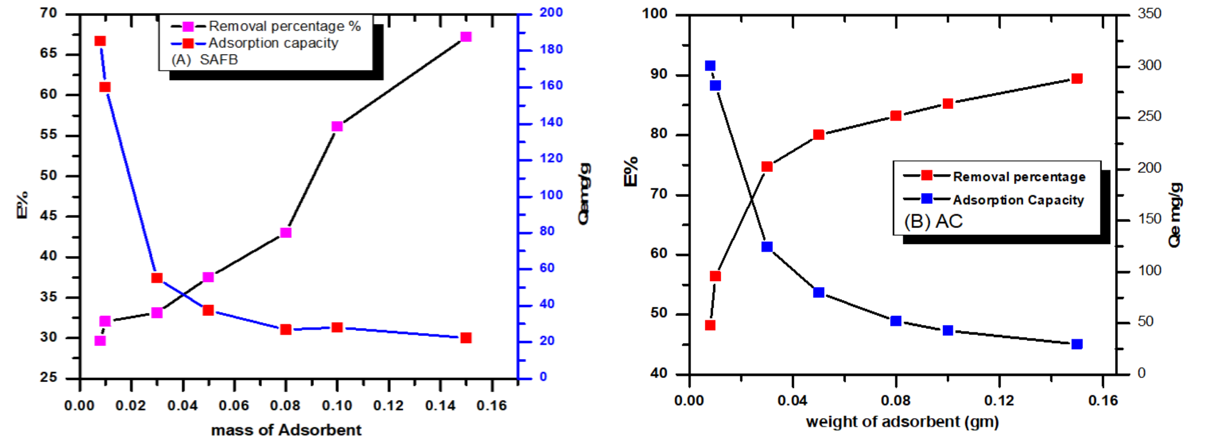

Fig. 4: (SAFB) and ACTIVE-SAFB surface concentration effect on Reactive green Experiment conditions: pH 6.2, 20oC and initial conc. 50mg/L.

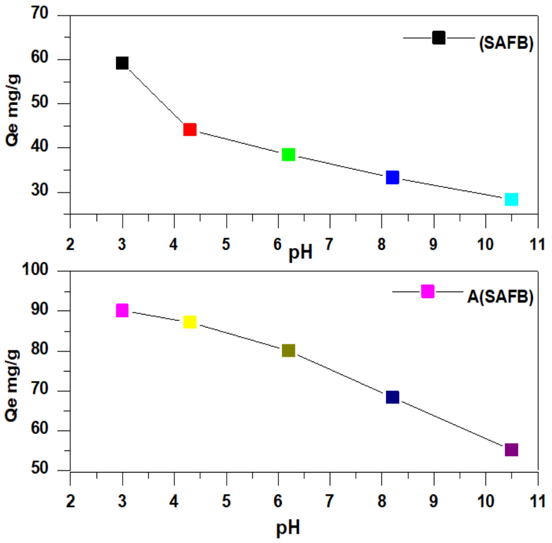

Fig.5: Effect of pH in adsorption uptake of RG dye on (SAFB) and ACTIVE-SAFB at 20°C

Adsorption isotherms

The isotherm model considers a very significant parameter for resolve adsorption methods. In truth, adsorption isotherms can detect adsorbent-adsorbate interactions. Sundry isotherm models found; of the equilibrium adsorption isotherms, the Freundlich multi-layer and Langmuir single-layer adsorption models apply to solid-liquid adsorption systems(Freundlich H 1939). The Langmuir isotherm (Eq. (3)) postulates that adsorption happens on a homogeneous surface via monolayer coverage The Freundlich isotherm (Eq. (4)) is an empirical model established on multi-layer adsorption on heterogeneous surfaces.

$$Q_e=(Q_m K_L C_e)/(1+K_L C_e) \quad (3)$$

Where Ce (mg/L) and Qe (mg/g) are the amounts of adsorbed RG dye per unit quantity of sorbent and dye RG conc. in solution at equilibrium, in that order. Qm is the maximum adsorption of the adsorbed RG dye per unit weight of the surface to form a complete mono - layer on the surface bound at great Ce (mg/ g), and KL (L. m/g) is a Langmuir constant related to the affinity of the binding places on the surface of adsorbent . (Hadi 2014; P. V. Thitame 2016) :

$$Q_e = k_f [C_e]^{(1/n)} \quad (4)$$

While Kf (L/mg) is the constant Freundlich, and 1/n is the heterogeneity factor.

