Supplementary information

Sludge biochar-based catalyst for improved pollutant degradation by activating peroxymonosulfate

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This supporting information contains 19-page document, including 3 tables, 14 figures, references and this cover page.

Table S1 Oxidant Dosages Reported in Literatures

Catalyst		**Pollutant**		**Oxidant**		**pH**	**Oxidant utility**	**Ref.**
Type	g/L	Type	mM	Type	mM		mol/mol oxidant/h	
rGO	0.1-0.5	Phenol	0.1225	PMS	0.80-3.189	6.5	0.027	[1]
N-CNT	0.2	Phenol	0.2127	PMS	3.25	6.5	0.087	[2]
N-CNT	0.1	Phenol	0.2127	PMS	6.5	6.5	0.098	[3]
Biochar	1	PCB	0.0039	PDS	8	7.4	0.00012	[4]
Nanodiamond	0.1	Phenol	0.01	PDS	1	7.0	0.059	[5]
CuO/Fe_3O_4	0.3	Phenol	0.1	PDS	5	5.6	0.008	[6]
$Fe_xCo_{3-x}O_4$	0.1	BPA	0.0877	PMS	0.325	6.0	0.269	[7]
Noble metals	0.25	4-CP	0.1	PMS	0.25	7.0	1.6	[8]
Fe-Mn-Co/C	0.1	BPA	0.0877	PMS	0.325	6.0	1.34	[9]
Biochar	**0.2**	**BPA**	**0.0439**	**PMS**	**0.041**	**4-10**	**3.21**	**This work**
Biochar	**0.2**	**Phenol**	**0.106**	**PMS**	**0.122**	**6.0**	**3.47**	**This work**
Biochar	**0.2**	**BPA**	**0.0439**	**PDS**	**0.093**	**6.0**	**1.42**	**This work**

Table S2 Elemental Compositions of As-prepared Biochars

Pyrolysis temperature	Elemental percentage (%)				
°C	C	H	N	O	Total
400	64	4	12	18	98
600	68	3	11	17	99
800	71	3	10	15	99

Table S3 Main Metals in the Sewage Sludge

	Ca	Mg	Al	Fe	Cu	Zn	Total
Amount (%)	1.21	0.53	1.95	0.42	0.39	0.48	4.98

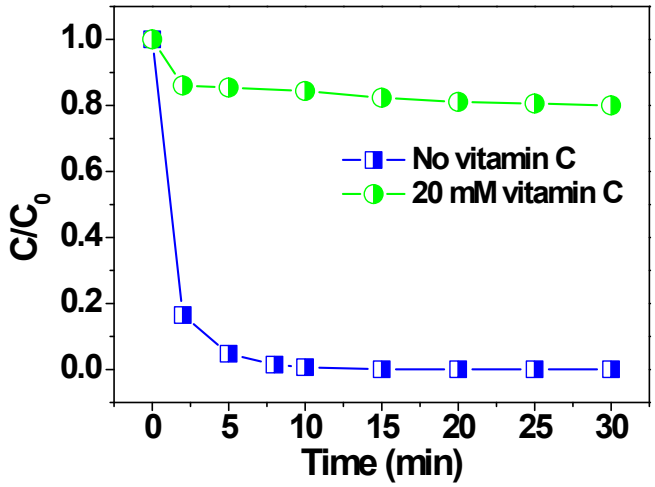

Figure S1. Effectiveness of vitamin C in terminating BPA degradation reaction. Experimental conditions: 0.2 g/L biochar, 0.1 g/L PMS, 10 mg/L BPA in 0.1 M phosphate buffer (pH=6.0).

