Supplementary Materials

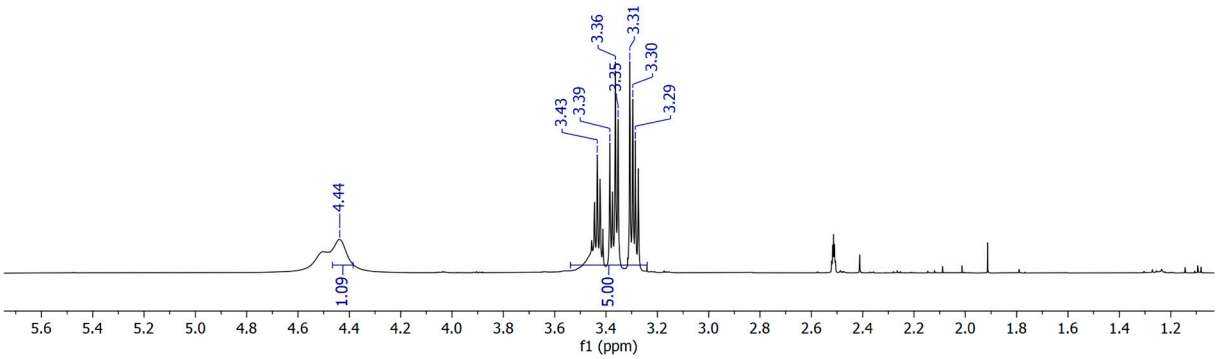


Figure S1. ^{1}H-NMR spectra (50 mg/ml in DMSO-d6) of acetone-soluble fraction extracted from the spent biomass ZDR.

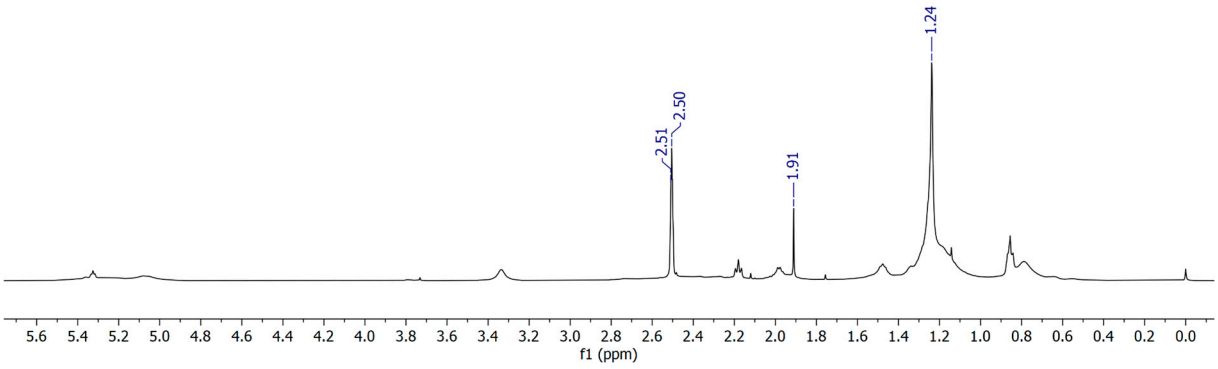


Figure S2. ^{1}H-NMR spectra (50 mg/ml in $CDCl_3$) of acetone-soluble fraction extracted from the spent biomass PPR.

