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SUPPLEMENTARY MATERIAL TO

Nitrogen-modified nanoporous activated carbon from eucalyptus leaves for ultrasound-assisted removal of basic dyes using derivative spectrophotometric method

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FT-IR analysis of the pristine and modified AC samples

FT-IR spectra of modified AC samples were shown in Figs. S-1a and b. For oxidized AC (Fig. S-1a), the peak at 3430 cm^{-1} is attributed to O–H stretching vibrations of the absorbed water molecules and the structural OH groups (phenol, alcohol, and carboxylic acid). The peak at 1725 cm^{-1} is related to C=O stretching in ketones and carboxylic acids and the peak at 1705 cm^{-1} is associated to C=O stretching in lactones. The broad peak at 1100 cm^{-1} is corresponded to C–O stretching vibrations. The two bands at 2850–2950 cm^{-1} and the peak at 1628 cm^{-1} are assigned to C–H and C=C stretching vibrations, respectively. As shown in Fig. S-1b, for the nitrogen-modified AC, the –NH$_2$ and –OH groups were indicated by the peaks at 3330 and 3444 cm^{-1}, respectively. The peaks at 1150 and 1220 cm^{-1} were attributed to –C–N (aliphatic and aromatic) stretching vibration. As it can be seen from this Figure, most of the carboxylic acid groups were eli–minated from the surface of OAC by urea treatment of this sample; this is ref–lected by disappearance of the 1725 cm^{-1} band in the spectrum of NOAC sample, which exists in the spectra of the oxidized AC sample.

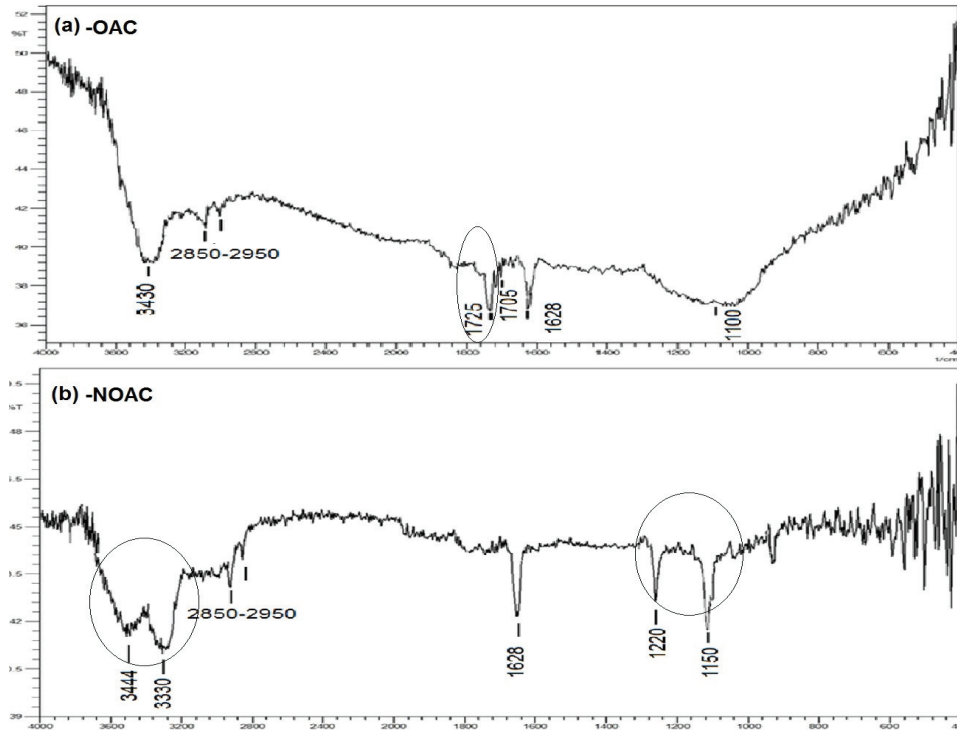* Corresponding author. E-mail: akhalighv@gmail.com

