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Adsorption process efficiency of activated carbon from date pits in removing pollutants from dye wastewater

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Abstract. The presence of high amounts of organic and inorganic contaminants in textile wastewater is a major environmental concern. Therefore, the treatment of textile wastewater is an urgent issue to save the aquatic environment. The disposal of large quantities of untreated textile wastewater into inland water bodies can cause serious water pollution. In this study, synthetic dye wastewater samples were prepared using orange dye in the laboratory. The synthetic samples were then treated by a batch adsorption process using the prepared activated carbon (AC) from date pits. The wastewater parameters studied were the pH, total dissolved solids (TDS), total suspended solids (TSS), electrical conductivity (EC) and salinity. The activated adsorption process showed that the maximum removal efficiencies of electric conductivity (EC), salinity, TDS and TSS were 65%, 92%, 89% and 90%, respectively. The removal efficiencies were proportional to the increase in contact time (30-120 min) and AC adsorbent dose (1, 3 and 5 g/L). The adsorption profile indicates that 5 g/L of adsorbent delivers better results for TDS, EC, TSS and salinity at contact time of 120 min. The adsorption characteristics are better suited to the pseudo-second-order kinetic model than to the pseudo-first-order kinetic model. The Langmuir and Freundlich isotherms were well suited for describing the adsorption or contact behavior of EC and TSS within the studied system.
Keywords: activated carbon (AC); adsorption; dye; isotherms; kinetic model; textile wastewater

1. Introduction

The extreme growth rate of the population and methodological development of the technological and industrial sectors are supplemented with the rapid creation of industrial and municipal wastewater that can pollute the environment. This waste is regarded as one of the gravest ecological issues currently facing worldwide. Therefore, proper treatment of all types of wastewaters is required prior to discharge into surface water (Fueyo *et al*. 2003). Untreated water can cause potential health hazards to the consumers (Karim *et el*. 2023). Organic pollution is a great concern and can be defined as the presence of large amounts of organic elements in wastewater. Organic components come from wastewater, sewage and urban runoff, and from various industries and processes, such as sewage/wastewater treatment plants, industrial effluents, food processing industry, paper and pulp industry, and agricultural industry. Microbes use a large quantity of dissolved oxygen in water to decompose organic matter. As a result, it often causes oxygen depletion, which has severe consequences for aquatic life and stream biota, such as freshwater fish (Gottipati 2012, Gupta *et al*. 2006, Yangui 2013).

Wastewater with organic pollutants contains large quantities of suspended solids, which reduce light availability to photosynthetic organisms and alter the characteristics of the river bed, rendering it an unsuitable habitat for many invertebrates (Crini 2005, Derbyshire *et al*. 2001, Dias *et al*. 2007, EnviroCarbon 2004). Organic pollutants include pesticides, fertilizers, hydrocarbons, phenols, plasticizers, biphenyls, detergents, oils, greases, pharmaceuticals, proteins, and carbohydrates (Ali *et al*. 2004, 2012, Damià, 2005). Several studies have confirmed the use of cheap and readily available materials as solvents for the adsorption of pollutants (Erabee *et al*. 2017a, b).

The activated carbon (AC) can be produced from various materials. Tran *et al*. (2021) studied on coffee husk, a carbonaceous precursor and common agricultural waste in Vietnam, to produce AC with high adsorption capacity by hydrothermal carbonization (HTC). Mechnou *et al*. (2023) found that the coffee husk-based AC is a promising sorbent for the removal of methylene blue from aqueous solutions and the HTC method has advantages of using a low temperature and concentration of KOH. Ampiaw *et al*. (2019) studied on toxins produced by cyanobacteria causing a major environmental threat to surface water resources. Among the several techniques employed for toxin removal, adsorption with AC has been extensively studied and has

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gained wide attention as an effective adsorbent (Ampiaw *et al*. 2019). Li *et al*. (2021) studied on hydrophobic modification methods of AC using tetraethyl orthosilicate and trimethylchlorosilane to improve the selectivity of volatile organic compounds (VOCs). Water vapor is inevitable in VOCs emissions, leading to the deterioration of AC adsorption performance. Liu *et al*. (2016) found when the relative humidity (RH) values are increased from 0% to 60% and 90%, the saturated adsorption capacity of Bare-AC are decreased by 45% and 64%, respectively. Guahk *et al*. (2021) studied on the adsorption and desorption behavior on pitch-based AC fibers with various Brunauer–Emmett–Teller (BET) surface areas and it was found that fixed-bed AC adsorption experiments performed at 20, 5, –15, –20 and −25°C showed that the use of lower temperatures resulted in an increase in the adsorption capacity. Wasilewska *et al*. (2021) studied the temperature dependence of AC adsorption equilibrium for nitrophenol removed from aqueous solutions. The surface and structural characteristics of AC were determined by potentiometric titration and nitrogen adsorption or desorption.