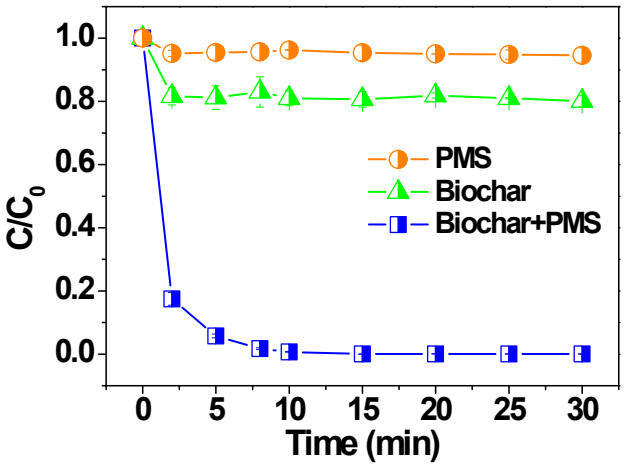

Figure S2. The contribution of biochar adsorption and PMS auto-decomposition to the overall BPA removal efficiency. Experimental conditions: 0.2 g/L biochar, 0.1 g/L PMS, 10 mg/L BPA in 0.1 M phosphate buffer (pH=6.0).

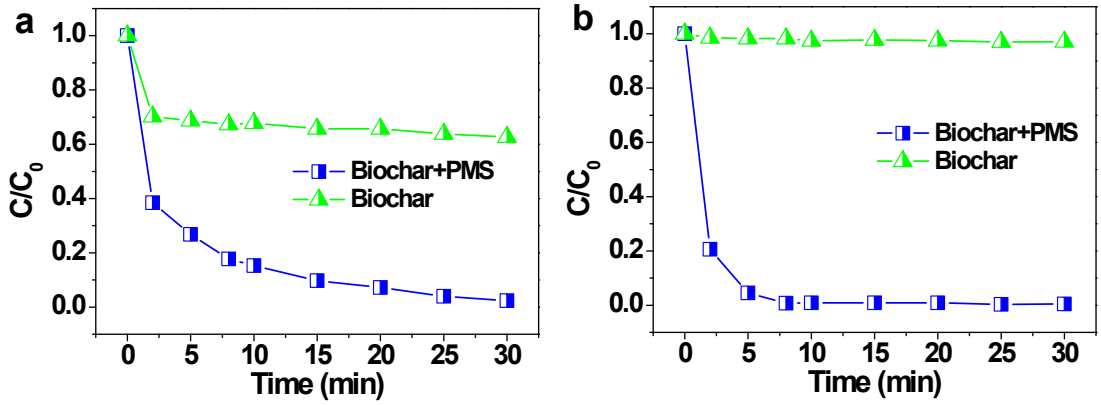

Figure S3. Catalytic activity of the biochar toward PMS for degradation of Rhodamin B (a) and phenol (b). Experimental conditions: 0.2 g/L catalyst, 0.1 g/L PMS, and 10 mg/L BPA in 0.1 M phosphate buffer (pH 6.0).

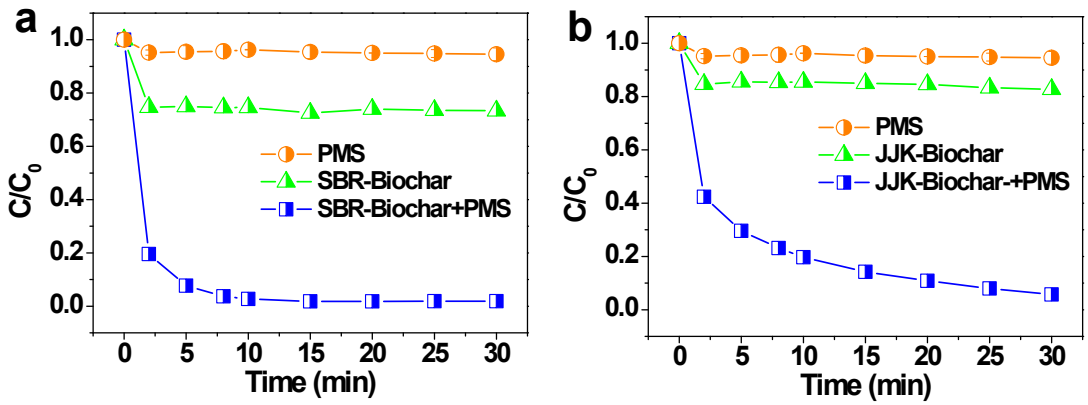

Figure S4. BPA degradation with biochars originated from bench-scale sequencing batch reactor (a) and Jinkai Wastewater Treatment Plant (b). Experimental conditions: 0.2 g/L catalyst, 0.1 g/L PMS, and 10 ppm initial BPA in 0.1 M phosphate buffer (pH 6.0).

