

Fig. S1. BET surface area plot of KB-BC350 (A), KB-BC550 (B) and KB-BC750 (C).

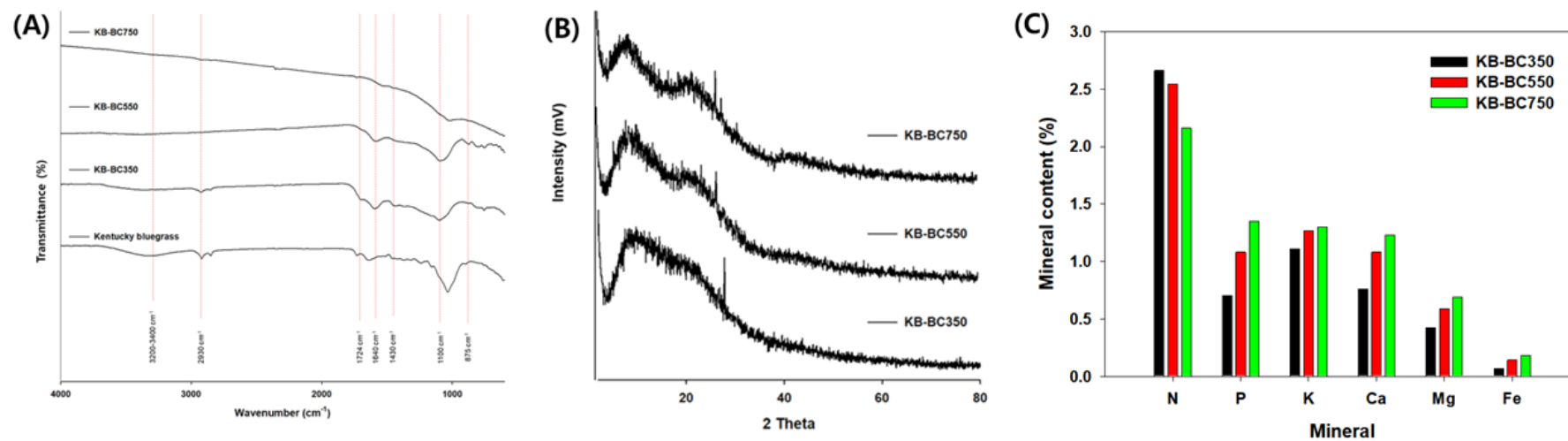


Fig. S2. Comparison of FT-IR spectrum (A) and mineral contents (B) of KB-BCs. Comparison of mineral content in different samples (C).

Table S1. Adsorption isotherm and kinetic models

Model	Equation
	Freundlich: $Q_e = K_f C_e^{\frac{1}{n_f}}$
	Temkin: $Q_e = \frac{RT}{b_T} \ln (K_T C_e)$
	Langmuir: $Q_e = \frac{Q_m K_L C_e}{1 + K_L C_e}, R_L = \frac{1}{1 + K_L C_0}$
Isotherm	<p>‘K<sub>f</sub>’ is a constant to indicate the adsorption capacity of BZ, ‘C<sub>e</sub>’ is the liquid-phase concentration of BZ at equilibrium (mg/L), 1/n<sub>f</sub> is an indicator of adsorption effectiveness, ‘C<sub>0</sub>’ is the liquid-phase concentration of BZ at initial (mg/L), ‘R’ is the universal constant (8.314 J mol<sup>-1</sup> K<sup>-1</sup>), ‘T’ is the temperature in terms of Kelvin, ‘b<sub>T</sub>’ is Temkin constant, ‘K<sub>T</sub>’ is equilibrium bond constant related to the maximum energy of bond, and ‘Q<sub>m</sub>’ is the maximum adsorption capacity of BZ (mg/g), ‘K<sub>L</sub>’ is the Langmuir constant (L/mg) related to the adsorption/desorption energy, ‘R<sub>L</sub>’ is separation constant.</p>
	Pseudo-first order: $Q_t = Q_e (1 - \exp(-K_1 t))$
	Pseudo-second order: $Q_t = Q_e (1 - \exp(-K_2 t))$
	Elovich: $Q_t = \left(\frac{1}{b}\right) \ln ab + \left(\frac{1}{b}\right) \ln t, t_0 = \frac{1}{ab}$
	Intra-particle diffusion: $Q_t = K_i \sqrt{t} + C_i$
	Liquid film diffusion: $\ln(1 - F) = -K_{fd} t, F = \frac{Q_t}{Q_e}$
Kinetic	<p>Two-compartment: <math>\frac{Q_t}{Q_{t=\infty}} = F_{fast} (1 - \exp^{-t K_{fast}}) + F_{slow} (1 - \exp^{-t K_{slow}}), F_{fast} + F_{slow} = 1</math></p> <p>‘Q<sub>t</sub>’ is the adsorption capacity of BZ onto biochar (mg/g) at time t (min), ‘Q<sub>e</sub>’ is the adsorption capacity of BZ onto biochar (mg/g) at equilibrium time, ‘K<sub>1</sub>’ is a rate constant of pseudo-first order, ‘K<sub>2</sub>’ is a rate constant of pseudo-second order, ‘a’ is a rate constant of chemisorption, ‘b’ is constant of the surface coverage, ‘K<sub>i</sub>’ is intra-particle diffusion rate constant (mg min<sup>0.5</sup>/g), ‘C<sub>i</sub>’ is a constant (mg/g), ‘K<sub>fd</sub>’ is BZ adsorption rate constant, ‘F<sub>fast</sub>’ is the mass fraction of fast, ‘F<sub>slow</sub>’ is the mass fraction of slow, ‘K<sub>fast</sub>’ is the first-order rate constant for transfer into fast (h<sup>-1</sup>), ‘K<sub>slow</sub>’ is the first-order rate constant for transfer into slow (h<sup>-1</sup>), and ‘h’ is hour.</p>

