Supplementary Information (SI) for New Journal of Chemistry. This journal is © The Royal Society of Chemistry and the Centre National de la Recherche Scientifique 2025

Supplementary information

- 2 Enhanced norfloxacin removal by eco-friendly MgFe₂O₄ modified sugarcane
- 3 bagasse biochar: Adsorption performances and mechanisms
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9 Test S1. The equations and parameters of adsorption kinetic, isotherm and thermodynamic models.
10 Pseudo-first-order (Eq. (1)), pseudo-second-order (Eq. (2)) and intra-particle diffusion (Eq. (3)) models were used to fit the kinetic data. Langmuir (Eq. (4) and Eq. (5)), Freundlich (Eq. (6)),
12 Temkin (Eq. (7)) and Dubinin-Radushkevich isotherm models (Eq. (8), Eq. (9) and Eq. (10)) were
13 applied to fit the isothermal data. The thermodynamic parameters were calculated by the following
14 Eq. (11) and Eq. (12).

15
$$Q_t = Q_e (1 - e^{-k_1 t})$$
 (1)

16
$$Q_{t} = \frac{Q_{e}^{2}k_{2}t}{1 + Q_{e}k_{2}t}$$
(2)

17
$$Q_t = k_i t^{1/2} + C_i (3)$$

$$Q_{e} = \frac{Q_{m} K_{L} C_{e}}{1 + K_{L} C_{e}}$$
(4)

$$RL = \frac{1}{1 + KLC0}$$
(5)

20
$$Q_e = K_F C_e^{1/n}$$
 (6)

$$Q_{e} = \frac{RT}{B_{T}} ln(K_{T}C_{e})$$
(7)

$$Q_e = Q_m e^{-K_D \varepsilon^2}$$
(8)

$$\epsilon = RTln(1 + 1/C_e) (9)$$

24
$$E = (2K_D)^{-0.5}$$
 (10)

$$\Delta G^0 = \Delta H^0 - T \Delta S^0 (11)$$

$$\ln \frac{Q_e}{C_e} = \frac{\Delta S^0}{R} - \frac{\Delta H^0}{RT}$$
(12)

27 where $Q_t (mg/g)$ and $Q_e(mg/g)$ are the adsorption amount at time t (min) and equilibrium, 28 respectively; $k_1 (1/min)$, $k_2 (g/(mg \cdot min))$ and $ki (mg/g \cdot min^{1/2})$ represent the rate constants of pseudo-29 first-order, pseudo-second-order and intraparticle diffusion models, respectively; $C_i (mg/g)$ is 30 related to the thickness of the boundary layer; $C_e (mg/L)$ is the adsorption equilibrium concentration; 31 $Q_m (mg/g)$ is the maximum adsorption capacity; $K_L (L/mg)$ is the Langmuir equilibrium constant; 32 R_L is dimensionless separation factor; K_F (mg/g·(L/mg)^{1/n}) is the Freundlich equilibrium constant 33 and represents the adsorption capacity; n is the isothermal constant and represents the adsorption 34 strength; R is the gas constant (8.314 J/mol·K); T (K) is the absolute temperature; B_T (kJ/mol) is 35 the Temkin constant related to the heat of sorption; and K_T (L/mg) is the Temkin binding constant; 36 K_D (mol²/J²) is the constant related to adsorption energy; ε is the Polanyi potential; E (kJ/mol) is the 37 adsorption free energy; ΔG^0 (kJ/mol), ΔH^0 (kJ/mol) and ΔS^0 (kJ/(mol·K)) are the changes in Gibbs 38 free energy, enthalpy and entropy, respectively.