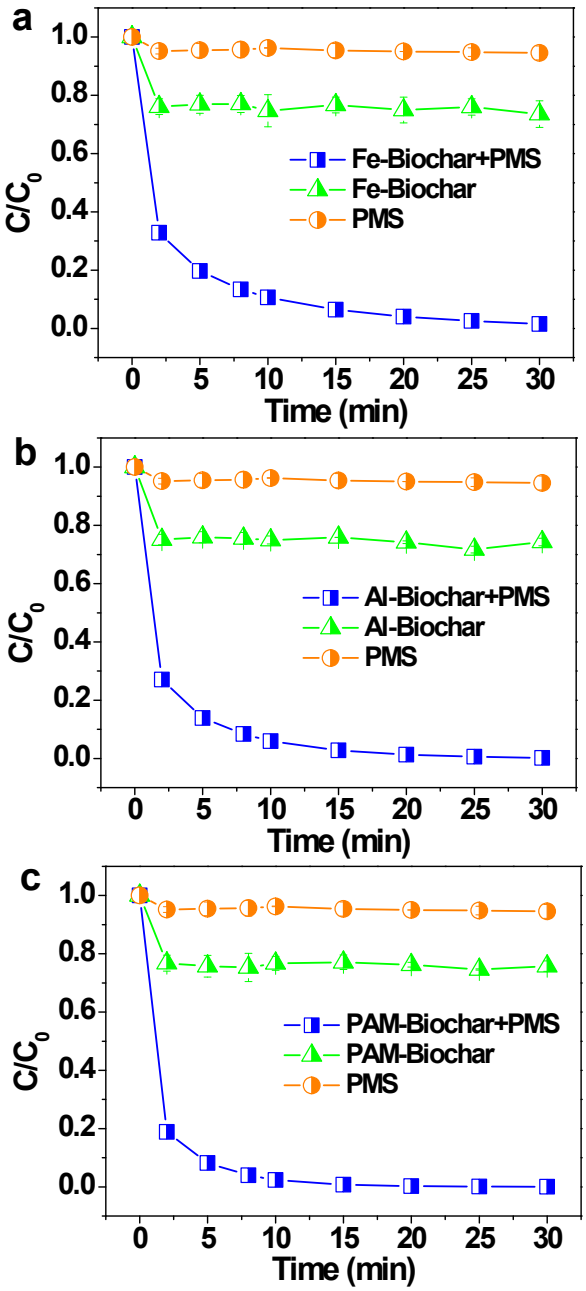

Figure S5. BPA degradation performance by using the biochars originated from the coagulant-pretreated sludge. 3 mg Fe^{3+}/g sludge (a), 3 mg Al^{3+}/g sludge (b), and 1 mg polyacrylamide/g sludge (c). BPA degradation conditions: 0.2 g/L catalyst, 0.1 g/L PMS, and10 mg/L BPA in 0.1 M phosphate buffer (pH 6.0)

