Supporting information

Heavy metal removal using SnO_2 nanoparticles prepared in a grape extract media

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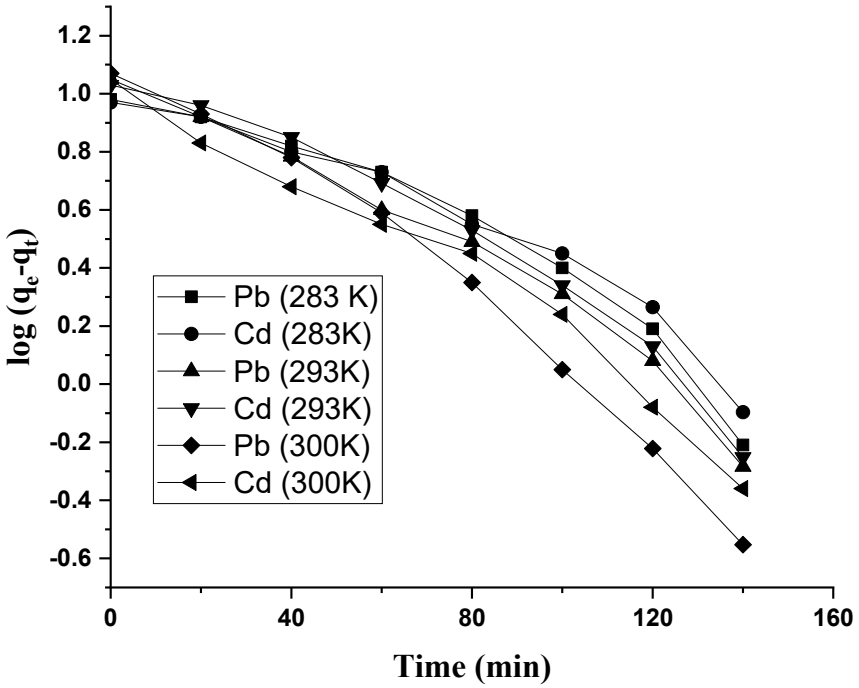

Fig. S1. Plots of $\log(q_e-q_t)$ *vs. t* at three different temperatures.

