Supplementary material

Supplementary materials captions

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Table S1 Elementar compositon of the materials (wt%)

Sample	C	O	Mg	Al	Si	Cl	K	P	Ca	Ti	Mn	Fe	Zn
In natura	15.54	59.91	0.21	10.03	9.16	0.13			0.32	0.26	0.14	4.30	
80	11.58	59.48	0.18	11.46	8.76	0.15			0.36	0.50	0.17	7.06	0.30
200	10.05	54.93	0.44	17.63	15.66	0.32	0.29		0.72	0.58	0.33	10.53	
500	9.59	60.67	0.19	11.18	10.14			0.33	0.50	0.32	0.36	6.71	
500 + KOH	4.81	61.88	0.31	14.59	17.56		0.66		0.49	1.48	0.56	38.66	

Table S2 Al, Fe, and Mn leaching from the adsorbent under different pH conditions

		Al (mg/L)	Fe (mg/L)	Mn (mg/L)
In natura	pH 5	<LOQ	< LOQ	0.65
	pH 7	0.17	<LOQ	0.68
	pH 9	0.73	<LOQ	0.14
80	pH 5	<LOQ	<LOQ	0.49
	pH 7	0.25	<LOQ	0.15
	pH 9	<LOQ	0.12	0.47
200	pH 5	<LOQ	0.09	1.00
	pH 7	<LOQ	0.08	0.78
	pH 9	<LOQ	<LOQ	0.90
500	pH 5	ND	<LOQ	0.19
	pH 7	ND	<LOQ	0.18
	pH 9	ND	0.12	0.18
500 + KOH	pH 5	<LOQ	<LOQ	<LOQ
	pH 7	<LOQ	<LOQ	<LOQ
	pH 9	<LOQ	<LOQ	<LOQ

LOQ: limit of quantification (Al: 0.17 mg/L; Fe: 0.03 mg/L; Mn: 0.06 mg/L)

ND: not detected

Table S3 Results of the 2^{5-1} fractional factorial design for Mn adsorption

Factor/interaction	Degrees of Freedom	F-value	p-value
Model	16	479.49	0.036
Linear	5	750.33	0.028
pH	1	284.01	0.038
Adsorbent dose (g)	1	17.01	0.151
Mn concentration (mg/L)	1	1485.13	0.017
Time (min)	1	1540.13	0.015
Temperature (ºC)	1	425.35	0.039
Interaction pH × Mn concentration	1	1065.68	0.019
Interaction pH × time	1	666.13	0.025
Interaction time × temperature	1	300.13	0.037
Curvature	1	1876.54	0.015
Error	1	—	—

Table S4 Kinetic parameters for manganese adsorption (initial concentration 0.58 mg/L, 0.5 g adsorbent, 25 °C)

Parameters	
t (min)	720
$*q_{e,exp}$	0.04 mg/g
	Pseudo-first order
$**q_e$	0.0346
k_1	0.0053
R^2	0.5264
	Pseudo-second order
$**q_e$	0.0435
k_2	0.180 g/mg min
R^2	0.9726

$*q_{e,exp}$: experimental equilibrium adsorption capacity (mg/g); $**q_e$: calculated equilibrium adsorption capacity (mg/g).