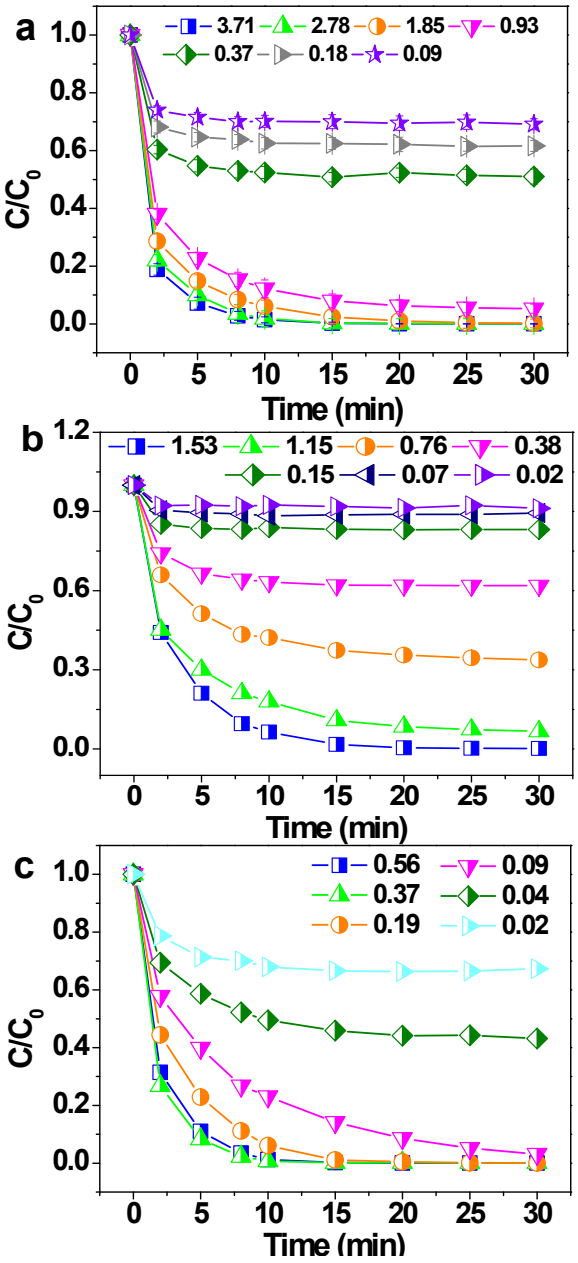

Figure S6. Effects of PMS dosage ([PMS]/[Pollutant]) on BPA (a) and phenol (b) removal and influences of PDS ([PDS]/[BPA]) dosages (c) on BPA removal. Experimental conditions: 0.2 g/L catalyst and 10 mg/L pollutants in 0.1 M phosphate buffer (pH 6.0).