Wang *et al*. (2020) studied on AC with a high surface area for outstanding adsorption performance for dye removal. The AC was activated by a chemical process and pyrolysis of sodium carboxymethyl cellulose. Saeed *et al* (2022) focused on the different characterization techniques and experimental adsorption isotherms were utilized to interpret the adsorption mechanism using three dye molecules such as methyl violet, allura red and congo red. It showed competitive performance for dye removal in aqueous solutions and can be used in industrial applications. Pennington *et al*. (2002) and Fawcett-Hirst *et al*. (2020) focused on the treatment of wastewater that had been contaminated with hazardous, insensitive, high explosive materials such as 1,3,5-trinitroperhydro-1,3,5-triazine (RDX), 2,4-dinitoranisole (DNAN), and 3-nitro-1,2,4-triazol-5-one (NTO) and the ACs were able to adsorb RDX and DNAN at concentrations of up to 40 mg/L and 150 mg/L, respectively. Zhang *et al*. (2021) studied the adsorption effects of ACs on condensable particulate matter (CPM) at different temperatures. CPM rapidly forms liquid or solid particles through atmospheric dilution and cooling, which is harmful to public health. The removal efficiency of the inorganic fraction is higher than that of the organic fraction. Yoshikawa *et al*. (2021) studied on the ACs for the complete removal of $CHCl_3$ from indoor atmosphere and drinking water and found that $CHCl_3$ adsorption on well-characterized pitch-based activated carbon fibers (ACFs) can provide a clear guideline on adsorption sites for $CHCl_3$ and the adsorbed structure. Yin and Shang (2020) studied on the removal of three selected micropollutants (i.e., bisphenol A, diclofenac and caffeine) in drinking water using the UV-LED/chlorine advanced oxidation process (AOP) followed by AC adsorption. Chlorination (>60%), direct UV photolysis (>80%), and radical oxidation (>90%), respectively, contributed most to the degradation of bisphenol A, diclofenac, and caffeine. Khaleel *et al*. (2015) researched the use of granular activated carbon (GAC) adsorption to treat wastewater contaminated with organic chemicals. Both the GAC adsorbents made from palm shell (GACP) and coconut shell (GACC) were evaluated. The two adsorbents produced similar COD and turbidity results. Furthermore, for both approaches, the best times to remove BOD and TDS were 1 h and 3 h, respectively. Ingole *et al*. (2016) investigated the application of polysulfone membranes with AC integration for dye separation. It was inferred that dye rejection Nano Filtration (NF).

Alighardashi *et al*. (2017) investigated the performance of a membrane bioreactor (MBR) coupled with modified walnut shell granular activated carbon (WSGAC) for the treatment of tannery wastewater. Ammonium removal ranged from 70 to 99%. It is suitable for removing organics from tannery wastewater even under adverse operational conditions. Abbasi *et al*. (2018) studied on the Artificial Neural Network (ANN) used for prediction of permeate flux for oily wastewater treatment by hybrid powdered activated carbon-microfiltration (PAC-MF) process. Permeate flux was predicted as a function of time and PAC concentration. El Said and Kassem (2018) studied nano- and micro-composites with a highly porous surface area, which acted as an AC. It has attracted great interest, particularly in the synthesis of high-performance porous and thin-film sheets. Ahmed *et al*. (2021) studied on activated carbon fiber (ACF) preparation from different materials. ACF is rich in micropores and can be produced from luffa through processes such as pre-treatment, pre-oxidation and carbonization activation. El-Gawad *et al*. (2018) studied the effects of various operating parameters on phosphate and COD removal efficiencies. El-Gawad *et al*. (2018) found that the entrapped AC in alginate polymer is capable of COD and phosphate removal from aqueous solution. Salman *et al*. (2021) experimented on AC derived from Eichhornia. It is an efficient adsorbent for the heavy metal ions removal whereas, the maximum sorption capacities of the Pb^{2+} and Cd^{2+} ions are detected as 102 and 49.5 (mg/g), respectively. They have also studied various kinetic models. Ab Ghani *et al*. (2016) derived AC from banana stem through chemical activation process. The effects of activation parameters such as activation time (30, 60, 90 and 120 min), activation temperature (400, 500, 600, 700 and 800°C), activating chemical agent ($ZnCl_2$ and H_3PO_4) and impregnation ratio (1:1, 1:2, 1:3, 1:4 and 1:5) were evaluated.

In this study, dye wastewater samples were treated via a batch adsorption process using activated carbon (AC) prepared from date pits. Date pits are waste materials, however, they can be converted into useful products, for example, AC. The effects of various contact times (30-120 min) and AC adsorbent doses (1, 3 and 5 g/L) on the removal efficiency were studied. The performance of the activated adsorption process for removing various pollutants from dye wastewater was investigated. Finally, the adsorption kinetics and the Langmuir and Freundlich isotherms were evaluated.