40 Test S2. The calculation process of ionization distribution of NOR.

NOR⁺(%) =
$$\frac{(10^{(-pH)})^2}{(10^{(-pH)})^2 + 10^{(-pK_{a1})} \times 10^{(-pH)} + 10^{(-pK_{a1})} \times 10^{(-pK_{a2})} \times 100$$
 (13)
41
NOR[±](%) = $\frac{10^{(-pK_{a1})} \times 10^{(-pH)}}{(10^{(-pH)})^2 + 10^{(-pK_{a1})} \times 10^{(-pH)} + 10^{(-pK_{a1})} \times 10^{(-pK_{a2})} \times 100$ (14)
42
NOR⁻(%) = $\frac{10^{(-pK_{a1})} \times 10^{(-pK_{a1})} \times 10^{(-pK_{a2})}}{(10^{(-pH)})^2 + 10^{(-pK_{a1})} \times 10^{(-pK_{a2})} \times 100$ (15)
43
44

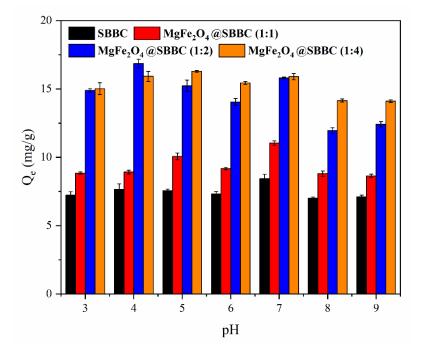
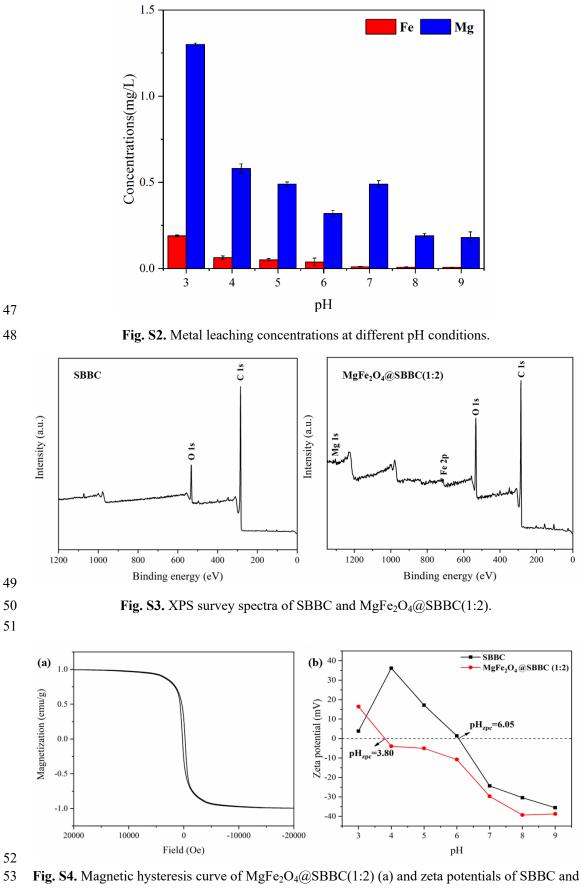




Fig. S1. NOR adsorption capacities of different biochar materials.



MgFe₂O₄@SBBC(1:2) (b).

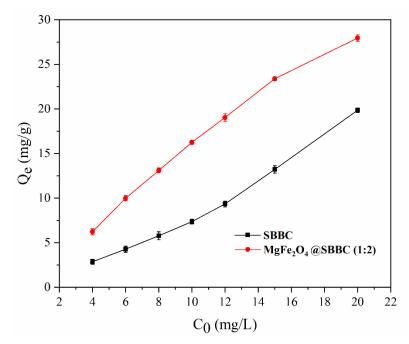
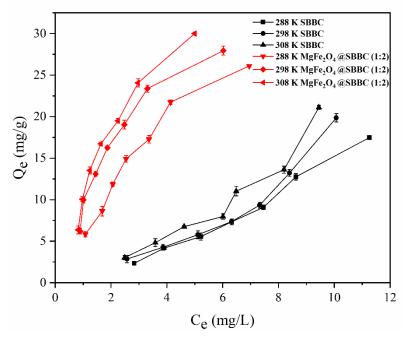


Fig. S5. Effect of initial concentrations on the NOR adsorption onto SBBC and $MgFe_2O_4@SBBC(1:2)$.