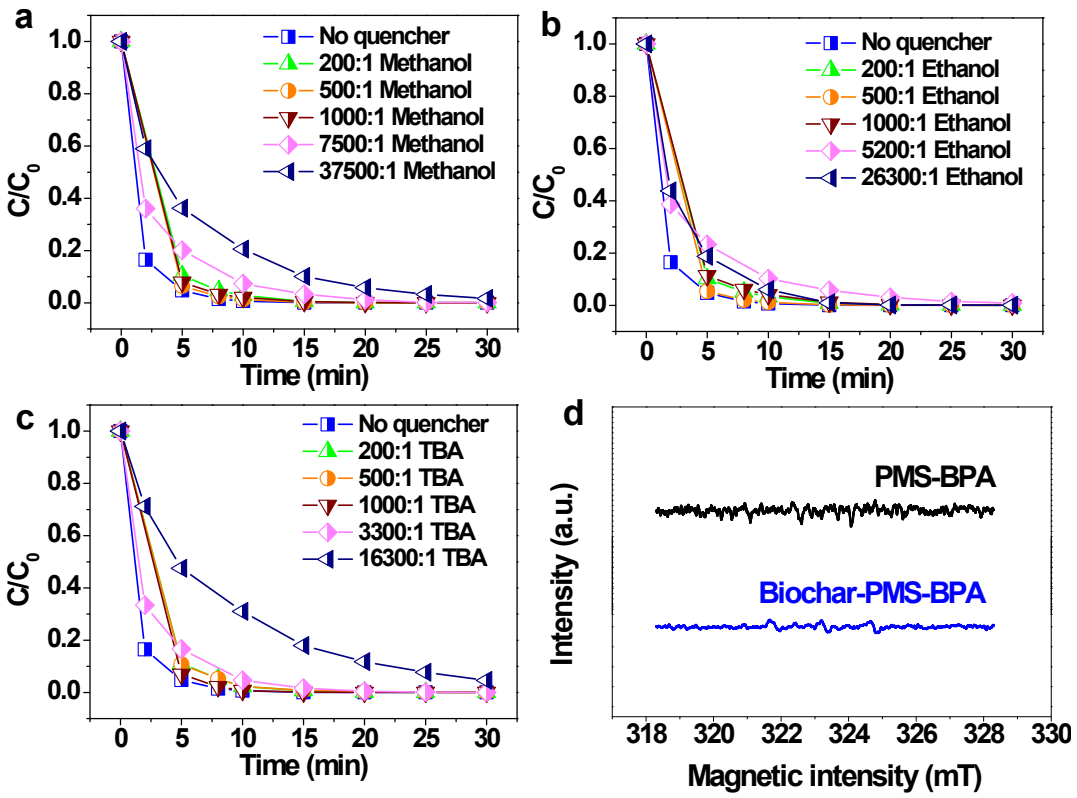

Figure S7. BPA removal performance in the presence of different mole ratios of methanol (a), ethanol (b), tert-butyl alcohol (c) to PMS. Electron spin resonance analysis by using 5,5-dimethylpyrroline-N-oxide as trapping agent (d). Experimental conditions: 0.2 g/L catalyst, 0.1 g/L PMS, and 10 mg/L BPA in 0.1 M phosphate buffer (pH 6.0).

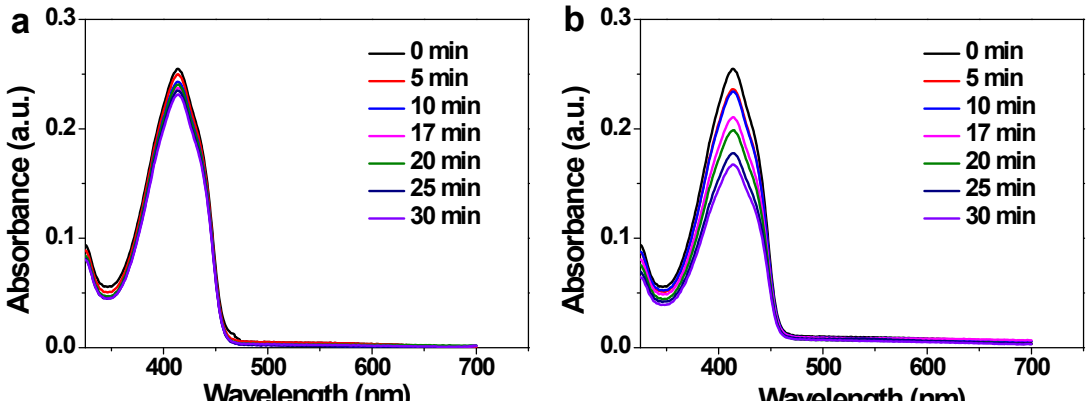

Figure S8. Absorption spectra of DPBF after dose of PMS (a) and biochar (b) into solution.