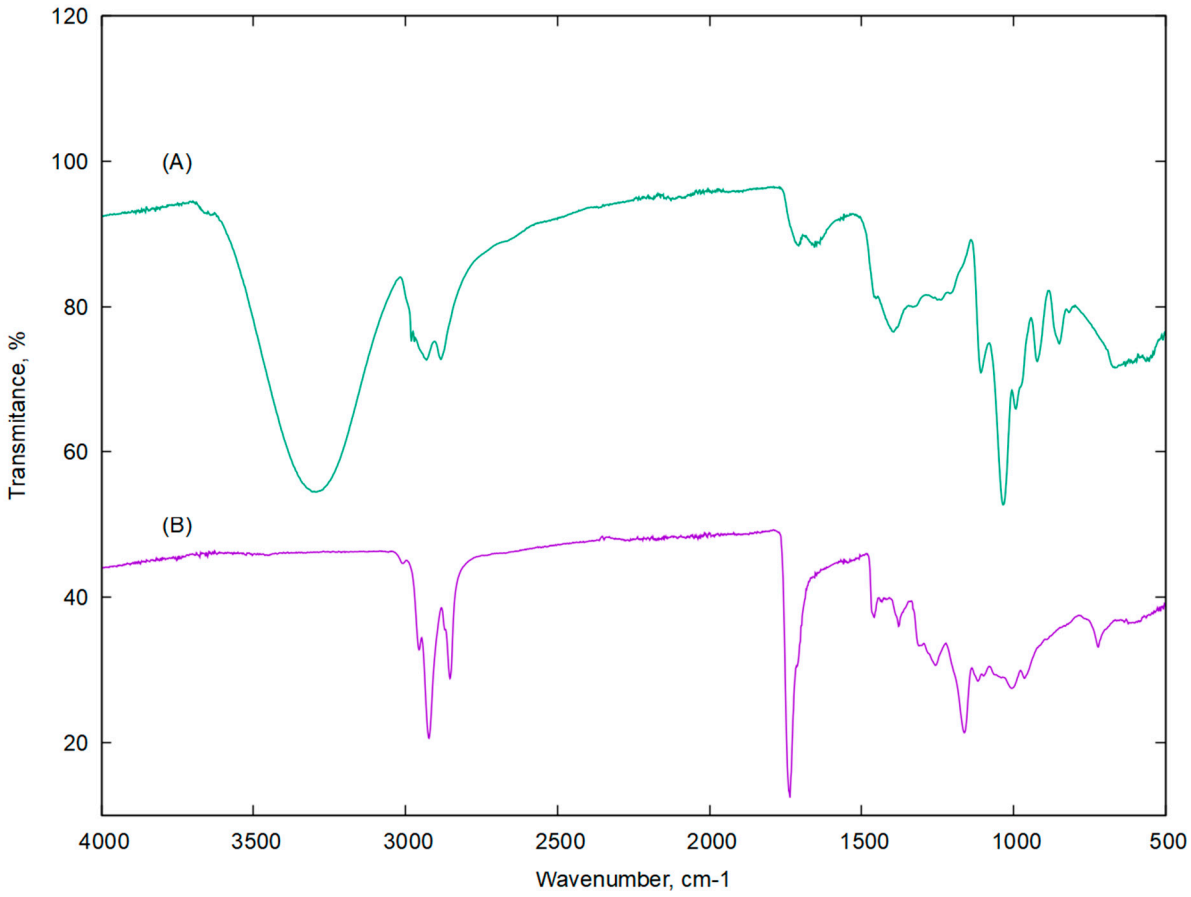


Figure S3. FTIR spectra of acetone-soluble fraction extracted from the spent biomass (A) ZDR; (B) PPR.

Table S1. Amino acids profile (mg/g) of the spent biomass ZDR and PPR

Amino acid	ZDR	PPR
Asp	52.0	48.2
Thr	25.8	25.3
Ser	18.9	18.3
Glu	63.5	72.3
Pro	18.2	19.7
Gly	27.1	28.1
Ala	38.4	41.2
Cys. acid	7.90	5.39
Val	29.4	29.4

Sulf met	26.5	13.0
Ile	24.3	19.8
Leu	43.5	42.8
Tyr	15.7	15.7
Phe	20.2	20.3
His	12.7	11.0
Lys	27.7	34.7
Arg	32.3	32.7
Trp	17.5	17.7

Table S2. Parameters for Langmuir, Freundlich and Temkin isotherm models

	Cd^{2+}				**Pb^{2+}**			
Parameters	**ZDR**	**ZDE**	**PPR**	**PPE**	**ZDR**	**ZDE**	**PPR**	**PPE**
Langmuir								
R^2	0.3115	0.1704	0.8763	0.9286	0.9900	0.8798	0.8640	0.8707
q_{max} (mg/g)	213.33	667.90	231.76	202.35	153.18	173.49	172.10	173.85
K_l (dm^3/g)	0.0025	0.0004	0.0016	0.0023	0.1102	0.0046	0.0064	0.0051
Freundlich								
R^2	**0.9961**	**0.9784**	**0.9856**	**0.9942**	**0.9967**	**0.9794**	**0.9822**	**0.9808**
1/n	0.9977	0.9280	0.8094	0.7408	0.2595	0.6436	0.5791	0.6197
$K_F(mg^{1-(1/n)}(dm^3)^{1/n}g^{-1})$	0.3166	0.3212	0.7314	1.1972	38.587	2.5852	4.1795	3.0740
Temkin								
R^2	0.9328	0.7714	0.9439	0.9357	0.9557	0.9078	0.8829	0.8930
K_T (dm^3/g)	0.0255	0.0502	0.0318	0.0405	18.1928	0.0686	0.1056	0.0793
B_T	52.455	94.8358	70.7432	72.4380	144.927	74.5844	78.0974	75.8684