2. Materials and methods

Fig. 1 shows the flow chart of the research methodology

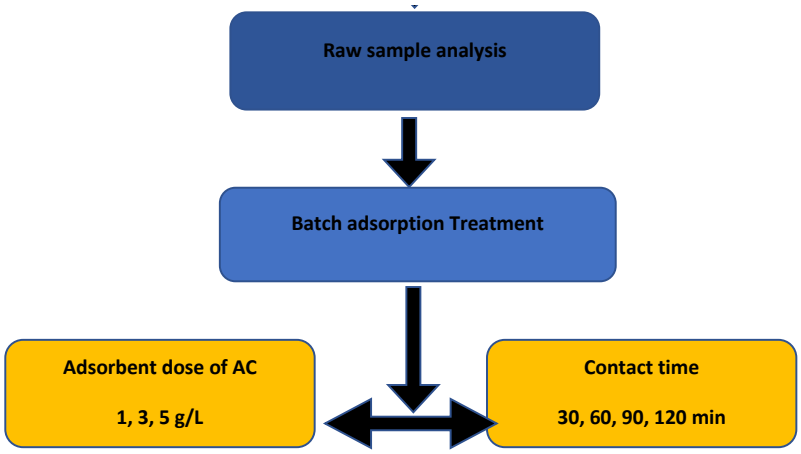


Fig. 1 Flow chart of research methodology

2.1 Preparation of activated carbon

Activated carbon was used as an adsorbent in this study to decrease the final concentrations of pollutants in dye wastewater. Activated carbon was prepared from date pits using a chemical activation method. The first step involved washing the date pits with tap water several times. The washed date pits were then ground to a granular size and sieved before being placed in a drying oven for 24 h at a temperature of 105 °C. Chemical activation was performed by mixing the dried sample with a determined quantity of chemical agents such as $ZnCl_2$ (ratio 1:2) for 2 h (Ab Ghani *et al.* 2016). Distilled water was used to wash it again and dry it in the laboratory at room temperature. The resulting product was stored in a dry place until further use.

2.2 Preparation of dye wastewater sample

The second step in this research involved the preparation of the raw wastewater sample by mixing 1 L of water with 50 mg of orange dye. An artificial dye was applied in textile factories to dye fabric that is obtained from a local market. The samples were collected in plastic bottles and stored in the laboratory at room temperature. A Pocket Tester (multi-meter) was used to measure and analyze the parameters (pH, electrical conductivity, salinity and TDS) of the synthetic samples. TSS was tested in the laboratory according to the Standard Methods of Water and Wastewater Examination (Rice *et al*. 2012, APHA 2005, Ahsan *et al*. 2023). Details of the composition of TSS and TDS can be found in Butler and Ford (2018) and Rice *et al*. (2012).

2.3 Batch adsorption test

This test aims to study the sorption capacity of organic contaminants on a granular activated carbon sample. In this test, different adsorbent doses of activated carbon (1, 3 and 5 g/L) were mixed with 100 mL of wastewater sample by placing the mixture in four conical flasks. Each conical flask represented the batch adsorption test at specified contact time (30, 60, 90 and 120 min). The initial volume of the sample was 100 mL. The conical flasks were incubated at room temperature. A mechanical shaker (Orbital Shaker 100-240 VAC, HS4010A) was used and the flasks were stirred at 150 rpm.

Different contact times were chosen, e.g. 30, 60, 90 and 120 min, respectively (Moreno-Castilla, 2004). Thus, the shaker was stopped, and samples were removed after each time interval. The changes in the different parameters resulting from AC's adsorption action during the shaking process were recorded. Lastly, calculation of the removal percentages for each parameter was performed. The parameters investigated were pH, electrical conductivity, salinity, TSS, and TDS.

A known quantity of AC was used as an adsorbent in a dyed wastewater sample to examine the removal efficiency (RE) for various wastewater quality parameters. The following equation was used to determine the percentage removal efficiency of each parameter over various time periods:

$$RE(\%) = \frac{(C_0 - C_e)}{C_0} \times 100 \quad (1)$$

where, C_o is the initial concentration (mg/L) and C_e is the concentration (mg/L) at any time, t.

The following equations from Azaman *et al*. (2018), Eqs. 2 and 3, were used to compute the pollutants' adsorbed levels at time t, q_t (mg/g), and at equilibrium condition, q_e (mg/g).:

$$q_t = \frac{(C_0 - C_t)V}{W} \quad (2)$$

$$q_e = \frac{(C_0 - C_e)V}{W} \quad (3)$$

where C_0 and C_e are the concentrations (mg/L) of dye at initial and equilibrium conditions, respectively. V is the volume (L) of the solution, and W is the weight (g) of the adsorbent used.

2.5 Adsorption Kinetics

The pseudo first order and pseudo second order were used to study the adsorption system's kinetics. From

Gaballah *et al*. (2018), Inyinbor *et al*. (2016) and Lagergren (1898) Eqs. (3)and (4) respectively represent the Lagergren pseudo-first-order and pseudo-second-order kinetic equations.

$$In(q_e - q_t) = lnq_e - K_1 t \quad (3)$$

where q_t is the amount absorbed at time t (mg/g) and q_e is the amount absorbed at equilibrium (mg/g). K_1 is the pseudo-first-order sorption's rate constant (min-1). K_1 and calculated q_e can then be obtained from the linear regression analysis.

$$\frac{t}{q_e} = \frac{1}{K_2 q_e^2} + \frac{1}{q_e} \quad (4)$$

where K_2 is the rate constant of the pseudo-second-order kinetic equation in g/mg min^{-1}, q_e is the maximum sorption capacity in mg/g and q_t (mg/g) is the amount of sorption at time t. q_e and K_2 can be calculated from linear regression analysis.