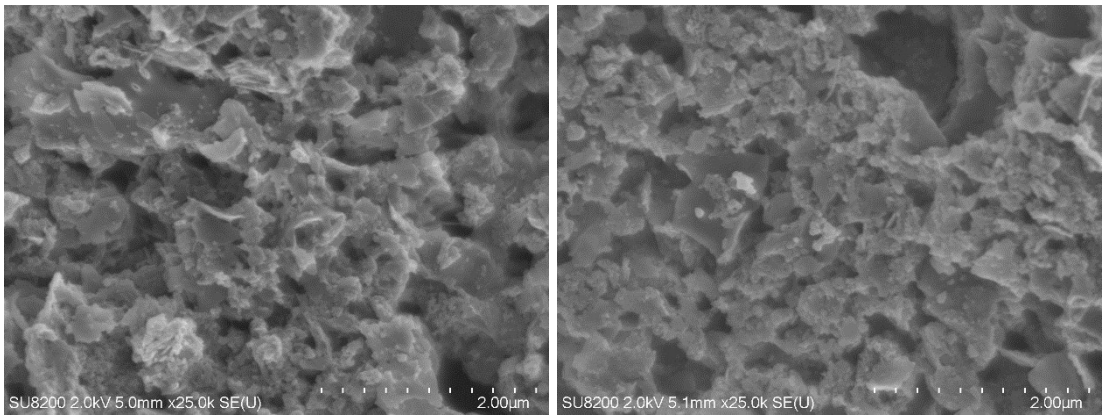

Figure S9. SEM images of the prepared biochar.

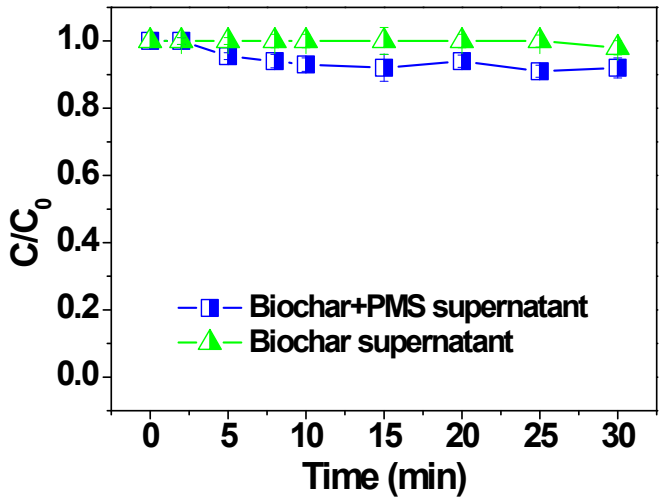

Figure S10. The impacts of supernatant derived from different reaction systems on BPA removal.

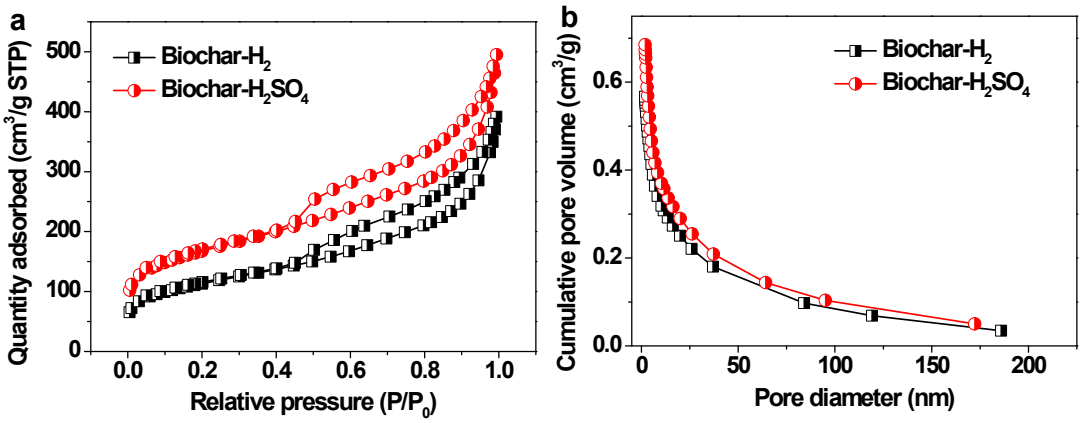

Figure S11. Nitrogen adsorption-desorption isotherms (a) and pore size distributions (b) of the biochars with different chemical treatments.