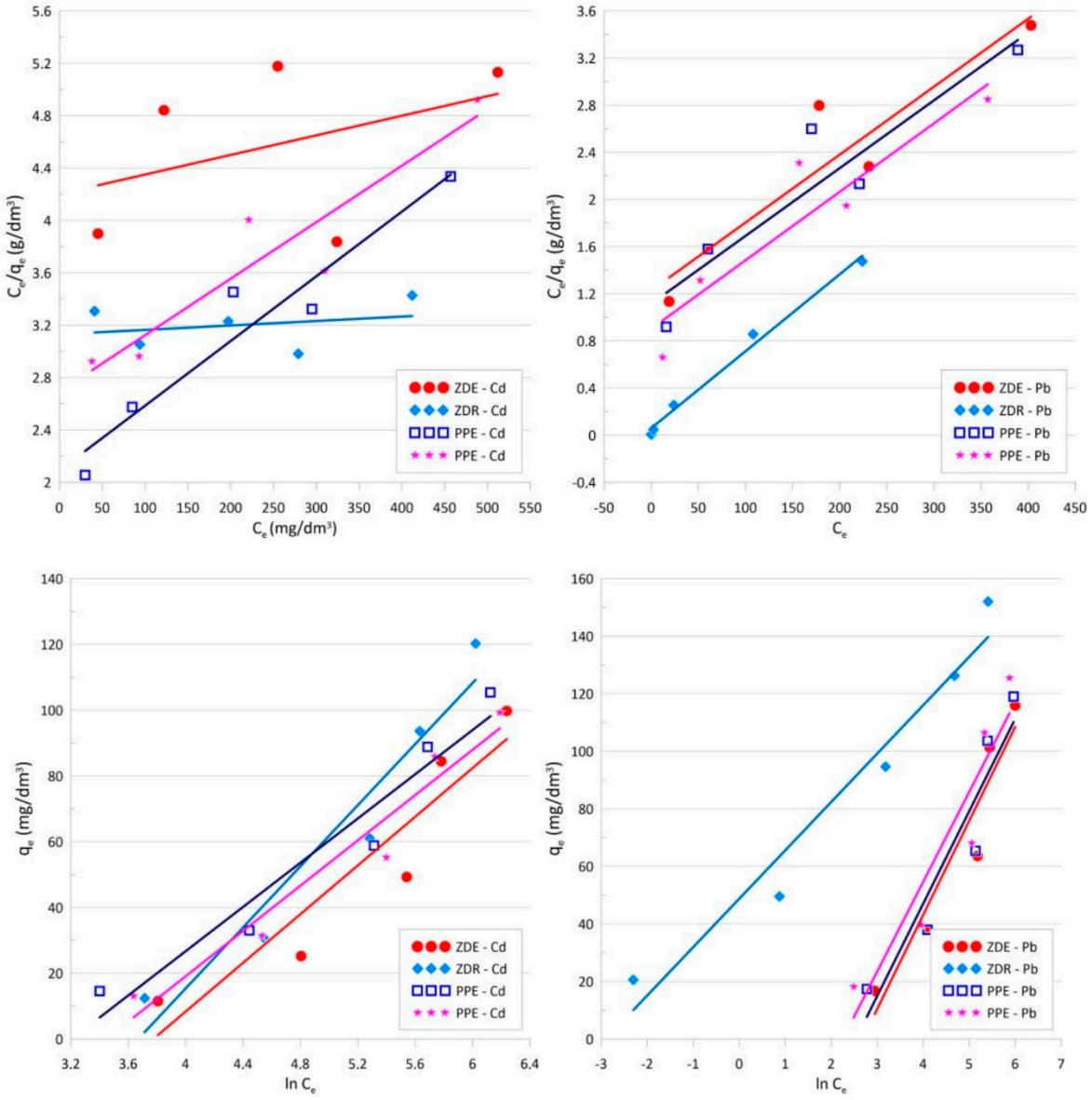


Figure S4. The graphs of the Langmuir and Temkin isotherm models for both Cd2+ and Pb2 for all used biomass.