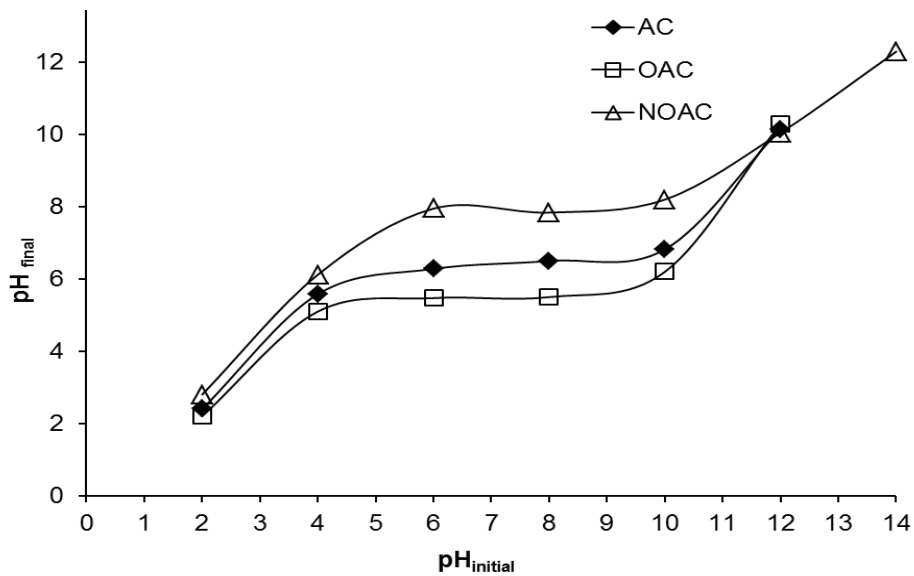Fig. S-1. FTIR spectra of (a) oxidized AC and (b) nitrogen-modified AC.

Fig. S-2. Final pH versus initial pH plots for pristine, oxidized and nitrogen modified AC samples.
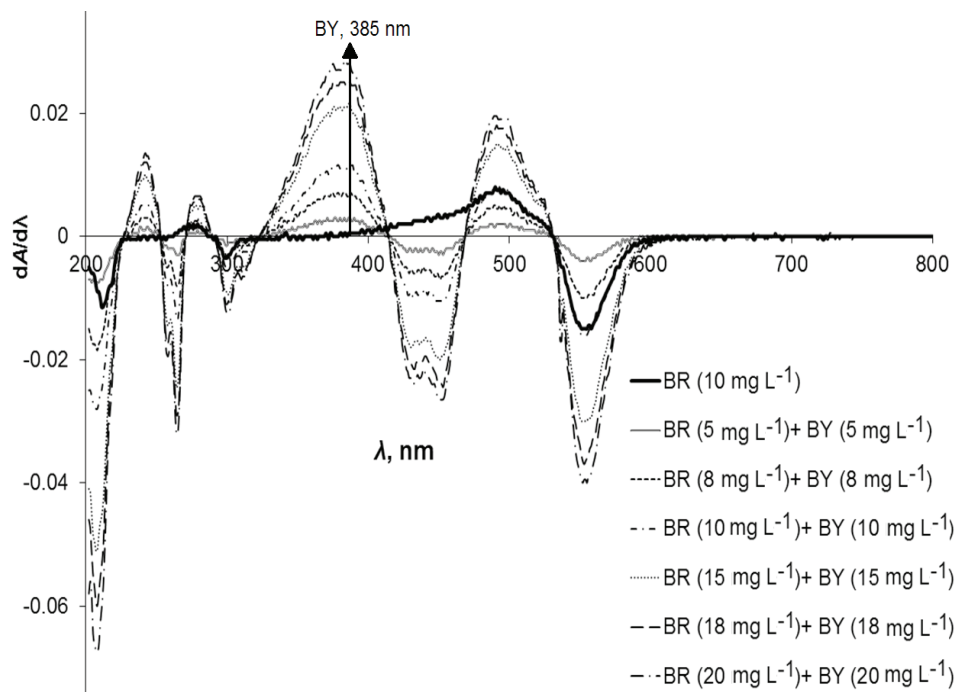
Fig. S-3. First order derivative spectra of BR46 and BY13 in binary solutions in the range of 5–20 mg L^{-1} of each two dyes concentration.
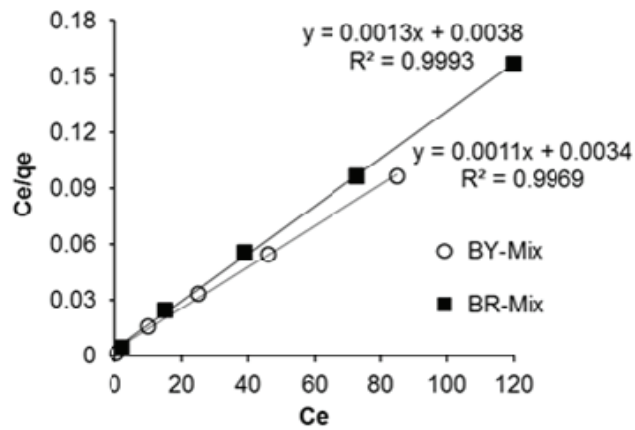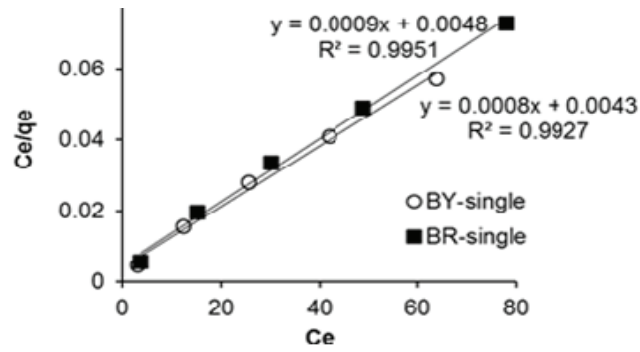
Fig. S-4. Langmuir plots for the adsorption of BY13 and BR46 dyes onto NOAC in single and binary dye solutions ($V_{solution}$=100 mL, C_{single}=200=400 mg L^{-1}, C_{mix}=150-300 mg L^{-1}, pH=9, m=30 mg, t= 8 min, T=25 °C).
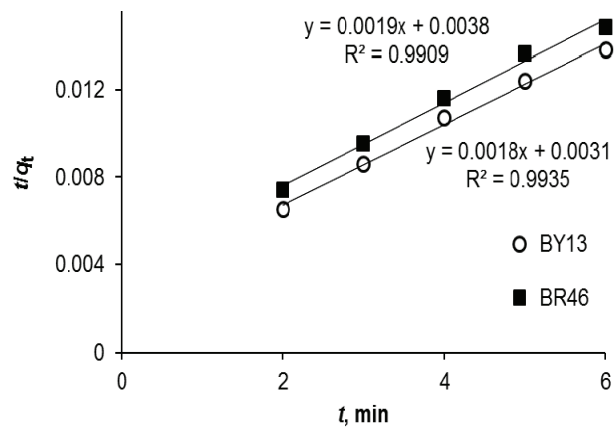