2.6 Langmuir adsorption isotherm

The monolayer adsorption on a surface with a given number of identical sites is described by the Langmuir isotherm model. It assumes that there will be no lateral movement of the adsorbate within the surface plane and homogeneous adsorption energies (Dada *et al*. 2021). Following equation represents Langmuir adsorption isotherm

$$q_e = \frac{Q_0 K_L C_e}{1 + K_L C_e} \quad (5)$$

The Langmuir equation (5) was converted into linear form to calculate the Langmuir adsorption parameters.

$$\frac{1}{q_e} = \frac{1}{Q_0} + \frac{1}{Q_0 K_L C_e} \quad (6)$$

where K_L is the Langmuir constant (L/mg), C_e is the equilibrium concentration of adsorbate (mg/L-1), q_e is the amount of metal adsorbed per gram of the adsorbent at equilibrium (mg/g) and Q_o is maximum monolayer coverage capacity (mg/g)

2.7 Freundlich adsorption isotherm

The adsorption characteristics on heterogeneous surfaces are frequently described using the Freundlich adsorption isotherm. It provides a useful model to explain how adsorbates interact with various surface sites while taking into account differences in their adsorption intensities and capacities (Dada *et al.* 2021). Following equation represents Freundlich adsorption isotherm

$$q_e = K_f C_e^{\frac{1}{n}} \quad (7)$$

where K_f is Freundlich isotherm constant (mg/g), n is adsorption intensity, C_e is the equilibrium concentration of adsorbate (mg/L) and q_e is the amount of metal adsorbed per gram of the adsorbent at equilibrium (mg/g).

Table 1 Initial concentrations of parameters in dye wastewater sample

Parameter	Unit	Initial concentration (C_o)
pH	-	8.3
Electric conductivity (EC)	µS/cm	1654
Salinity	mg/L	1.08
TDS	mg/L	965
TSS	mg/L	1420

After linearizing equation (7)

$$log\ q_e = log\ K_f + \frac{1}{n} \log C_e \quad (8)$$

3. Results and discussion

Table 1 shows the initial concentrations of tested parameters in dye wastewater sample.

Table 2 shows the result of final concentrations of tested parameters (pH, electrical conductivity, salinity, TSS and TDS) using 1, 3 and 5 g/L of adsorbent dose in batch adsorption process. Four conical flasks were used to represent each interval time (30, 60, 90 and 120 min) for different adsorbent doses of activated carbon (1, 3 and 5 g/L). It shows that the concentration of most parameters is decreased when the contact time is increased from 30 to 120 min. Table 3 shows the removal efficiency of tested parameters using 1, 3 and 5 g/L of adsorbent dose at different contact times. It is revealed that the removal efficiency of each parameter is increased when the contact time is increased from 30 to 120 min. A similar trend is reported by El-Gawad and El-Aziz (2018), who studied the effects of various operating parameters on phosphate and COD removal efficiencies. They found that with the increasing of the AC contact time, the adsorption capacity increased.

Fig. 2 shows the pH values using different adsorbent doses at different contact times. It shows that the concentration of pH is decreased when the contact time is increased from 30 to 120 min. Figs. 3 illustrates the effects of contact time and adsorbent dose of AC in the removal efficiencies of electric conductivity, salinity, TSS and TDS, respectively. The highest removal efficiencies of AC for the tested wastewater parameters such as electrical conductivity, salinity, TDS and TSS were 65, 92, 89 and 90%, respectively. Different adsorbent doses, e.g. 1, 3 and 5 g/L of activated carbon were used to adsorb contaminants from the wastewater samples at different contact time intervals varied from 30 to 120 min. It is revealed that the removal efficiencies of tested parameters were increased with the increase in contact time and reached the maximum removal percentage at 120 min of contact time. In addition, it is observed that the maximum removal percentages for all tested parameters were obtained for 5 g/L of activated carbon dose. If AC doses increases, the AC surface area and adsorption sites increase. A similar trend is reported by Kassem *et al*. (2014), who studied the influence of

Table 2 Final concentrations of tested parameters using various adsorbent doses at different contact times

Adsorbent dose (g/L)	Time (min)	pH	EC (µS/cm)	TDS (mg/L)	TSS (mg/L)	Salinity (mg/L)
1	30	7.67	1328	959	1237	0.68
	60	7.41	1307	915	1081	0.64
	90	7.26	1282	915	877	0.64
	120	7.25	1277	909	786	0.63
3	30	7.99	1209	627	1102	0.57
	60	7.8	1154	623	878	0.5
	90	7.8	1138	615	534	0.41
	120	7.8	1129	609	344	0.38
5	30	8.06	1114	591	845	0.31
	60	7.93	1098	585	760	0.26
	90	7.56	1085	566	476	0.21
	120	7.45	1074	545	245	0.17

Table 3 Removal efficiencies of tested parameters using various adsorbent doses at different contact times

Adsorbent dose (g/L)	Time (min)	RE (%)			
		EC	TDS	TSS	Salinity
1	30	27	41	43	37
	60	43	55	56	41
	90	57	65	76	66
	120	60	71	78	75
3	30	36	55	54	47
	60	56	65	56	54
	90	60	76	76	78
	120	63	89	82	86
5	30	53	59	56	71
	60	45	67	76	76
	90	56	86	82	86
	120	65	89	90	92