Table S3. Parameters for pseudo-first-rate order model, pseudo-second-rate order model and Weber- Morris kinetic model

parameter	**ZDE**					**ZDR**					**PPE**					**PPR**				
	Cd^{2+} Concentration (mg/dm^3)																			
	100	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**
I order																				

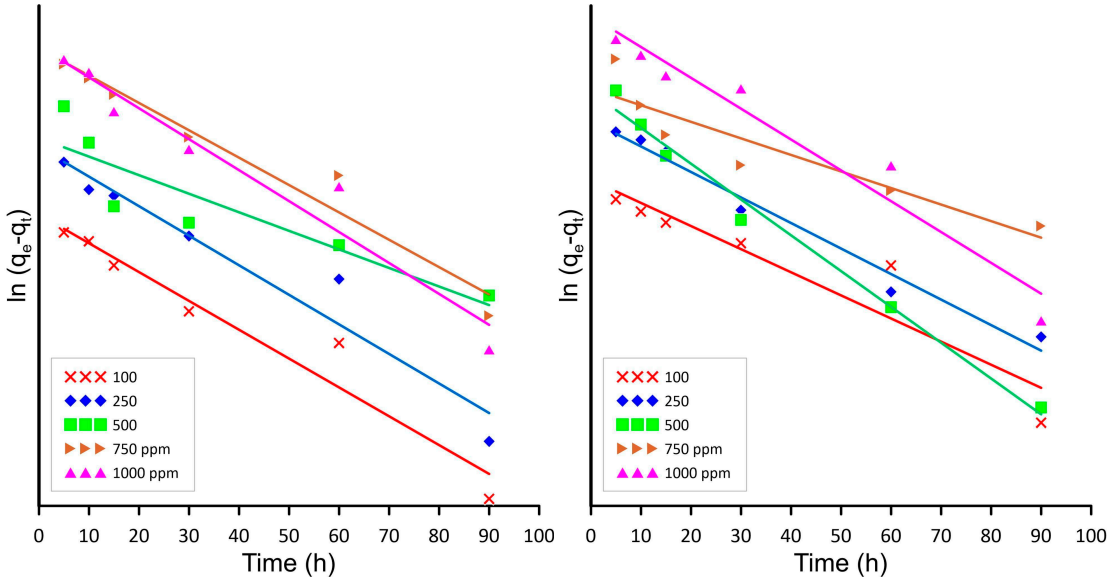
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	Cd^{2+} Concentration (mg/dm^3)																			
	100	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**
q_e	12.25	25.04	46.71	88.20	94.89	9.236	20.36	38.36	67.68	75.61	14.04	26.80	58.32	77.36	83.92	13.08	27.96	59.14	78.51	82.91
k1	0.0399	0.0333	0.0553	0.0335	0.0433	0.0500	0.0332	0.0499	0.0399	0.0444	0.0015	0.0029	0.0037	0.0045	0.0034	0.0012	0.0030	0.0037	0.0043	0.0036
R^2	0.9433	0.9411	0.8111	0.9556	0.9444	0.9800	0.9558	0.7822	0.9887	0.9220	0.9999	0.9777	0.9223	0.9400	0.9772	0.9663	0.9661	0.9336	0.9223	0.9775
II order																				
q_e	14.779	34.571	72.875	115.323	111.936	12.921	29.020	58.236	93.899	117.836	16.3374	31.2291	65.5440	104.629	101.982	38.9001	31.0889	108.334	125.343	101.789
k2	0.00019	0.00007	0.00004	0.00002	0.00005	0.00093	0.00046	0.00032	0.00012	0.00014	0.00012	0.00024	0.00006	0.00005	0.00009	0.00001	0.00017	0.00001	0.00002	0.00007
R^2	**0.9833**	**0.9557**	**0.8900**	**0.9855**	**0.9992**	**0.9999**	**0.9995**	**0.9995**	**0.9998**	**0.9998**	**0.9940**	**0.9989**	**0.9973**	**0.9969**	**0.9994**	**0.9971**	**0.9984**	**0.7966**	**0.8533**	**0.9996**
Weber Morris																				
I	-0.	-1.	1.891	-8.	3.626	3.383	8.642	21.593	23.040	43.421	-1.5	3.5	-1.0	7.7	15.6	-2.3	1.1	-5.8	3.5	10.3