60 Fig. S6. Effect of temperature on the NOR adsorption onto SBBC and MgFe₂O₄@SBBC(1:2).

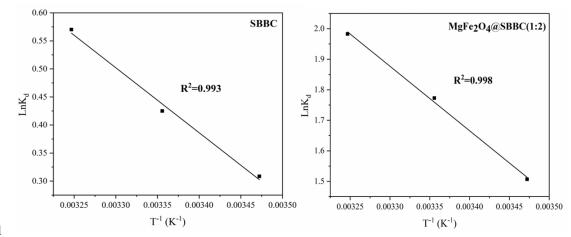
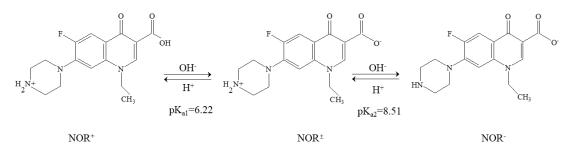


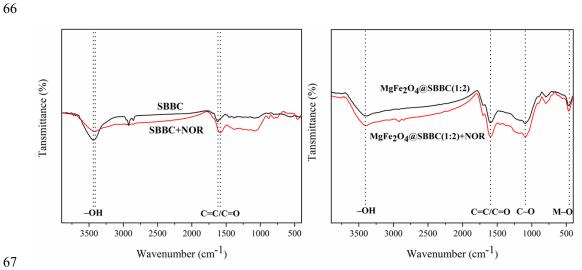


Fig. S7. Thermodynamic studies of NOR adsorption on SBBC and MgFe₂O₄@SBBC(1:2).



65

Fig. S8. Chemical speciation of NOR in aqueous solution.