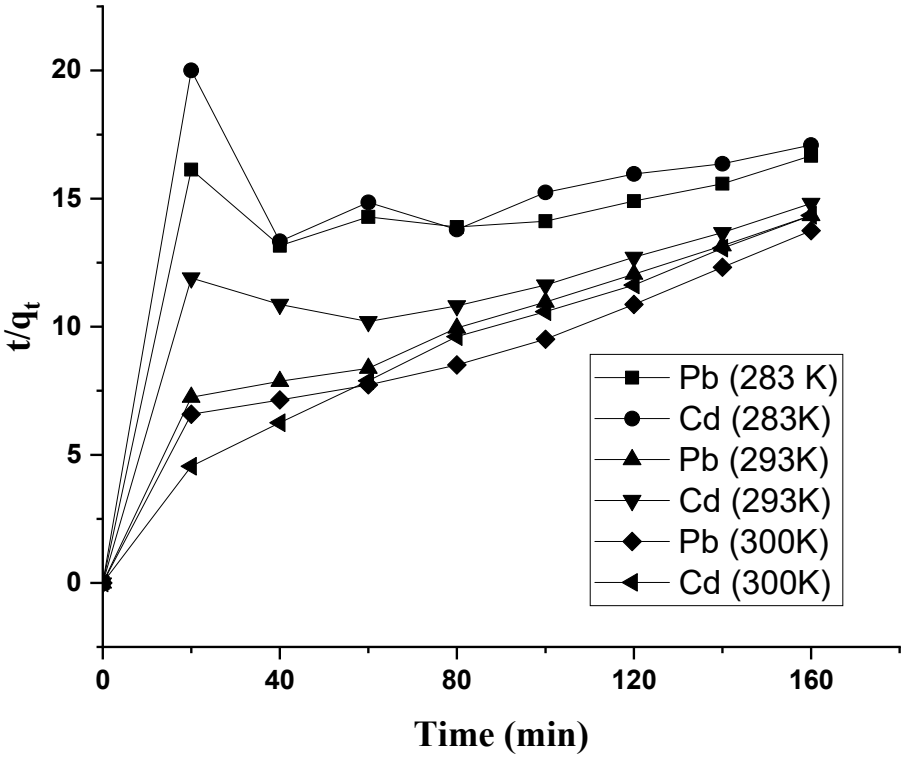

Fig. S2. Plots of t/q_t *vs. t* at three different temperatures.

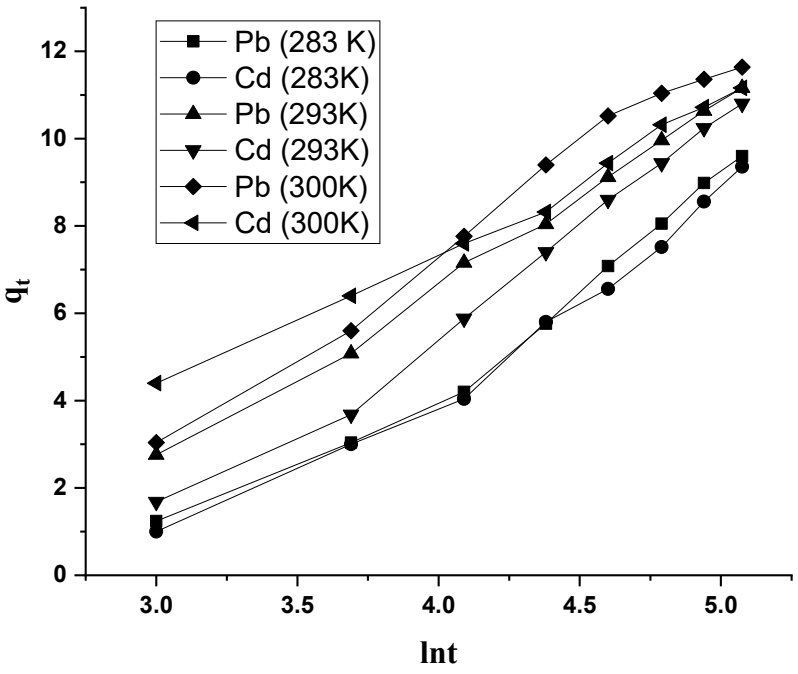

Fig. S3. Plots of q_t *vs.* ln*t* at three different temperatures.

