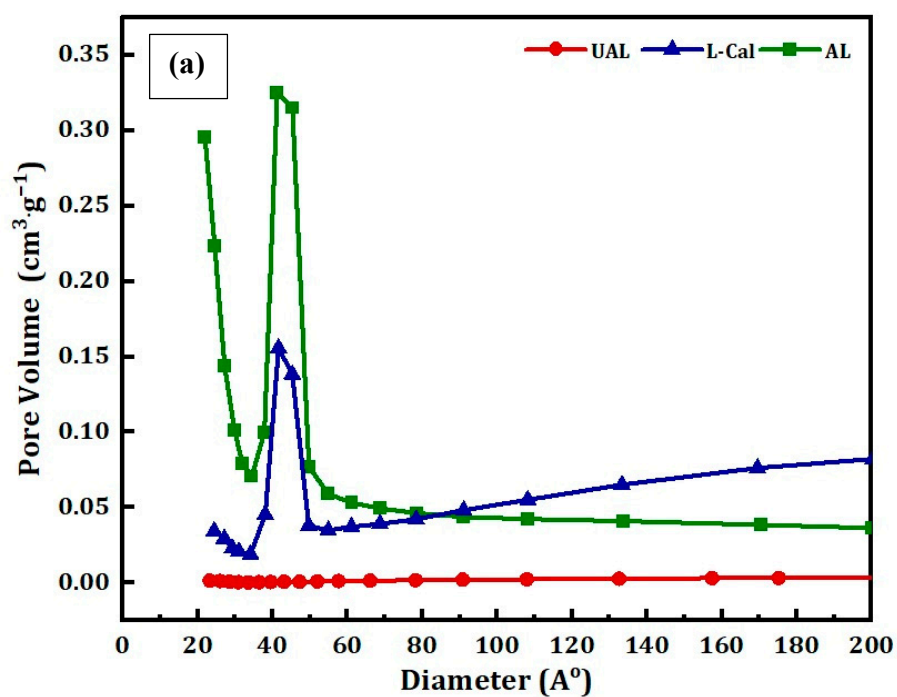
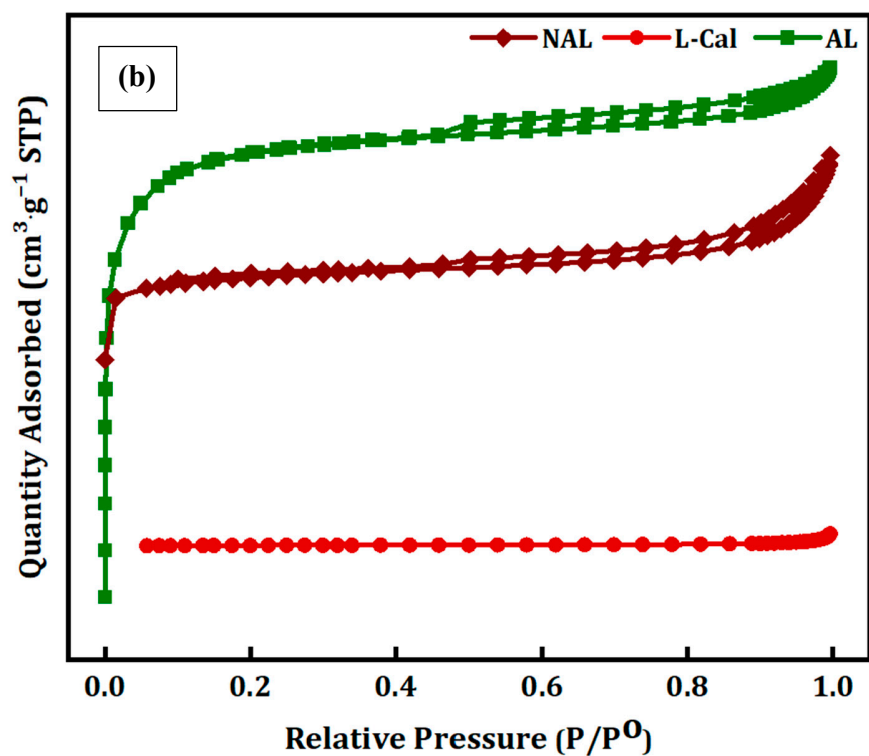
