Supplementary data

Recovery NH_4^+-N and PO_4^{3-}-P from urine using sludge-derived biochar as a fertilizer: Performance and Mechanism

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Table S1 Basic properties of soils.

pH	Organic matter（g/kg）	Total Pb （mg/kg）	Total Cd （mg/kg）	Toatal Cr（mg/kg）
6.12	32.51	10.23	0.51	3.64

Table S2 The fitting parameters of Intra-particle diffusion model.

		Intra-particle diffusion model								
		k_1	C_1	R^2_1	k_2	C_2	R^2_2	k_3	C_3	R^2_3
NH+4-H	BS300	2.88	12.71	0.999	1.67	26.21	0.989	0.07	62.13	0.972
	BS400	3.77	14.47	0.971	2.13	27.79	0.989	0.06	78.86	0.948
	BS500	3.58	19.32	0.980	1.94	36.90	0.998	0.27	76.91	0.956
	BS600	4.33	16.61	0.979	1.98	52.05	0.991	0.29	94.32	0.992
PO3-4-P	BS300	0.80	2.58	0.982	0.88	0.19	0.999	0.06	19.03	0.913
	BS400	0.84	4.67	0.992	0.54	8.80	0.957	0.06	20.27	0.896
	BS500	1.12	8.27	0.988	0.57	12.61	0.955	0.02	25.10	0.965
	BS600	1.13	11.01	0.988	0.56	16.72	0.999	0.05	28.21	0.999

Table S3 Comparison of the adsorption capacity of different biochar for Ni(II)

		Pyrolysis temperature	Experimental conditions	Q_{max}	References
Biochar derived from *Erythrina Variegate*	NH_4^+-H	700	pH=7.0, 303 K, Aqueous solution	3.03	1
	PO_4^{3-}-P	700	pH=7.0, 303 K, Aqueous solution	3.05	
Unfermented sludge based biochar	NH_4^+-H	700	/，298K，Aqueous solution	11.91	2
	PO_4^{3-}-P	700	/，298K，Aqueous solution	9.32	
Fermented sludge based biochar	NH_4^+-H	700	/，298K，Aqueous solution	22.04	2
	PO_4^{3-}-P	700	/，298K，Aqueous solution	8.17	
α-Fe_2O_3 and activated carbon	PO_4^{3-}-P	/	pH=6.8，298K, Urine	5.87	3
Bamboo leaf biochar	NH_4^+-H	600	/，298K, Aqueous solution	22.92	4
	PO_4^{3-}-P	600	/，298K, Aqueous solution	37.34	
Panda manure biochar	NH_4^+-H	600	/，298K, Aqueous solution	37.34	4
	PO_4^{3-}-P	600	/，298K, Aqueous solution	62.99	
BS600	NH_4^+-H	600	pH=6.92，298K, Urine	114.71	This work
	PO_4^{3-}-P	600	pH=6.92，298K, Urine	30.29	

Table S4 Content of heavy metals in pakchoi cabbage (mg/kg).

	Pb	Cr	Cd	As	Ni	Zn	Cu
BS300	0.08	0.06	ND	ND	ND	1.67	0.86
BS400	0.02	ND	ND	ND	ND	1.01	0.75
BS500	ND	ND	ND	ND	ND	0.77	0.44
BS600	ND	ND	ND	ND	ND	0.34	0.06
Adsorbed BS300	0.03	0.01	ND	ND	ND	1.12	0.77
Adsorbed BS400	0.01	ND	ND	ND	ND	0.86	0.54
Adsorbed BS500	ND	ND	ND	ND	ND	0.51	0.15
Adsorbed BS600	ND	ND	ND	ND	ND	0.11	ND
Vegetable heavy metal content testing standards (GB14935-94)	0.2	0.5	0.05	0.5	0.6	20	10

ND = No detected.