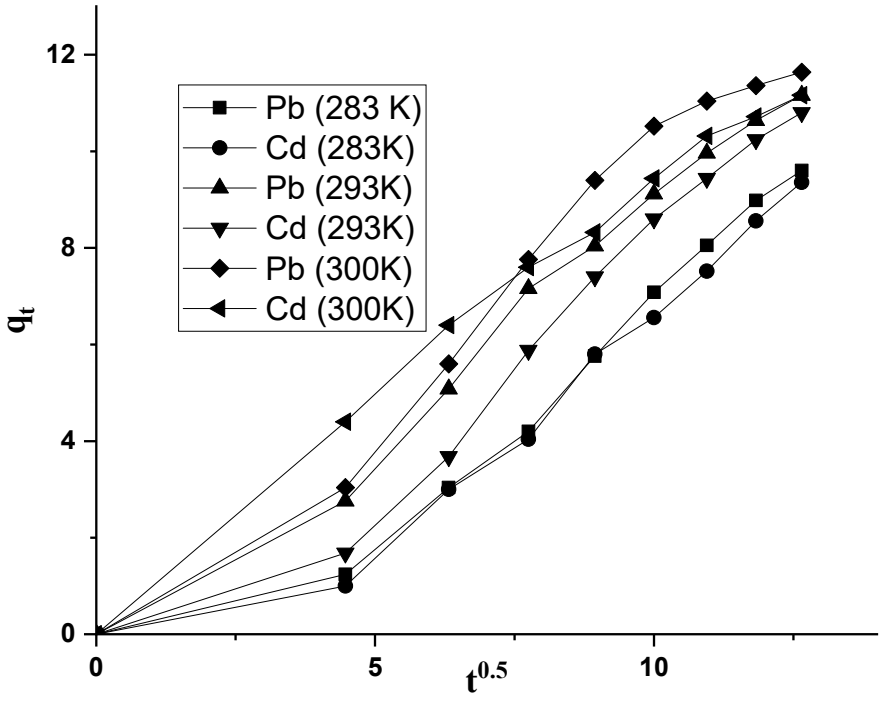

Fig. S4. Plots of q_t *vs.* $t^{0.5}$ at three different temperatures.

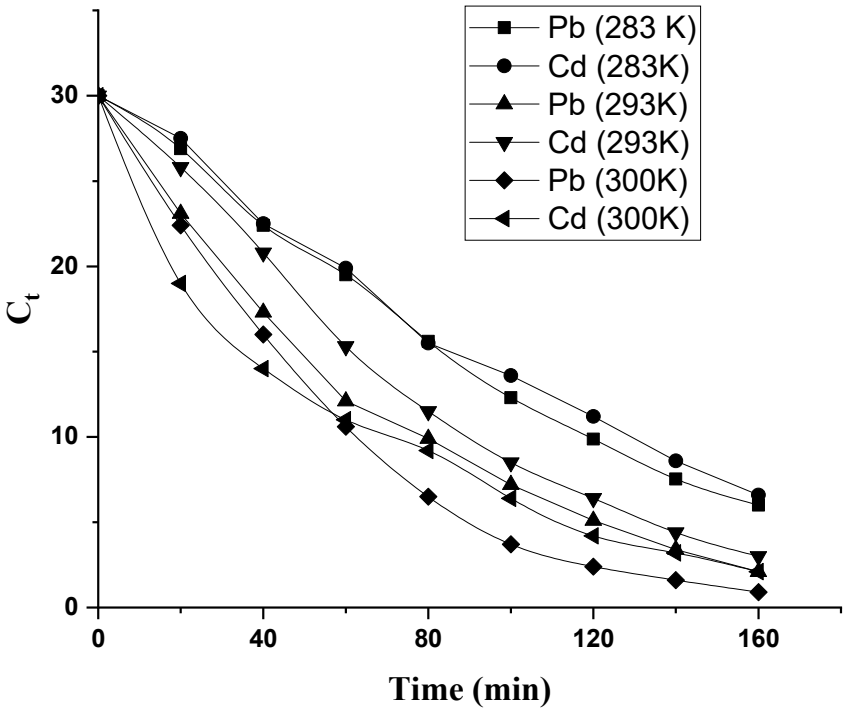

Fig. S5. Plots of C_t *vs. t* at three different temperatures.