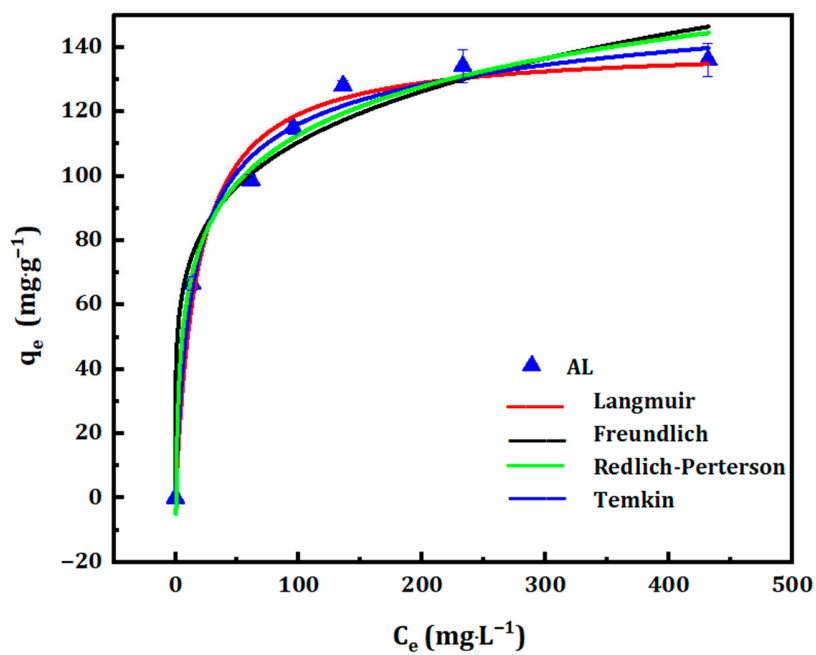