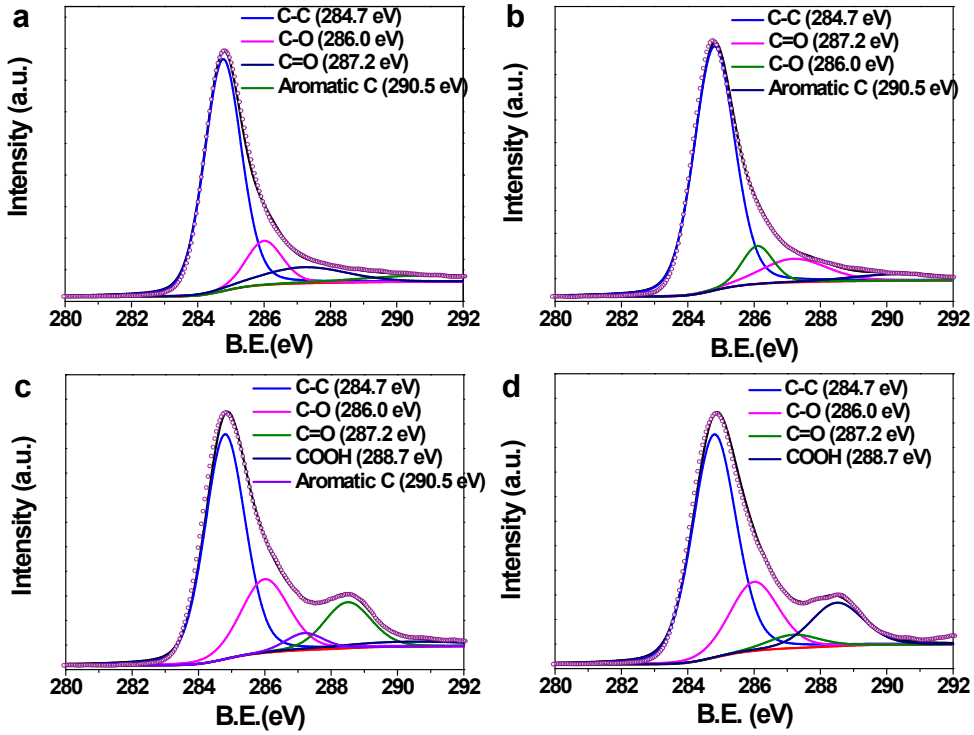

Figure S12. XPS spectra of C1s of the biochars treated with H_2 (a), N_2H_4 (b), strong H_2SO_4 (c), and strong HNO_3 (d).