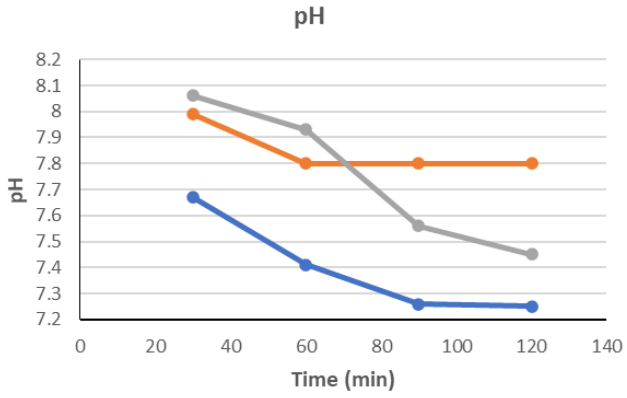


Fig. 2 pH values using different adsorbent doses at different contact times

adsorbent doses (2-10 g/L) of two types AC on equilibrium uptake. They found that with the increasing of the AC dose, the adsorption capacity increased.

According to the adsorption profile in Fig. 4, 5 g/L of adsorbent produces better results for pH, EC, TSS, and salinity, whereas 1 g/L of adsorbent produces better results for TDS. The kinetic model constants for AC adsorbent dose (1, 3 and 5 g/L) corresponding to various water quality parameters are shown in Tables 4 and 5 with non-linear errors. The adsorption system may suit better to the pseudo-second-order kinetic model according to the higher computed R^2 values. In general, it is discovered that the calculated q_e for the pseudo-second-order kinetic model is lower than the q_e for the pseudo-first-order kinetic model. Negative R-squared value implies that the model is performing worse than a model that simply predicts the mean of the dependent variables. This can happen when the model is overfitting the data or when the relationship between the independent and dependent variables is non-linear.

Fig. 5 presents the linearized Langmuir and Freundlich isotherms for different parameters. Table 6 shows the Langmuir and Freundlich isotherms intercepts, constants and slopes for pH, EC, TDS, TSS and salinity. EC, TSS and salinity follow the Freundlich and Langmuir isotherm models. This result is corroborated by the R-squared (R^2) values, which show that these models fit the EC and TSS

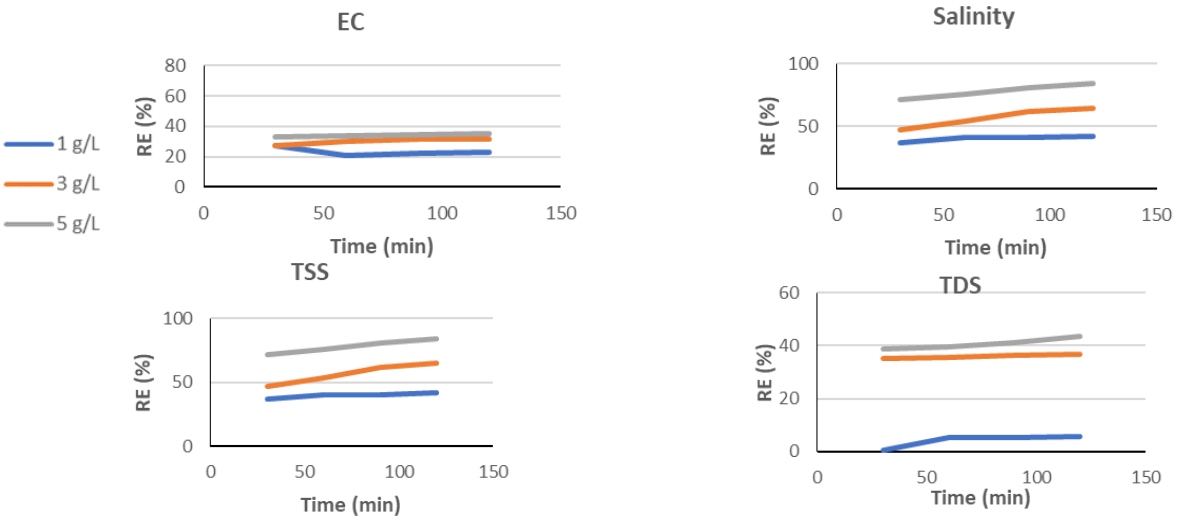


Fig. 3 Removal efficiencies of electrical conductivity, salinity, TSS and TDS values using different adsorbent doses at different contact times