**Figure S1:** Experimental determination of pHpzc.

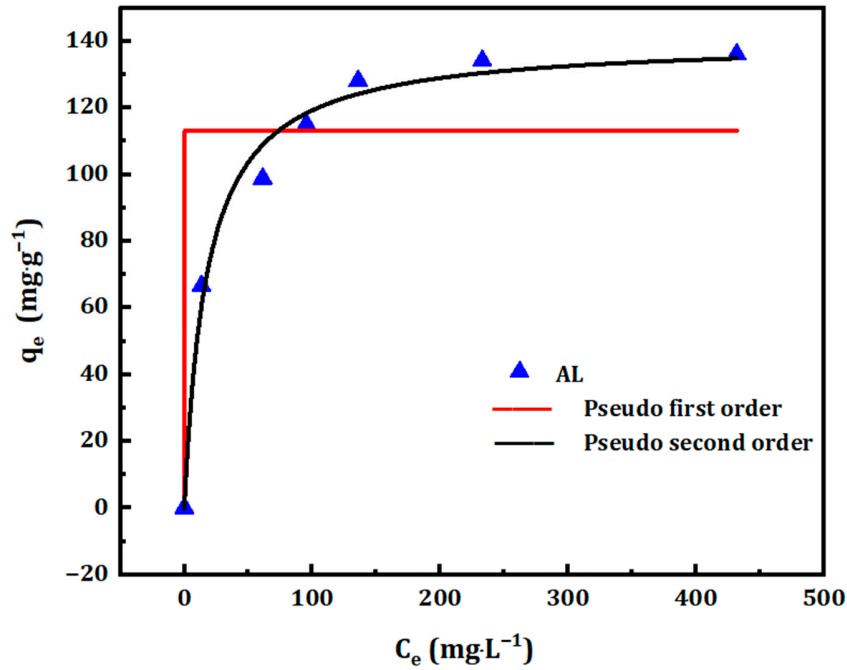




**Figure S2:** (a) Pore size distribution of the synthesized samples and (b) Nitrogen physisorption isotherms.



**Figure S3:** Nonlinear fitting of adsorption isotherm models.



**Figure S4:** Nonlinear fitting of adsorption kinetic models.

**Table S1:** Langmuir, Freundlich, Redlich-Peterson and Temkin Isotherm Constants for the AL

CM Samples	Langmuir Constants			Freundlich Constants		
	$Q_{\max}$ (mg·g <sup>-1</sup> )	$K_L$ (L·mg <sup>-1</sup> )	$R^2$	$1/n$	$K_F$ (mg <sup>1-1/n</sup> ·L <sup>1/n</sup> ·g <sup>-1</sup> )	$R^2$
AL	140.36	0.056	0.987	0.19	45.82	0.976
	Redlich-Peterson Constants			Temkin Constants		
	$B$	$A$	$R^2$	$B$	$A$	$R^2$
AL	0.93	0.12	0.992	21.613	1.852	0.987

**Table S2:** Pseudo-first-order and Pseudo-second-order Constants for the AL

Kinetics Model	$q_{\text{theo.}}$	K	$R^2$
Pseudo-first-order	113.1	21.7	0.755
Pseudo-second-order	140.36	0.0004	0.987

**Table S3:** Comparison of Various Adsorbent-Based Hydrochars Prepared by the HTC Process for their Lead (II) Removal

Adsorbent	pH	Adsorbent dosage (g·L <sup>-1</sup> )	Concentrations used (mg·L <sup>-1</sup> )	Equilibrium time (hr)	$q_{\max}$ (mg g <sup>-1</sup> )	Advantages	Limitations	Reference
Canola straw	6.3	0.4	0, 50, 75, 100, 150, 200	3	24.4	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ &gt; 80% of lead(II) adsorption occurred in the first 3 h</li> <li>▪ Production temperature is low (180 °C)</li> <li>▪ The yield is relatively high (60.5%)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low surface area (4.4 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Low adsorption capacity</li> </ul>	[22]
Wheat straw	5.4	0.4	0, 50, 75, 100, 150, 200	3	9.94	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ &gt; 80% of lead(II) adsorption occurred in the first 3 h</li> <li>▪ Production temperature is low (180 °C)</li> <li>▪ High yield (69.5%)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low surface area (4.5 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Not suitable for lead removal due to low adsorption capacity</li> </ul>	[22]
Sawdust of white spruce	3.3	0.4	0, 50, 75, 100, 150, 200	3	7.69	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ &gt; 80% of lead(II) adsorption occurred in the first 3 h</li> <li>▪ Production temperature is relatively low (240 °C)</li> <li>▪ The yield is relatively high (54.5%)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low surface area (30.6 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Not suitable for lead removal due to low adsorption capacity</li> </ul>	[22]
Manure pellet	5.5	0.4	0, 50, 75, 100, 150, 200	3	23.8	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ &gt; 80% of lead(II) adsorption occurred in the first 3 h</li> <li>▪ Production temperature is low (180 °C)</li> <li>▪ High yield (67.5%)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low surface area (11.7 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Low adsorption capacity</li> </ul>	[22]
<i>Crocus sativus</i> petals	5	0.5	50,75,100, 125, 150, 175, 200	11.5	89.5	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ High surface area (862.4 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low yield (21%)</li> <li>▪ High activation temperature (800 °C)</li> </ul>	[23]
Paulownia leaves	5	1	0, 30, 50, 70, 100, 150, 200, 300, 400, 500	25	174.8	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (220 °C)</li> <li>▪ Good adsorption capacity</li> </ul>		[16]
Grape pomace	5	0.5	40–180	3	137	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (220 °C)</li> </ul>		[24]