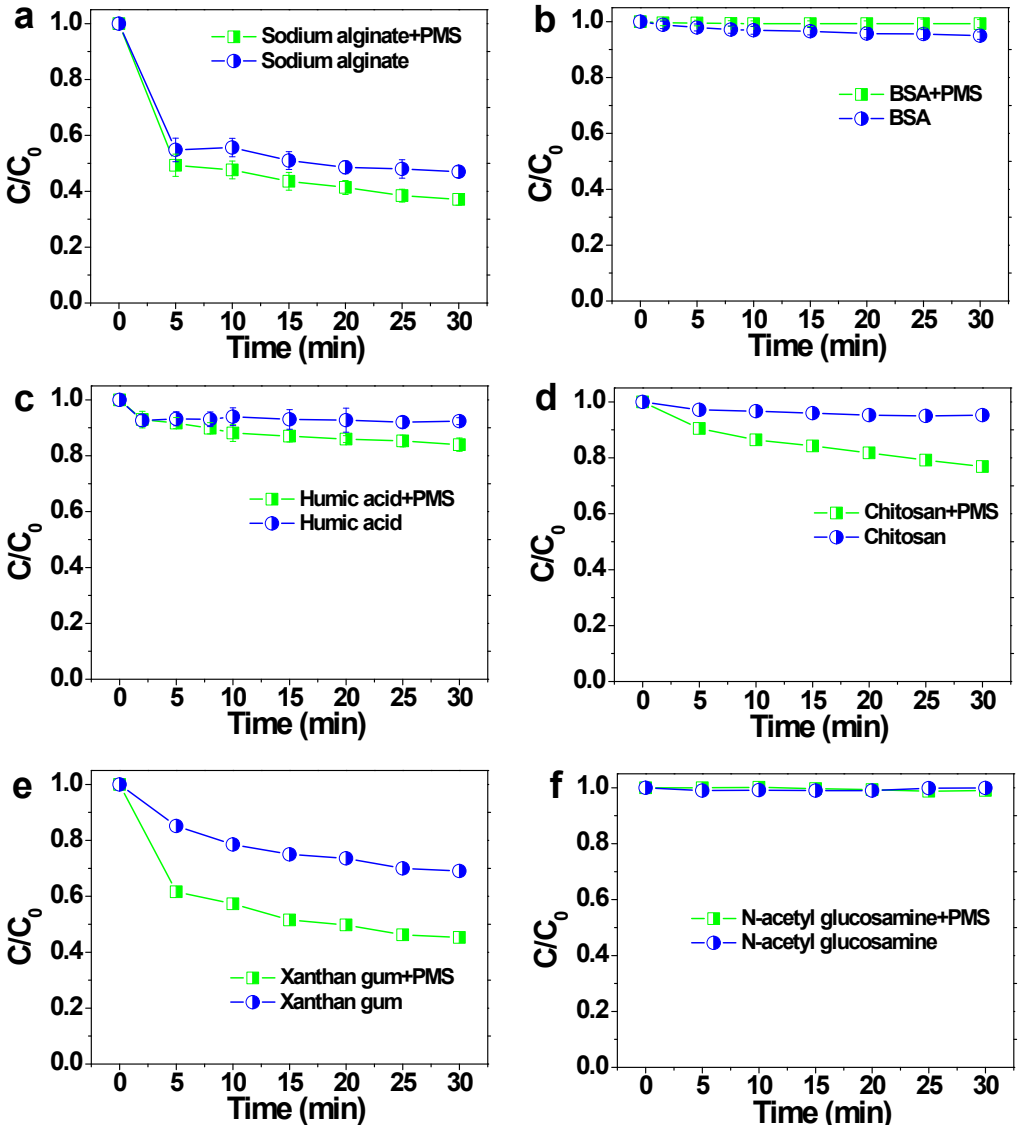

Figure S13. BPA removal performance by using sludge analogous components obtained as a catalyst to activate PMS. Experimental conditions: 0.2 g/L catalyst, 0.1 g/L PMS, and 10 mg/L BPA in 0.1 M phosphate buffer (pH 6.0).

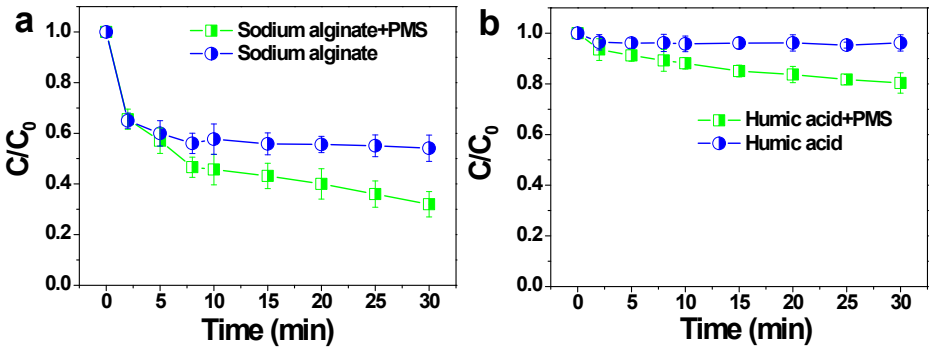

Figure S14. Effects of pre-mixing metals with sodium alginate (a) and humic acid (b) on the product's catalytic ability toward PMS to degrade BPA. Experimental conditions: 0.2 g/L catalyst, 0.1 g/L PMS, and 10 mg/L BPA in 0.1 M phosphate buffer (pH 6.0).

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