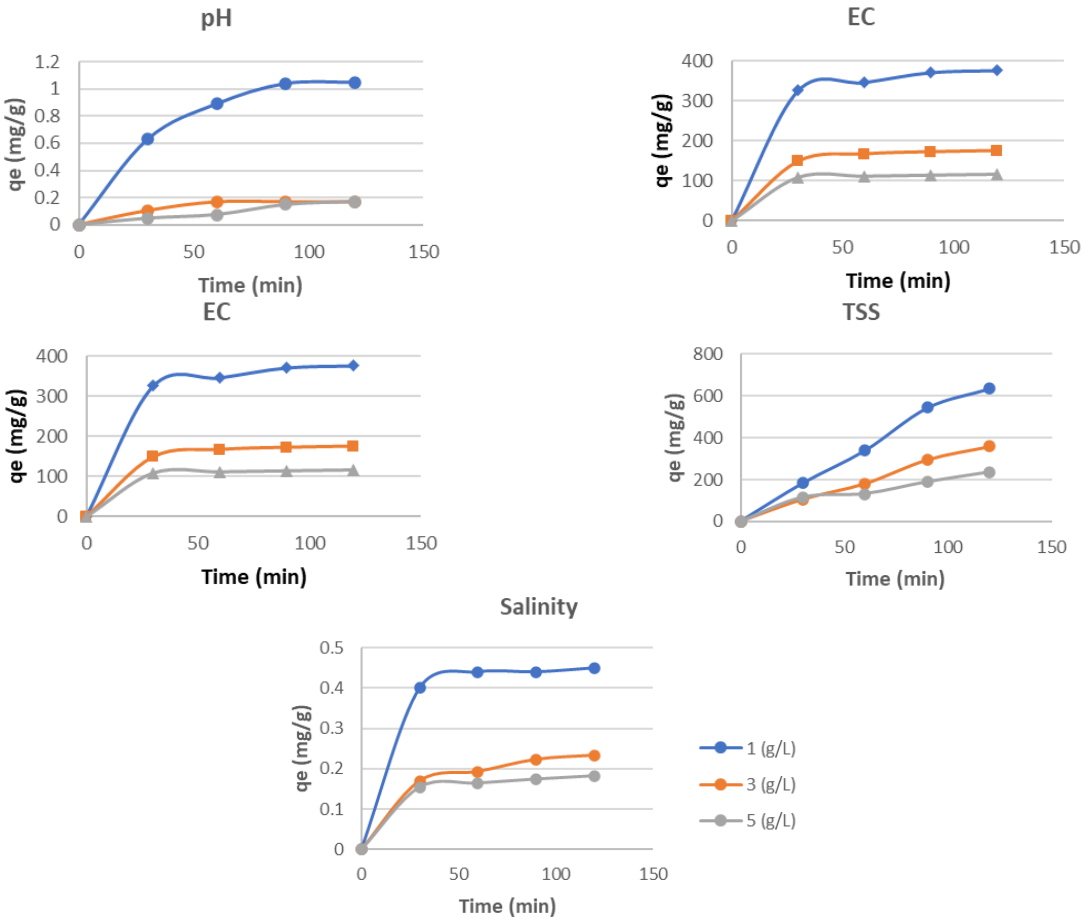


Fig. 4 Adsorption profile of pH, EC, TDS, TSS and salinity values using different adsorbent doses at different contact times

Table 4 Pseudo first order kinetic model

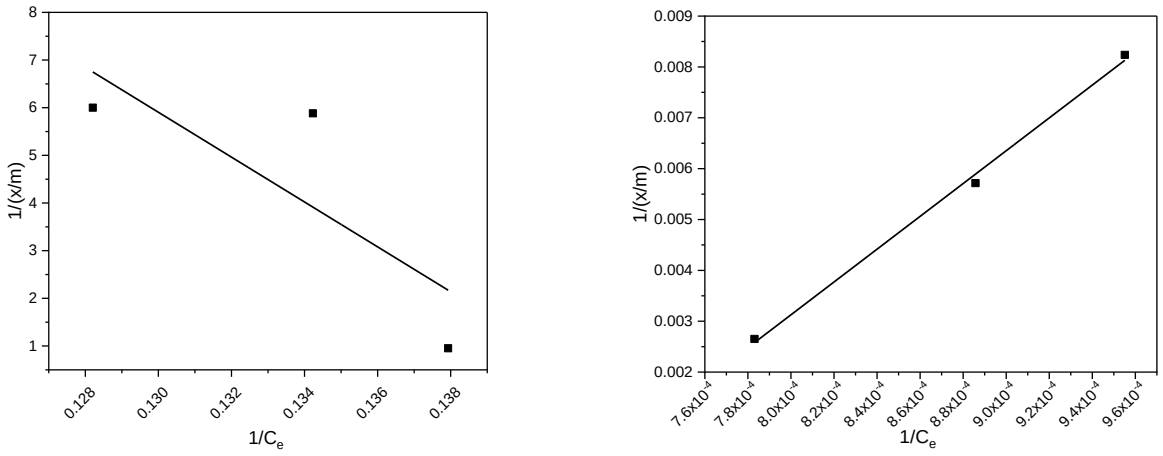
Adsorbent dose (g/L)	Parameter	q_e (mg/g)	K_1	R^2
1		1.954690551	-0.00049	0.924083
3	pH	0.331629341	-0.00155	0.707975
5		1.079733041	-0.00043	0.891477