Fig. S-5. Pseudo-second order kinetic plots for the adsorption of BY13 and BR46 dyes onto NOAC in binary dye solution (100 mL of 150 mg L^{-1} dyes solution, pH=9, m=30 mg, t= 2-6 min, T=25 °C).
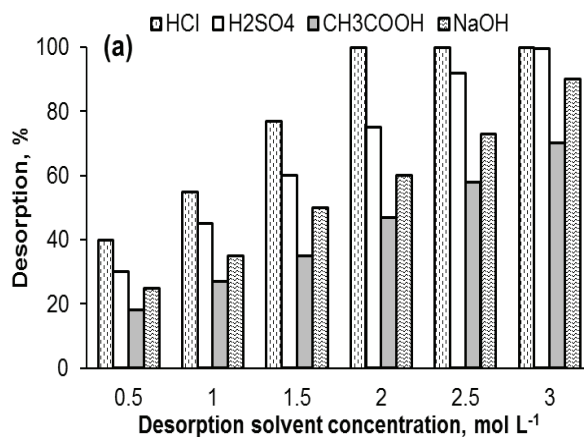
Fig. S-6. Effect of solvent type and concentration on the desorption of: a) BY13 and b) BR46 dyes from loaded NAC (desorption solvent volume 100 mL, spent NOAC = 30 mg, t = 8 min, T = 25 °C).

TABLE S-I. Chemical structure and properties of basic dyes used in this study

Chemical structure	Commercial name	C. I. number	λ_{max} / nm	Molecular weigth g mol^{-1}
	Basic Red 46	110825	530	401.3
	Basic Yellow 13	48056	411	342.86

TABLE S-II. Initial dye concentrations in single and binary systems

Single system		Binary System (1)		Binary System (2)	
$c_{0,\,BR46}$ mg L^{-1}	$c_{0,\,BY13}$ mg L^{-1}	$c_{0,\,BR46}$ mg L^{-1}	$c_{0,\,BY13}$ mg L^{-1}	$c_{0,\,BR46}$ mg L^{-1}	$c_{0,\,BY13}$ mg L^{-1}
200–400	200–400	150–350	150	150–350	150–350
		150	150–350		

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TABLE S-III. Determination of percentage recovery and error values for BR46 and BY13 in binary mixture by zero and first order derivative spectra methods

c_t / mg L^{-1}		c_m / mg L^{-1}		Recovery, %		Error, %	
C_{BY}	C_{BR}	C_{BY}	C_{BR}	C_{BY}	C_{BR}	C_{BY}	C_{BR}
5	5	4.83	5.06	96.60	101.20	–3.40	+1.20
8	8	7.78	8.20	97.25	102.50	–2.75	+2.5
10	10	10.20	9.65	102.00	96.50	+2.00	–3.50
15	15	15.18	14.70	101.20	98.00	–1.20	–2.00
18	18	17.24	17.40	95.78	96.67	–4.22	–3.33
20	20	20.25	20.38	101.25	101.90	+1.25	+1.90

TABLE S-IV. R_L values for BY13 and BR46 dyes in single and binary solutions

c_0 / mg L^{-1}	R_L of BY13		R_L of BR46	
	Single	Binary	Single	Binary
150	–	0.020	–	0.020
200	0.026	0.015	0.026	0.014
250	0.021	0.012	0.020	0.011
300	0.018	0.010	0.017	0.009
350	0.015	0.008	0.015	0.008
400	0.013	–	0.013	–