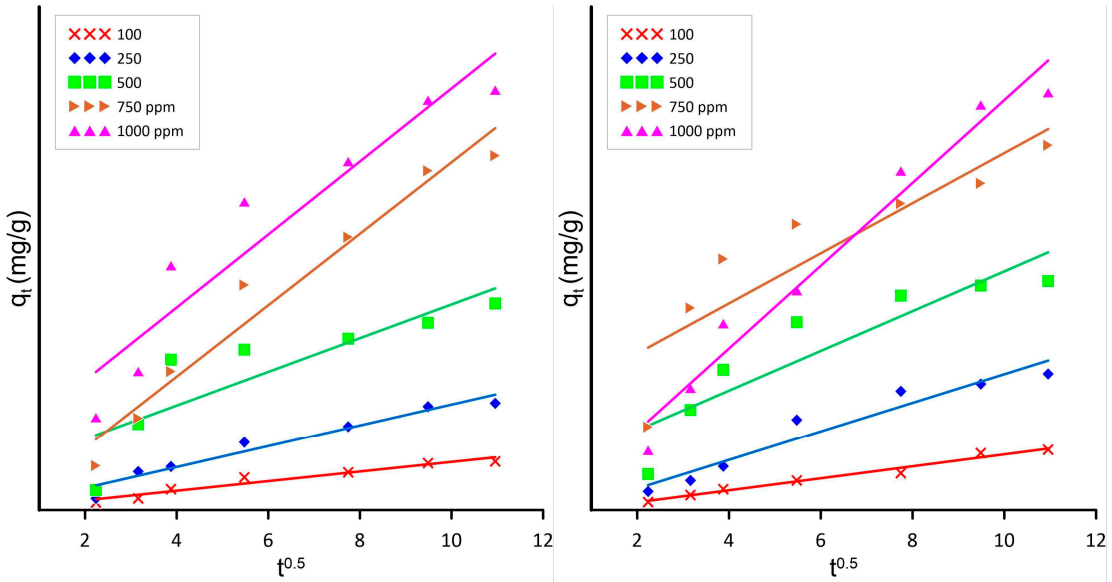
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	Cd^{2+} Concentration (mg/dm^3)																			
	100	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**
	920	597		550							94	80	07	35	25	86	35	85	13	42
K_{id}	1.378	2.960	5.838	10.115	11.223	1.102	2.368	4.671	8.092	8.978	1.359	3.018	6.358	9.687	9.712	1.223	3.081	6.536	9.479	9.970
R^2	0.946	0.952	0.739	0.962	0.903	0.900	0.958	0.756	0.945	0.900	0.990	0.963	0.919	0.816	0.939	0.987	0.946	0.931	0.826	0.926

parameter	ZDE					ZDR					PPE					PPR				
	Pb^{2+} Concentration (mg/dm^3)																			
	100	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**	**100**	**250**	**500**	**750**	**1000**
I order																				
q_e	15.639	42.758	67.364	79.694	103.081	11.3755	26.7088	56.7280	75.7642	102.0885	16.71100	41.86111	63.27110	79.34115	111.49117	16.66684	41.50117	62.44478	73.00449	110.55591
k_1	0.02006	0.03090	0.06007	0.04666	0.02227	0.02777	0.06666	0.05584	0.03340	0.02380	0.00162	0.00405	0.00502	0.00401	0.00279	0.00180	0.00421	0.00513	0.00392	0.00243

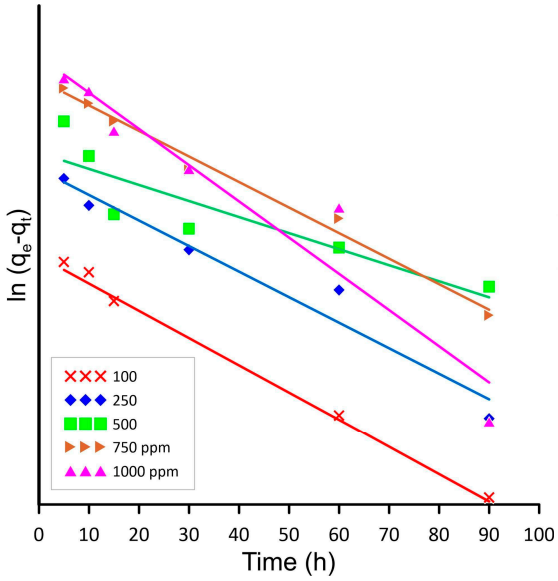
parameter	ZDE					ZDR					PPE					PPR				
	Pb^{2+} Concentration (mg/dm^3)																			
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R_2	0.87551	0.97992	0.98669	0.84882	0.95220	0.97155	0.94700	0.92675	0.96622	0.98335	0.97288	0.96300	0.99449	0.91449	0.98233	0.93588	0.99925	0.99934	0.91116	0.98442
II order																				
q_e	14.710	76.371	91.155	103.421	147.170	21.9483	51.6364	98.5165	116.8087	140.1165	19.32922	61.17334	95.84744	103.64222	179.20399	15.05077	54.92885	83.04669	103.52722	145.84227
k_2	0.00027	0.00002	0.00004	0.00009	0.00002	0.00053	0.00042	0.00018	0.00015	0.00008	0.00010	0.00003	0.00003	0.00009	0.00001	0.00028	0.00005	0.00007	0.00012	0.00002
R_2	**0.93332**	**0.97702**	**0.97772**	**0.98897**	**0.98855**	**0.99722**	**0.99992**	**0.99996**	**0.99960**	**0.99905**	**0.99530**	**0.99840**	**0.99683**	**0.99943**	**0.99541**	**0.99291**	**0.99849**	**0.99965**	**0.99953**	**0.99914**
Weber Morris																				
I	-0.32323	-7.63221	-0.61330	19.01211	-8.38990	6.25669	21.90455	36.45222	44.70399	33.99492	-1.78224	-5.71103	-0.76744	18.85547	-10.92933	-0.23044	-3.37669	4.29366	27.69555	-4.75800
K_{id}	1.43207	5.43007	8.55561	9.75997	13.34300	1.75667	3.81777	7.72736	8.73328	11.88800	1.60554	5.15477	8.59933	9.75022	14.3535	1.47378	5.14288	8.21223	9.02999	13.7272