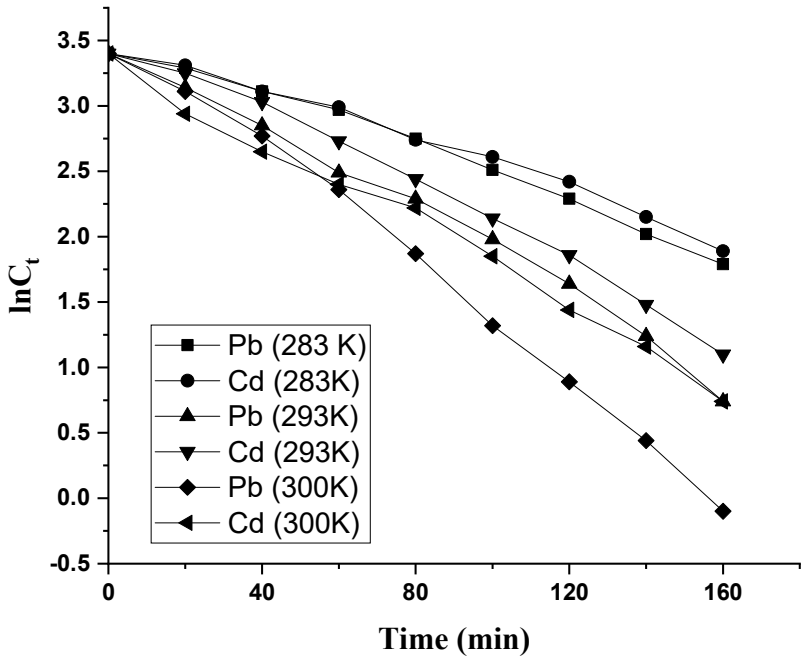

Fig. S6. Plots of ln C_t *vs. t* at three different temperatures.

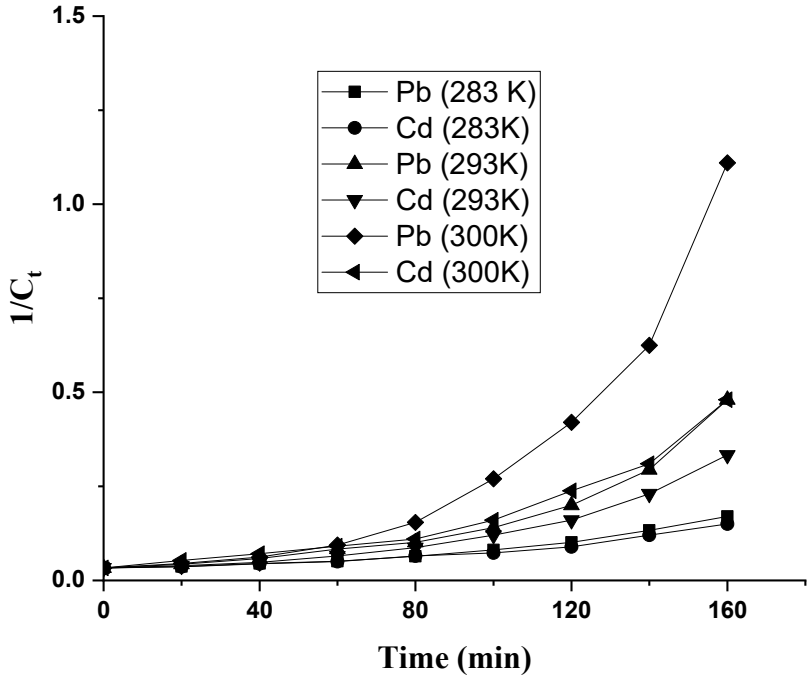

Fig. S7. Plots of $1/C_t$ *vs. t* at three different temperatures.

Table S1. Parameters and correlation coefficient of kinetic models (T= 283 K)

Model	**Linear equations**	**Parameters**	
		Pb	**Cd**
Pseudo-first-order model	$\log (q_e-q_t) = \log q_e - \frac{kt}{2.303}$	k = 0.018 R^2 = 0.9219 q_e= 12.86	k = 0.016 R^2 = 0.9341 q_e= 11.81
Pseudo-second-order model	$\frac{t}{q_t} = \frac{1}{kq_e^2} + \frac{t}{q_e}$	$k = 3.76\times10^{-4}$ R^2 = 0.378 q_e = 17.54	$k = 2.8\times10^{-4}$ R^2 = 0.2615 q_e = 19.011
Elovich equation	$q_t = \frac{\ln(\alpha.\beta)}{\beta} + \frac{\ln t}{\beta}$	β = 0.24 α = 0.23 R^2 = 0.9679	β = 0.25 α = 0.22 R^2 = 0.9732
Intra-particle diffusion	$q_t = k_i (t)^{0.5} + c$	c = -1.3838 k_i = 0.8286 R^2 = 0.9441	c = -1.359 k_i = 0.7965 R^2 = 0.9421