						<ul style="list-style-type: none"> <li>▪ Good adsorption capacity</li> </ul>		
<i>Laminaria japonica</i>		1	10–200	6	108	<ul style="list-style-type: none"> <li>▪ Production temperature is relatively low (200 °C)</li> <li>▪ Short residence time (45 min)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low yield (&lt; 27%)</li> <li>▪ Low surface area (2.23 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	[58]
Sawdust	5		10–200	1	92.8	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (260 °C)</li> <li>▪ Good adsorption capacity</li> </ul>		[59]
Lincomycin residue	5-6	1.33	10, 50, 100, 150, 200	4	57.4	<ul style="list-style-type: none"> <li>▪ Production temperature is relatively low (210 °C)</li> <li>▪ Short residence time (60 min)</li> <li>▪ Acceptable adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Medium yield (45%)</li> </ul>	[60]
Soybean	4	1.33	10–200	3	104	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (210 °C)</li> <li>▪ High yield (90%)</li> <li>▪ Good adsorption capacity</li> </ul>		[61]
Chitosan	4	1.33	10–200	3	86.2	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (210 °C)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Medium yield (41%)</li> </ul>	[61]
Oil-tea camellia shells	3–6	0.4	10–480	5	476	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ High adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Two steps of the heating process (600 °C for 1 h and 120 °C for 6 h)</li> </ul>	[62]
<i>Camellia sinensis</i>	5	1	100	6	143.9	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (240 °C)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Medium yield (51%)</li> </ul>	[63]
<i>Camellia sinensis</i>	5	1	0, 150, 300, 450, 600, 750, 900	24	198.7	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (240 °C)</li> <li>▪ Short residence time (2 h)</li> <li>▪ High adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low yield (35%)</li> <li>▪ Low surface area (18.7 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	[64]

Fresh banana peels	6	4	5–1000	5.5	241	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (230 °C)</li> <li>▪ Short residence time (2 h)</li> <li>▪ High adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low yield (29%)</li> <li>▪ Low surface area (31.5 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	[25]
Fresh banana peels	6	1	30, 60, 90, 120, 150, 180, 200, 250, 300, 350, 400, 500, 600, 700	12	238	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (200 °C)</li> <li>▪ Short residence time (2 h)</li> <li>▪ High adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low yield (26%)</li> <li>▪ Low surface area (47.2 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	[26]
Sludge	5–6	0.6	75, 100, 150	12.5	174	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (180 °C)</li> <li>▪ Short residence time (2 h)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low yield (26%)</li> <li>▪ Long residence time (10 h)</li> <li>▪ Low surface area (47.2 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	[65]
Sewage sludge	4.3	0.5	0–100	12.5	62.4	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is low (120 °C)</li> <li>▪ Acceptable adsorption capacity</li> </ul>		[66]
<i>Eupatorium adenophorum</i>	6	2	50, 100, 200, 300, 400, 500, 600, 800	2.5	165	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (220 °C)</li> <li>▪ Short residence time (1 h)</li> <li>▪ Good adsorption capacity</li> </ul>		[67]
Natural honey	5	0.2	100–700	15	133.2	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (180 °C)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Two long steps of the heating process (180 °C for 24 h and 300 °C for 20 h)</li> </ul>	[68]
Enteromorpha	8.1	30	0.2, 0.5, 0.8, 1, 2, 3, 5, 8	0.18	0.098	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (250 °C)</li> <li>▪ Short residence time (40 min)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Low surface area (29.7 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	[69]
Areca nut husks	6	0.1	0, 25, 50, 100		79.9	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (250 °C)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Long residence time (9 h)</li> </ul>	[70]

						<ul style="list-style-type: none"> <li>▪ Short residence time (40 min)</li> <li>▪ Good yield (59%)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Very low surface area (0.98 m<sup>2</sup> g<sup>-1</sup>)</li> </ul>	
Longan fruit exocarp	5.5	5	25, 50, 70, 90, 100, 150	6	22.7	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (300 °C)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Long residence time (24 h)</li> <li>▪ Low yield (35.89%)</li> <li>▪ Low surface area (10.76 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Low adsorption capacity</li> </ul>	[71]
Date palm leaves	5	1	500–800	0.5	74.5	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ Production temperature is relatively low (300 °C)</li> <li>▪ High yield (73%)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Long residence time (7 h)</li> </ul>	[72]
Palm date-activated leaflets (AL)	6	0.5	50-500	1	136	<ul style="list-style-type: none"> <li>▪ Abundantly available</li> <li>▪ High surface area (808 m<sup>2</sup> g<sup>-1</sup>)</li> <li>▪ Production temperature is relatively low (230 °C)</li> <li>▪ Good adsorption capacity</li> </ul>	<ul style="list-style-type: none"> <li>▪ Long residence time (8 h)</li> </ul>	This work