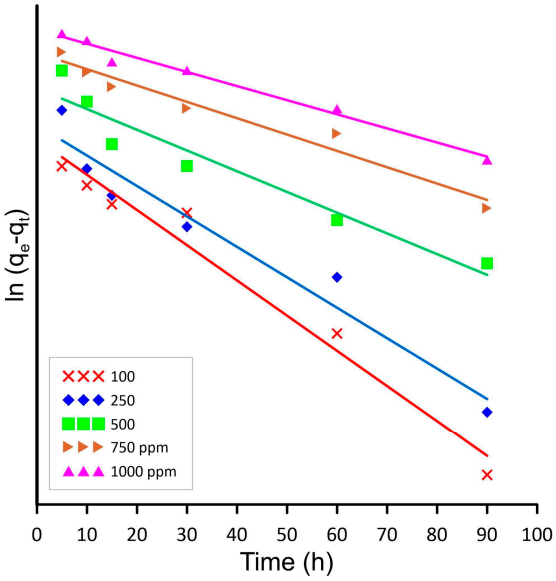
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	Pb^{2+} Concentration (mg/dm^3)																			
	100	250	500	750	1000	100	250	500	750	1000	100	250	500	750	10000	100	250	500	750	10000
															22					73
R^2	0.97775	0.93668	0.82009	0.78779	0.96994	0.91188	0.63333	0.74440	0.93660	0.97115	0.99952	0.93499	0.84441	0.86666	0.95722	0.98722	0.92278	0.86006	0.86144	0.97337