Table S2. Parameters and correlation coefficient of kinetic models (T= 293 K)

Model	**Linear equations**	**Parameters**	
		Pb	**Cd**
Pseudo-first-order model	$\log (q_e-q_t) = \log q_e - \frac{kt}{2.303}$	k = 0.021 R^2 = 0.968 q_e = 13.23	k = 0.02 R^2 = 0.9531 q_e = 14.2
Pseudo-second-order model	$\frac{t}{q_t} = \frac{1}{kq_e^2} + \frac{t}{q_e}$	$k = 1.4\times10^{-3}$ R^2 = 0.853 q_e = 13.95	$k = 5.54\times10^{-4}$ R^2 = 0.5508 q_e = 17.21
Elovich equation	$q_t = \frac{\ln(\alpha.\beta)}{\beta} + \frac{\ln t}{\beta}$	β = 0.24 α = 0.38 R^2 = 0.9964	β = 0.22 α = 0.29 R^2 = 0.9887
Intra-particle diffusion	$q_t = k_i (t)^{0.5} + c$	c = -0.5072; k_i = 0.9393 R^2 = 0.9865	c = -1.2419; k_i = 0.945 R^2 = 0.9602

Table S3. Parameters and correlation coefficient of kinetic models (T= 300 K).

Model	**Linear equations**	**Parameters**	
		Pb	**Cd**
Pseudo-first-order model	$\log (q_e-q_t) = \log q_e - \frac{kt}{2.303}$	k = 0.027 R^2 = 0.9785 q_e = 15.45	k = 0.022 R^2 = 0.969 q_e = 12.023
Pseudo-second-order model	$\frac{t}{q_t} = \frac{1}{kq_e^2} + \frac{t}{q_e}$	k = 1.5×10^{-3} R^2 = 0.8697 q_e = 14.73	k = 28.9×10^{-3} R^2 = 0.9471 q_e = 12.45
Elovich equation	$q_t = \frac{\ln(\alpha.\beta)}{\beta} + \frac{\ln t}{\beta}$	β = 0.23 α = 0.43 R^2 = 0.9877	β = 0.3 α = 0.58 R^2 = 0.991
Intra-particle diffusion	$q_t = k_i (t)^{0.5} + c$	c = -0.3934 k_i = 1.0136 R^2 = 0.974	c = 0.3809 k_i = 0.8906 R^2 = 0.9929

Table S4. Kinetic rate constants and correlation coefficients of adsorption at different temperatures.

Model	**Linear equations**	**Parameters**					
		Pb (283K)	**Cd (283K)**	**Pb (293K)**	**Cd (293K)**	**Pb (300K)**	**Cd (300K)**
Zero order	$C_t-C_0 = -k_0t$	k_0=0.1553 R^2=0.9861	k_0=0.1493 R^2 =0.9849	k_0=0.1667 R^2=0.9236	k_0=0.1732 R^2=0.9588	k_0=0.1774 R^2=0.8874	k_0=0.1527 R^2=0.8677
First order	$\ln C_t = -k_1t + \ln C_o$	k_1= 0.0103 R^2=0.9879	k_1=0.0094 R^2=0.9865	k_1=0.0161 R^2=0.9897	k_1=0.0145 R^2=0.9896	k_1=0.0223 R^2= 0.994	k_1=0.0158 R^2=0.9921
Second order	$\frac{1}{C_t} - \frac{1}{C_0} = k_2t$	k_2= 0.0008 R^2=0.8992	k_2= 0.0007 R^2=0.9038	k_2=0.0024 R^2=0.8049	k_2=0.0017 R^2=0.8521	k_2=0.0058 R^2=0.7776	k_2=0.0025 R^2=0.8477