Table 4 Continued

Adsorbent dose (g/L)	Parameter	q_e (mg/g)	K_1	R^2
1		15.10364117	-0.00019	-0.08978
3	Electric conductivity (EC)	9.041439269	-0.00019	-0.00073
5		5.028439434	-0.00016	0.051348
1		10.88932744	-0.00019	-0.05655
3	TDS	55.01563416	-0.00086	0.289424
5		5.8761136	-0.00015	-0.06491
1		56.97744528	-0.00017	-0.24185
3	TSS	202.5477723	-0.00061	0.031743
5		27.19373969	-0.00015	-0.23142
1		0.491254574	-0.00043	0.88506
3	Salinity	0.343057958	-0.00005	-0.22256
5		0.437229966	-0.00042	0.863487

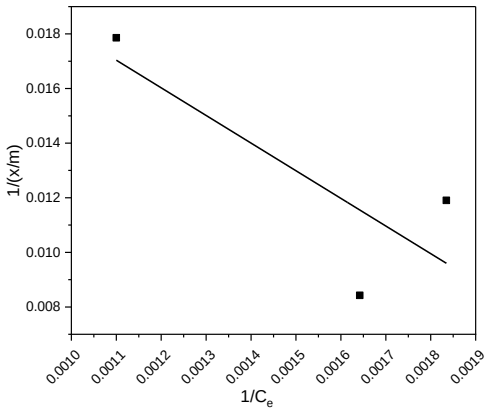
Table 5 Pseudo second order kinetic model

Adsorbent dose (g/L)	Parameter	q_e (mg/g)	K_1	R^2
1		1.121533721	0.130028	0.954278
3	pH	0.177548683	0.000714	0.961364
5		0.215073372	0.000171	0.309083
1		381.4291221	18817658	0.996282
3	Electric conductivity (EC)	177.2591627	1994210	0.997082
5		116.1868004	1113054	0.999099
1		276.3157895	42149.28	-0.32186
3	TDS	118.6883376	1478966	0.999304
5		83.70785887	214884.4	0.995256
1		788.7257936	9856097	0.449893
3	TSS	434.2372823	1672929	0.457453
5		242.5022457	631459.3	0.783047
1		0.452571429	0.051993	0.998568
3	Salinity	0.239027461	0.001917	0.978949
5		0.182802267	0.001738	0.994386

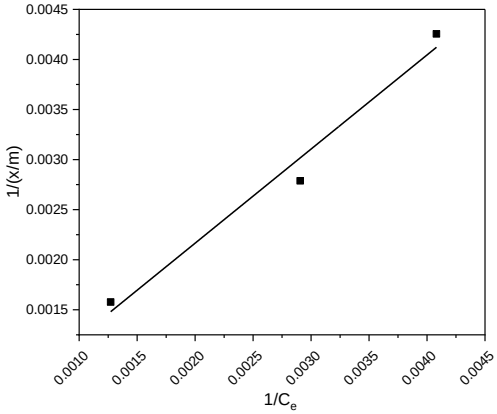


a) Linearized Langmuir isotherm for pH b) Linearized Langmuir isotherm for EC

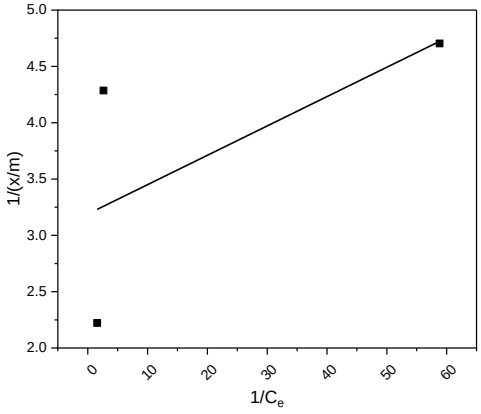
Fig. 5 Linearized Langmuir and Freundlich isotherms for different parameters



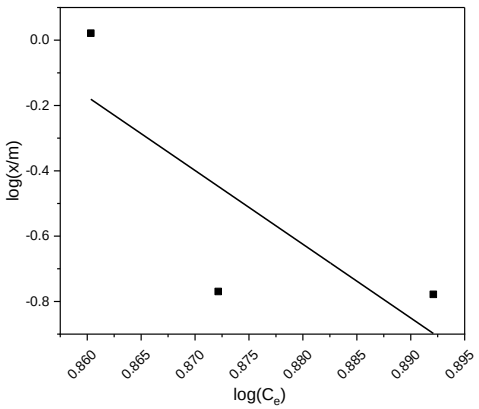
c) Linearized Langmuir isotherm for TDS



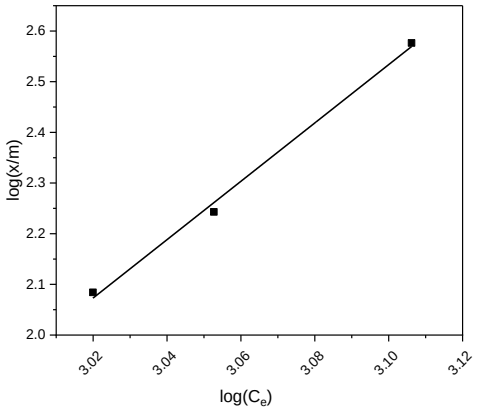
d) Linearized Langmuir isotherm for TSS



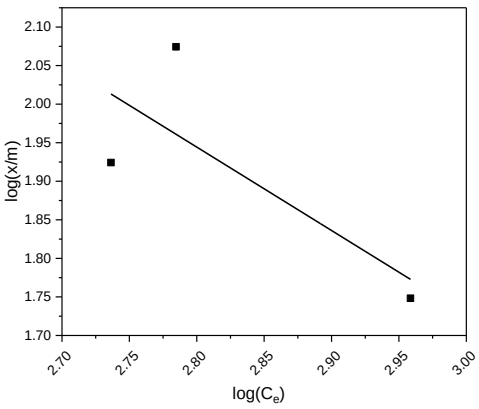
e) Linearized Langmuir isotherm for salinity