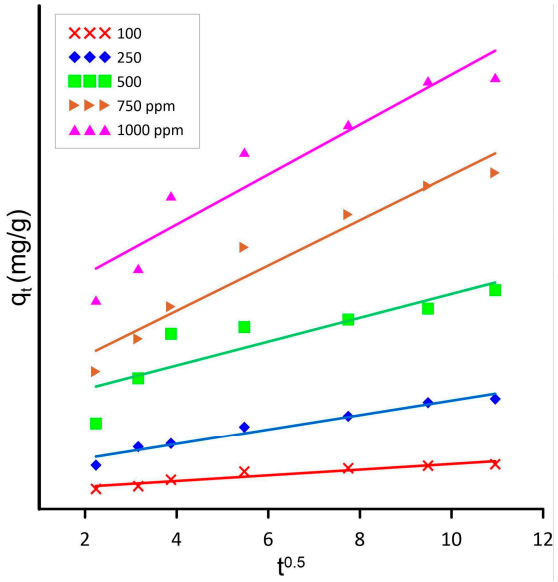


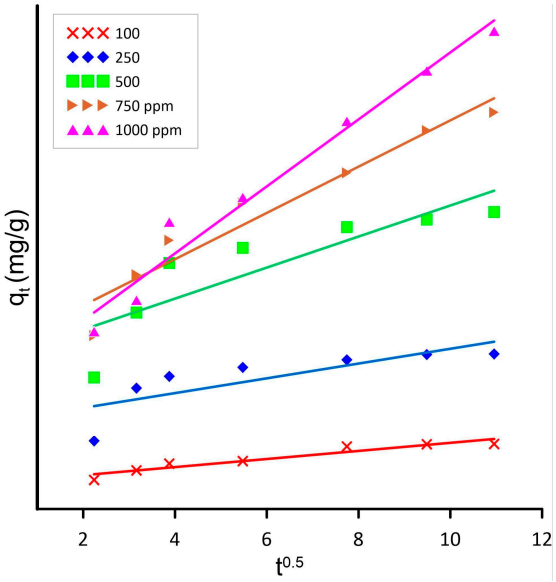


ZDE

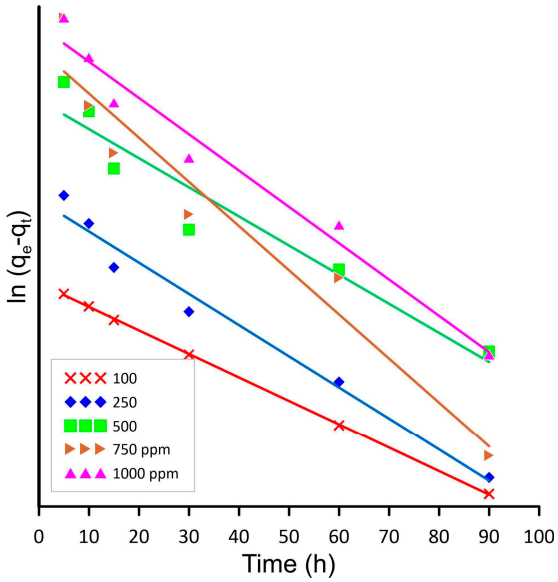

ln (qe-qt)
Time (h)
100
250
500
750 ppm
1000 ppm

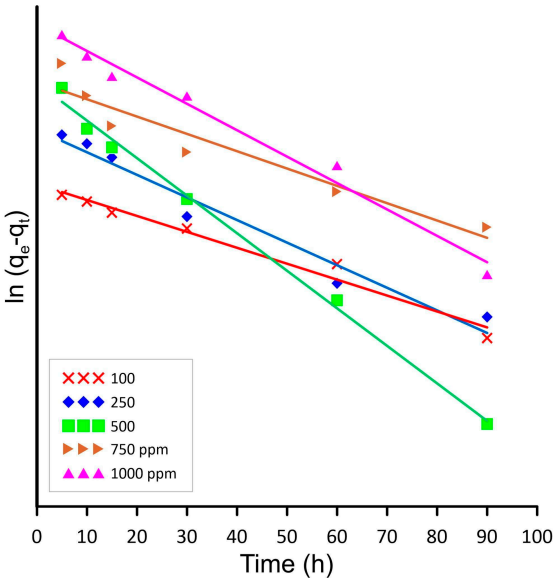

ln (qe-qt)
Time (h)
100
250
500
750 ppm
1000 ppm

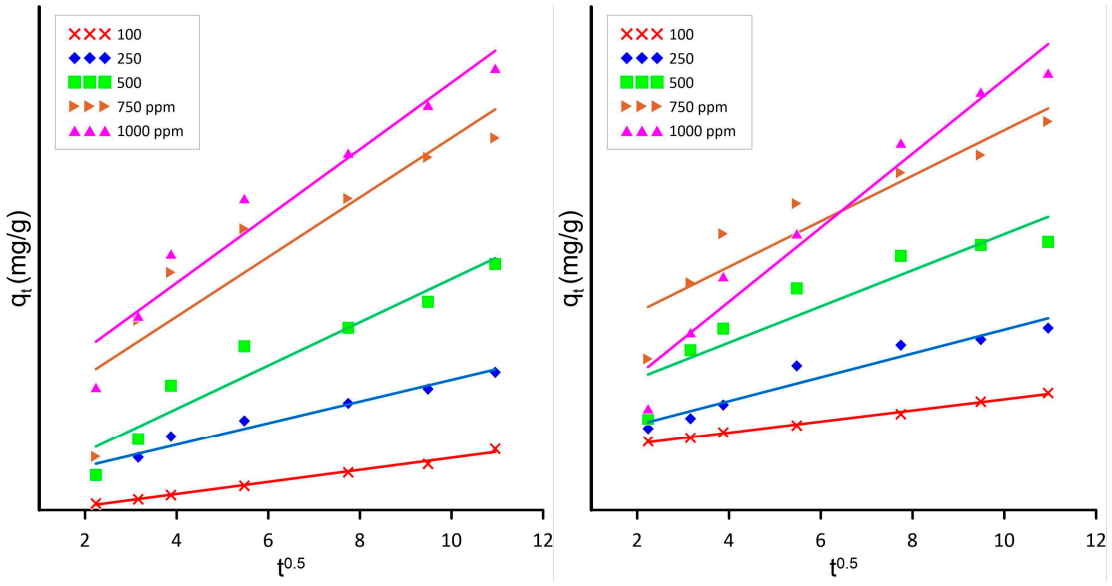

qt (mg/g)
t0.5
100
250
500
750 ppm
1000 ppm


qt (mg/g)
t0.5
100
250
500
750 ppm
1000 ppm

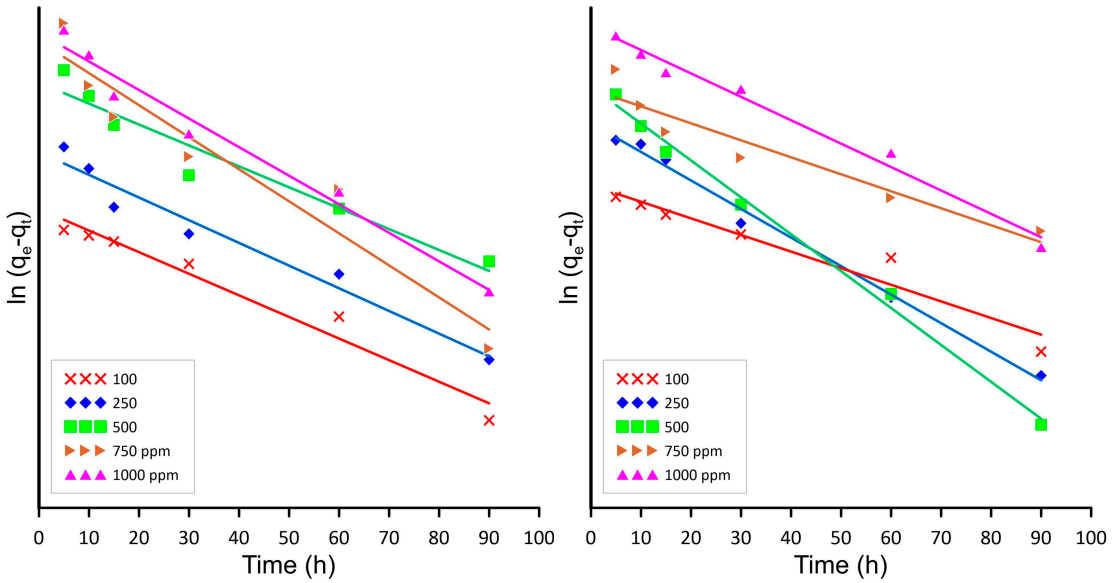
ZDR

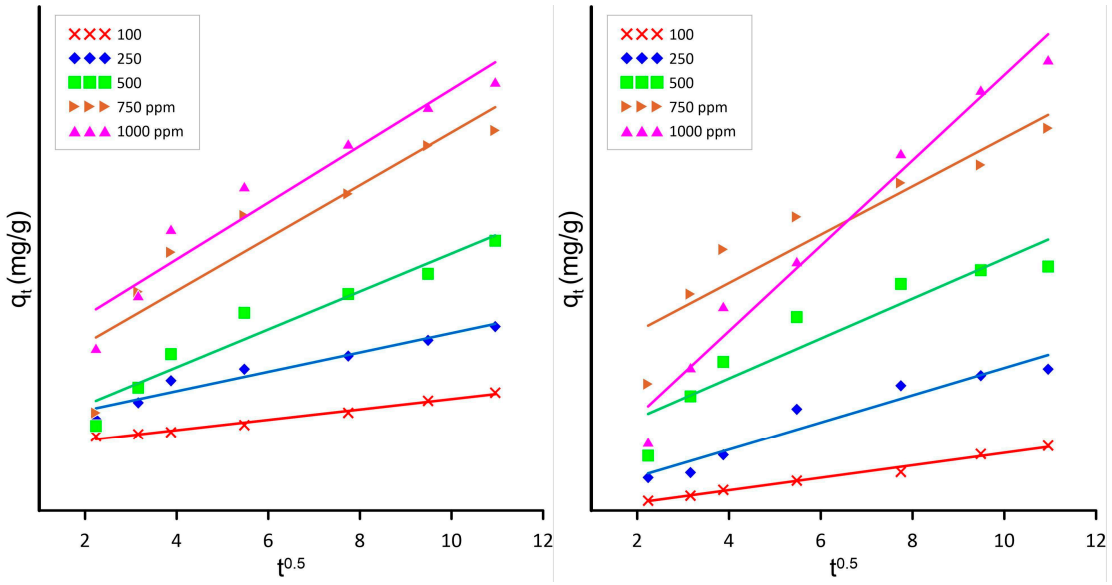

ln (qe-qt)
Time (h)
100
250
500
750 ppm
1000 ppm


ln (qe-qt)
Time (h)
100
250
500
750 ppm
1000 ppm


100
250
500
750 ppm
1000 ppm
q_t (mg/g)
$t^{0.5}$

PPE


100
250
500
750 ppm
1000 ppm
ln (q_e-q_t)
Time (h)


100
250
500
750 ppm
1000 ppm
q_t (mg/g)
$t^{0.5}$

PPR

Figure S5. The graphs of the PFO and W-B kinetic models for all used concentrations 100, 250, 500, 750, and 1000 ppm of both Cd^{2+} and Pb^{2+} for ZDE, ZDR, PPE and PPR biomass, respectively