A plot of adsorption capacity versus Ce appears in Figure (6), that values of 1/n , Kf are fixed from the slope and intercept of the linear retreating. As seen, good regression correlation coefficient was appear via the Freundlich model (R= 0.97311) , (R= 0.97691) (H. K. Farag) . This tick that the Freundlich model was so appropriate for characterizing the sorption of dye on (SAFB) and ACTIVE-SAFB compared to Langmuir model (R=0.96911), (R=0.96622). Data appear in (Figure (6)), the studied factor of two models clarify in Table (1).

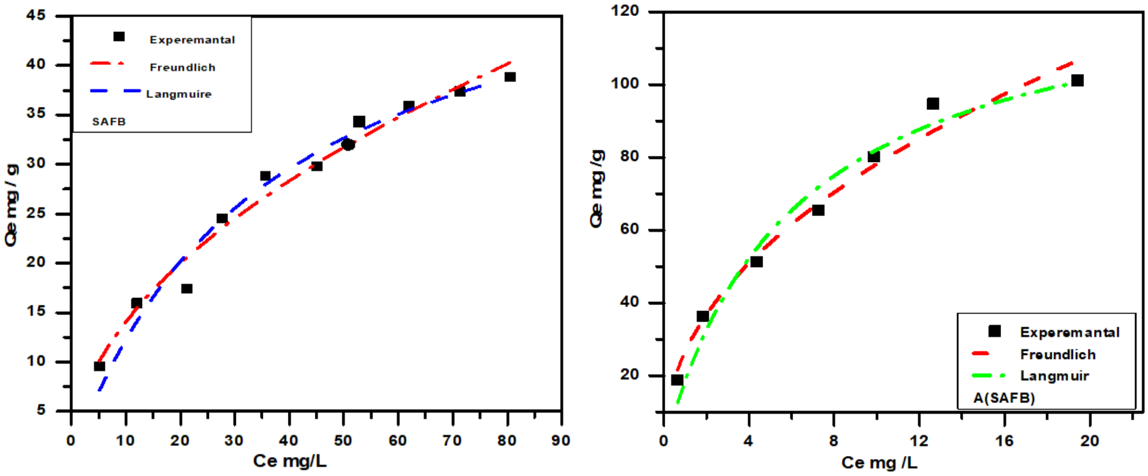

Fig.6: Several adsorption models nonlinear fit of adsorption RG dye on (SAFB) and ACTIVE-SAFB, primary conc. = 50 mg. L-1, Temp. = 20°C, and weight of surface 0.05 g/L).

Table (1): Freundlich and Langmuir isotherms model factors RG dye adsorbed on the surface of (SAFB) and ACTIVE-SAFB at 20 °C.

rm models	meters	B)	IVE-SAFB
ıdlich		± 0.612	6 ± 2.481
		± 0.035	± 0.037
		11	94
muir	ıg/g)	65 ± 4.19871	10 ± 12.209
	/mg)	± 0.004	± 0.038
		11	22

Conclusion

1- ACTIVE-SAFB and (SAFB) adsorbent can be utilized for dye removal from the solution.

2- Due to the greater activity of ACTIVE-SAFB and (SAFB) in the dye's adsorption, it might be utilized as adsorbent wastewater treatment for dye removal.

3- The adsorption efficiency of ACTIVE-SAFB and (SAFB) was higher for dye.

4-The adsorption model of dye onto ACTIVE-SAFB and (SAFB) obeyed Freundlich model.

5- The best removal percentage (%) RG dye in acidic medium

6 comparative between the Maximum adsorption of removal percentage 68.21% of (SAFB) and 94.23% of ACTIVE-SAFB –

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