Table S5 Leaching concentration of heavy metals in soil after pot experiment (mg/L)

Soil sample	Pb	Cr	Cd	As	Ni	Zn	Cu
BS300	1.39	1.02	0.15	0.37	0.51	7.98	5.57
BS400	1.08	0.67	0.03	ND	0.23	4.39	2.73
BS500	0.51	0.22	ND	ND	ND	2.64	1.05
BS600	0.12	0.01	ND	ND	ND	1.58	0.34
Adsorbed BS300	1.01	0.94	0.05	0.13	0.24	6.68	5.54
Adsorbed BS400	0.74	0.35	ND	ND	0.03	2.48	3.19
Adsorbed BS500	0.24	0.11	ND	ND	ND	1.21	1.24
Adsorbed BS600	0.05	ND	ND	ND	ND	0.56	0.21
Identification standards for hazardous wastes-Identification for extraction toxicity (GB 5085.3-2007)	5	15	1	5	5	100	100

ND = Not detected.

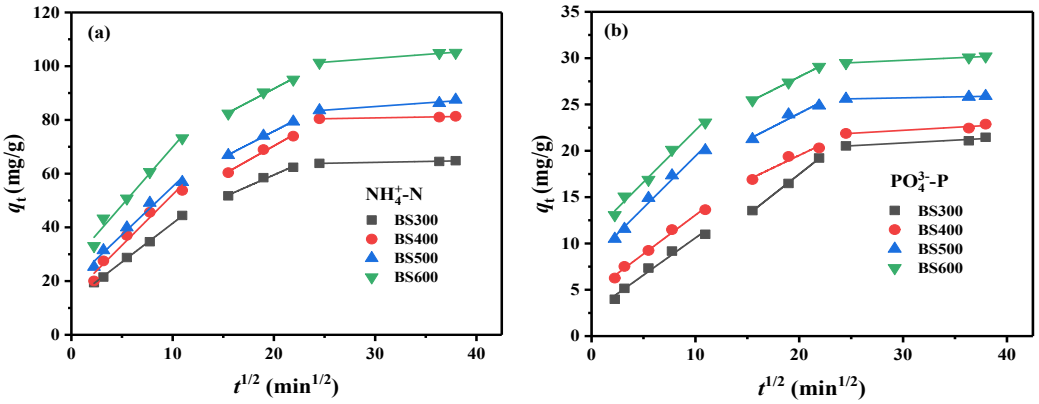

Fig. S1 Intra-particle diffusion model of sludge-derived biochar for NH+ 4-N (a) and PO3- 4-P (b) removal.

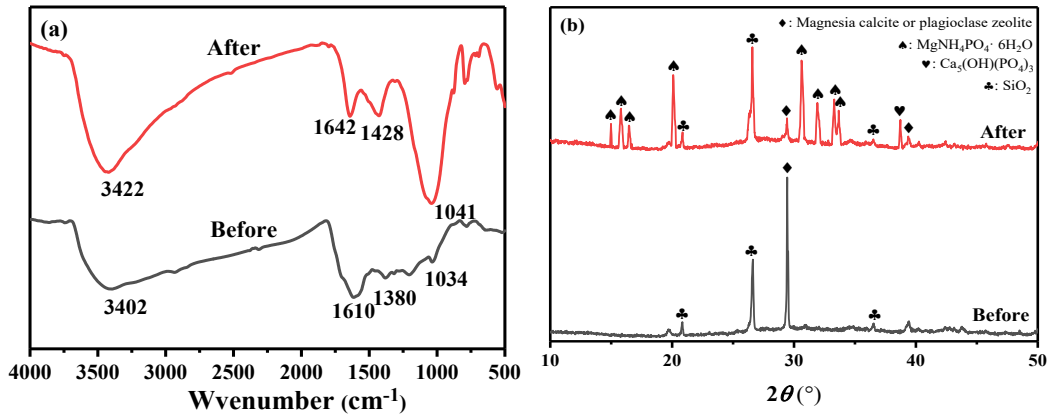

Fig. S2 FTIR (a) and XRD (b) analysis of BS600 after adsorption of NH+ 4-N and PO3- 4-P form urine.

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