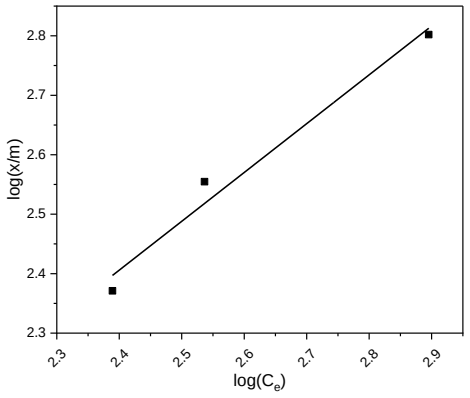
f) Linearized Freundlich isotherm for pH



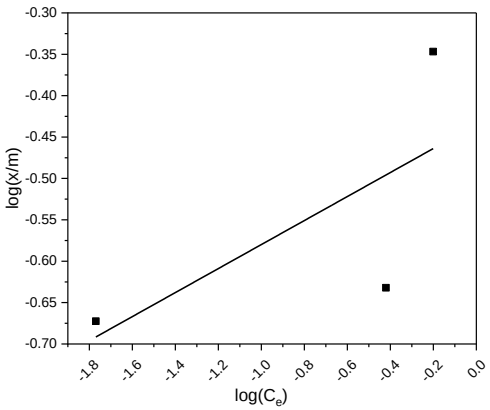
g) Linearized Freundlich isotherm for EC



h) Linearized Freundlich isotherm for TDS



i) Linearized Freundlich isotherm for TSS



j) Linearized Freundlich isotherm for salinity

Fig. 5 Continued

Table 6 Langmuir and Freundlich isotherms for pH, EC, TDS, TSS and salinity

	Langmuir isotherm					Freundlich Isotherm		
Parameter	Intercept (1/a)	a	Slope (1/ab)	b	R^2	slope (1/n)	Intercept (K_f)	R^2
pH	67.09693	0.014904	-470.7114	-31583.3	0.28662	-22.57956	19.24518	0.24663
EC	-0.02268	-44.0917	32.26404	-0.73175	0.99382	5.75732	-15.31395	0.99185
TDS	0.02817	35.49876	-10.12186	-0.28513	0.30751	-1.08148	4.97242	0.19879
TSS	2.86E-04	3502.283	0.93987	0.000268	0.95564	0.82117	0.43512	0.95449
Salinity	3.18963	0.313516	0.02606	0.083122	-0.1749	0.14504	-0.43485	-0.03625

data quite well. This implies that the adsorption or contact behavior of EC and TSS inside the system is well described by the Langmuir and Freundlich isotherms. Negative R^2 value shows that salinity is not applicable for these isotherms.

4. Conclusions

The activated carbon was used as adsorbent in adsorption treatment by calculating the final concentrations of the wastewater quality parameters. The study also included calculation of removal efficiencies of these parameters in order to investigate the performance of the adsorbent in reducing the initial concentrations of the parameters in the sample of wastewater. The adsorption process of activated carbon (AC) prepared from date pits was employed to treat dye wastewater samples, which were prepared in laboratory. The maximum removal efficiencies of AC for the tested wastewater parameters; electrical conductivity (EC), salinity, TDS and TSS were 65, 92, 89 and 90%, respectively. The removal efficiencies were increased with the increase of contact time (30-120 min) and of AC adsorbent dose (1, 3 and 5 g/L). It was revealed that the maximum removal efficiencies of all the tested parameters were obtained for 5 g/L of AC dose at 120 min of contact time. The results of experimental work indicated the achievement of higher removal percentage of the tested parameters using the adsorption process of low cost activated carbon, which is abundant. The removal efficiency of pollutants in the sample increases with the increase of contact time and of AC dose due to the increase of surface area of AC. Based on the understanding adsorption profile, 1 g/L of adsorbent performs better for TDS than 5 g/L for salinity, pH, EC, and TSS. Kinetic model constants show higher R-squared values favoring the pseudo-second-order model, with correspondingly lower q_e values, while negative R-squared values indicate potential overfitting or non-linearity in the variables' relationship. Also, it is observed that the Langmuir and Freundlich isotherms are suitable for modeling the adsorption or contact behavior of EC and TSS. As the AC used in the treatment process is available in bulk and low price, it can help in solving the pollution problem of disposing untreated wastewater, which is one of the major environment problems in the current world. Further experimentation and data collection could enhance the understanding and refine these adsorption profiles, kinetic models and isotherms for more accurate predictions. It is recommended to study further on the possibility of reusing the AC.

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