Table S2. The adsorption isotherm parameters of benzene onto KB-BC550.

Conc. (mg/L)	Langmuir			Freundlich			Temkin		
	$K_L$	$Q_m$	$R^2$	$K_f$	$n_f$	$R^2$	$b_T$	$K_T$	$R^2$
300	0.008	238.919	0.934	8.065	1.778	0.963	60.48	0.122	0.910

Table S3. The adsorption kinetic parameters of benzene onto KB-BC550.

Conc. (mg/L)	Pseudo-first order					Pseudo-second order			
	$Q_e^a$	$Q_e^b$	$K_1$	SSE	$R^2$	$Q_e^b$	$K_2$	SSE	$R^2$
300	126.5	131.3	0.008	6.892	0.954	158.1	0.00005	8.806	0.926

Conc. (mg/L)	Elovich					Two-compartment first-order						
	a	b	$t_0$	SSE	$R^2$	$Q_e^b$	$F_{fast}$	$F_{slow}$	$K_{fast}$	$K_{slow}$	SSE	$R^2$
300	2.624	0.028	13.581	10.444	0.896	103.3	0.00000 9	1.270	4.982	0.483	6.892	0.954

Conc. (mg/L)	Liquid film diffusion				Intra-particle diffusion							
	$Q_e^b$	$K_{fd}$	SSE	$R^2$	$Q_e^b$	$K_i$	$K_{i1}$	$K_{i2}$	$K_{i3}$	$C_i$	SSE	$R^2$
300	131.3	0.008	6.828	0.941	94.1	4.270	5.097	0.971	0.518	30.5	14.6	0.795

$Q_e^a$  and  $Q_e^b$  are the adsorption capacity of BZ onto biochar (mg/g) at equilibrium time by experiment and calculation, respectively.

Table S4. Effect of different combination of various variables on adsorption capacity (mg BZ/g BC) of benzene analyzed by using Box-Behnken response surface design.

Run	Independent variables			Response (adsorption capacity, mg BZ/g BC; removal efficiency, %)	
	X <sub>1</sub> (g)	X <sub>2</sub> (mg/L; ppm)	X <sub>3</sub> (h)	Benzene	
	Quantity of biochar	Concentration of benzene	Reaction time	Experimental (mg BZ/g BC)	Experimental (%)
1	0.002	100	7	40.50 ± 8.14	11.98 ± 2.41
2	0.010	300	7	99.67 ± 3.01	73.80 ± 2.23
3	0.002	300	7	115.20 ± 48.77	17.06 ± 7.22
4	0.010	200	12	54.09 ± 1.92	60.05 ± 2.13
5	0.006	200	7	61.27 ± 4.41	40.80 ± 2.94
6	0.002	200	12	55.35 ± 21.10	12.25 ± 4.68
7	0.006	200	7	64.35 ± 6.18	42.88 ± 4.12
8	0.006	100	12	50.17 ± 0.59	44.54 ± 0.52
9	0.006	200	7	65.62 ± 7.98	43.73 ± 5.32
10	0.010	100	7	42.03 ± 3.12	62.24 ± 4.62
11	0.006	100	2	31.05 ± 6.07	27.58 ± 5.04
12	0.006	300	12	143.92 ± 5.10	63.96 ± 2.26
13	0.010	200	2	42.97 ± 3.17	47.75 ± 3.52
14	0.006	300	2	119.40 ± 7.02	53.04 ± 3.12
15	0.002	200	2	37.35 ± 14.24	8.26 ± 3.16