

## Supplementary Materials

**Dyeing sludge-derived biochar for efficient removal of malachite green from dyeing wastewater**

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**Supplementary Table 1. Design of experimental factor levels**

Factor code	Factor	Unit	Values for each level		
			-1	0	1
A	Pyrolysis temperature	°C	700	800	900
B	Carbonization time	h	1	1.5	2
C	Activation ratio	/	1:2	2:1	1:1

**Supplementary Table 2. ANOVA of regression equations**

Source	Sum of squares	Df	Mean square	F-value	<i>P</i> -value
Model	8880.74	9	986.75	22.66	0.0002
A	1093.72	1	1093.72	25.12	0.0015
B	145.78	1	145.78	3.35	0.1100
C	324.23	1	324.23	7.45	0.0294
AB	73.19	1	73.19	1.68	0.2359
AC	54.39	1	54.39	1.25	0.3006
BC	51.98	1	51.98	1.19	0.3107
A <sup>2</sup>	5690.29	1	5690.29	130.68	< 0.0001
B <sup>2</sup>	747.55	1	747.55	17.17	0.0043
C <sup>2</sup>	248.64	1	248.64	5.71	0.0482
Residual	304.80	7	43.54		
Lack of Fit	186.72	3	62.24	2.11	0.2419
Pure Error	118.08	4	29.52		
Cor Total	9185.54	16			

**Supplementary Table 3. Langmuir and Freundlich equation fitting parameters**

Adsorption model	Parameters	
Langmuir	$q_m$ (mg/g)	224.0962
	$K_L$	0.7214
	$R^2$	0.6819
Freundlich	$n$	13.1284
	$K_F$	154.9107
	$R^2$	0.4276

Notes:  $Q_{max}$ , maximum adsorption capacity from the Langmuir model;  $K_L$ , Langmuir constant;  $K_F$ , Freundlich constant;  $n$ , Freundlich exponent.

**Supplementary Table 4. Pseudo-first kinetic parameters at different temperatures**

Temperature (°C)	Linear equation	$q_e$ (mg/g)	$k_1$ (min <sup>-1</sup> )	$R^2$
20	$y = -0.0225x + 3.5786$	35.8234	0.0225	0.9873
30	$y = -0.0263x + 3.7657$	43.1939	0.0263	0.9606
40	$y = -0.0202x + 3.8916$	48.9892	0.0202	0.9665

**Supplementary Table 5. Pseudo-second kinetic parameters at different temperatures**

Temperature (°C)	Linear equation	$q_e$ (mg/g)	$k_l$ (min <sup>-1</sup> )	$R^2$
20	$y = 0.0087x + 0.0612$	114.9425	0.0012	0.9984
30	$y = 0.0089x + 0.0726$	112.3596	0.0011	0.9989
40	$y = 0.0077x + 0.0746$	129.8701	0.0008	0.9976

**Supplementary Table 6. Elovich parameters at different temperatures**

Temperature (°C)	Linear equation	$\alpha$ (mg/g·min)	$\beta$ (g/mg)	$R^2$
20	$y = 10.5961x + 56.9475$	2286.7092	0.0943	0.9838
30	$y = 12.1957x + 46.0807$	533.5334	0.0820	0.9813
40	$y = 16.2281x + 41.1176$	204.4805	0.0616	0.9682

**Supplementary Table 7. Intraparticle parameters at different temperatures**

Parameters	20 °C	30 °C	40 °C
$K_{d1}$	3.2802	4.258	6.1056
$C_1$	73.5355	62.6169	60.7031
$R^2$	0.9702	0.9814	0.9867
$K_{d2}$	2.1847	1.518	0.2752
$C_2$	83.4709	88.1849	118.2312
$R^2$	0.8461	0.8981	0.9444