68 Fig. S9. FTIR spectra of SBBC and MgFe₂O₄@SBBC(1:2) before and after adsorption.

Intensity (a.u.)	C 1s	(b) o 1s	(c) C Is	C-C/C=C		
Inte	0-C-0 294 292 290 288 286 284 282 29			20 25		
(d)	Binding energy (eV)	Binding energy (eV)	Fe 2p _{3/2} (f) Mg 1s	Binding energy (eV)		
Intensity (a.u.)	C-0/0-H C=0 M-0	Fe 2p _{1/2} Sat. Fe ³ Fe ³ Sat. F	ret for the state of the state	LAN MARKA		
52	38 536 534 532 530 528 5 Binding energy (eV)	26 740 730 720 Binding energy (eV)	710 1310 1308	1306 1304 1302 Binding energy (eV)		
Binding energy (eV) Binding energy (eV) Binding energy (eV) Fig. S10. XPS spectra C 1s and O 1s of SBBC (a, b) and C 1s, O 1s, Fe 2p and Mg 1s of						
		$e_2O_4@SBBC(1:2)$ (c-f) a		1 0		
Tal	Fable S1. S_{BET} , V_p , and D_p values of SBBC and MgFe ₂ O ₄ @SBBC(1:2) after adsorption.					
	Sample	$S_{BET} (m^2/g)$	$V_p (cm^3/g)$	D _p (nm)		
	SBBC+NOR	90	0.09	3.98		
М	[gFe ₂ O ₄ @SBBC(1:2)+NOR	100	0.1.4			
	<u>1610204@0DDC(112)+11011</u>	196	0.14	2.76		
	ble S2. Summary of the peak Binding energy (eV) Functional groups					
	ble S2. Summary of the peak Binding energy (eV)	area ratio of C 1s and O 284.6	1s of SBBC before 285.8	and after adsorptic 288.5		
	ble S2. Summary of the peak Binding energy (eV) Functional groups	area ratio of C 1s and O 284.6 C-C/C=C (%)	1s of SBBC before 285.8 C–O (%)	and after adsorptio 288.5 O–C=O (%)		
	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5	1s of SBBC before 285.8 C-O (%) 25.3	and after adsorptio 288.5 O-C=O (%) 13.9 13.9		
	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV)	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8	1s of SBBC before 285.8 C-O (%) 25.3	and after adsorptio 288.5 O–C=O (%) 13.9		
	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%)	1s of SBBC before 285.8 C-O (%) 25.3 29.6	and after adsorptio 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%)		
	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0	1s of SBBC before 285.8 C-O (%) 25.3 29.6	and after adsorptio 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0		
	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%)	1s of SBBC before 285.8 C-O (%) 25.3 29.6	and after adsorptio 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%)		
Tal	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0 70.0	1s of SBBC before 285.8 C-O (%) 25.3 29.6	and after adsorptio 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0 30.0		
Tal	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC SBBC+NOR ble S3. Summary of the peak	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0 70.0	1s of SBBC before 285.8 C-O (%) 25.3 29.6	and after adsorptio 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0 30.0		
Tal	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC SBBC+NOR ble S3. Summary of the peak after adsorption.	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0 70.0 area ratio of C 1s, O 1s, a	<u>1s of SBBC before</u> <u>285.8</u> C-O (%) <u>25.3</u> <u>29.6</u> O- and Fe 2p of MgFe ₂ O	and after adsorptic 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0 30.0 D ₄ @SBBC(1:2) be		
Tal	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC SBBC+NOR ble S3. Summary of the peak after adsorption. Binding energy (eV)	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0 70.0 area ratio of C 1s, O 1s, a 284.6	<u>1s of SBBC before</u> <u>285.8</u> C-O (%) <u>25.3</u> <u>29.6</u> O- and Fe 2p of MgFe ₂ (<u>285.8</u>	and after adsorptio 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0 30.0 D ₄ @SBBC(1:2) be 288.5		
Tal	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC SBBC+NOR ble S3. Summary of the peak l after adsorption. Binding energy (eV) Functional groups	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0 70.0 area ratio of C 1s, O 1s, a 284.6 C-C/C=C (%) 62.8	1s of SBBC before 285.8 C-O (%) 25.3 29.6 0- und Fe 2p of MgFe ₂ O 285.8 C-O (%)	and after adsorptic 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0 30.0 $D_4(@SBBC(1:2)$ be 288.5 O-C=O (%)		
Tal	ble S2. Summary of the peak Binding energy (eV) Functional groups SBBC SBBC+NOR Binding energy (eV) Functional groups SBBC SBBC+NOR ble S3. Summary of the peak after adsorption. Binding energy (eV) Functional groups MgFe ₂ O ₄ @SBBC(1:2)	area ratio of C 1s and O 284.6 C-C/C=C (%) 60.8 56.5 532.0 C-O (%) 64.0 70.0 area ratio of C 1s, O 1s, a 284.6 C-C/C=C (%) 62.8	1s of SBBC before 285.8 C-O (%) 25.3 29.6 O and Fe 2p of MgFe ₂ O 285.8 C-O (%) 19.9	and after adsorption 288.5 O-C=O (%) 13.9 13.9 533.6 -C=O (%) 36.0 30.0 $D_4@SBBC(1:2)$ between the second se		

	Functional groups	M–O (%)	C=O (%)	СО/ОН (%)
	$MgFe_2O_4@SBBC(1:2)$	36.9	36.1	27.0
	MgFe ₂ O ₄ @SBBC(1:2)+NOR	38.7	27.5	33.8
83				
	Binding energy (eV)	711.4, 724.5	713.5, 726.0	
	Valence state	Fe ²⁺ (%)	Fe ³⁺ (%)	
	MgFe ₂ O ₄ @SBBC(1:2)	45.5	26.3	
	MgFe ₂ O ₄ @SBBC(1:2)+NOR	33.6	29.4	
0.4				