

Deep eutectic solvent-consisted chemosensing of Fe (III), V(III), Co (II), and Pd (II) ions using paper-based micro-array decorated by silver nanoparticles

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Table S1. Molar ratio, density, viscosity, conductivity, and structure of selected DESs.

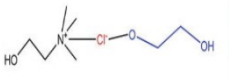
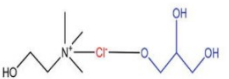
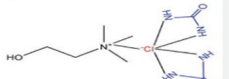
Type of DES	HBA/HBD	HBA: HBD molar ratio	$\rho/(\text{g}\cdot\text{cm}^{-3})$ (T/°C)	$\nu/(\text{mPa}\cdot\text{s})$ (T/°C)	$\sigma/(\text{mS}\cdot\text{cm}^{-1})$ (T/°C)	Structure DES
DES1	ChCl/EG	1:2	1.12 (25)	37 (25)	1.12 (25)	
DES2	ChCl/glycerol	1:2	1.18 (25)	259 (25)	1.18 (25)	
DES3	ChCl/urea	1:2	1.25 (25)	750 (25)	0.75 (25)	

Table S2. Wavelength, Average intensity of RGB, and Absorbance of developed DES-PCS of

Concentration of V^{3+} ($\mu\text{g}/\text{ml}$)	Wavelength (nm)	Average color value*			RGB-based Absorbance= $-\log [\text{RGB}/\text{R}_0\text{G}_0\text{B}_0]$		
		A_R	A_G	A_B	Abs_R	Abs_G	Abs_B
Blank	601	219	208	198	0.0000	0.0000	0
0.001	600	211	201	192	0.0162	0.0149	0.0134
0.005	600	209	199	189	0.0203	0.0192	0.0202
0.01	600	220	209	195	-0.0020	-0.0021	0.0066
0.05	597	221	209	192	-0.0039	-0.0021	0.0134
0.1	593	210	202	182	0.0182	0.0127	0.0366
0.2	592	211	201	173	0.0162	0.0149	0.0586
0.4	591	210	197	122	0.0182	0.0236	0.2103
0.6	589	208	183	54	0.0224	0.0556	0.5643
0.8	589	208	177	38	0.0224	0.0701	0.7169
1	588	234	206	21	-0.0288	0.0042	0.9744

different concentrations of V (III)

*Data was shown in the mean with 3 times testing

Table S3. Wavelength, Average intensity of RGB, and Absorbance of developed DES-PCS of different concentrations of Co (II)

Concentration of Co ²⁺ (μg/ml)	Wavelength (nm)	Average color value *			RGB-based Absorbance= $-\log [RGB/R_0G_0B_0]$		
		A _R	A _G	A _B	Abs _R	Abs _G	Abs _B
Blank	601	219	208	198	0.0000	0.0000	0.0000
0.001	601	204	195	186	0.0308	-0.0280	0.0272
0.005	602	203	194	186	0.0329	-0.0303	0.0272
0.01	597	205	199	190	0.0287	-0.0192	0.0179
0.05	578	206	207	198	0.0266	-0.0021	0.0000
0.1	540	189	203	190	0.0640	-0.0106	0.0179
0.2	524	175	173	199	0.0974	-0.0800	-0.0022
0.4	509	138	138	173	0.2006	-0.1782	0.0586
0.6	506	92	133	151	0.3767	-0.1942	0.1177
0.8	503	68	122	164	0.5079	-0.2317	0.0818
1	500	44	131	187	0.6970	-0.2008	0.0248

*Data was shown in the mean with 3 times testing

Table S4. Wavelength, Average intensity of RGB, and Absorbance of developed DES-PCS of different concentrations of Pd (II)

Concentration of Pd ²⁺ (µg/ml)	Wavelength (nm)	Average color value ^a			RGB-based Absorbance= $-\log [RGB/R_0G_0B_0]$		
		A _R	A _G	A _B	Abs _R	Abs _G	Abs _B
Blank	599	234	229	223	0.0000	0.0000	0.0000
0.001	602	220	209	206	0.0268	0.0397	0.0344
0.005	602	231	219	208	0.0056	0.0194	0.0302
0.01	602	224	212	203	0.0190	0.0335	0.0408
0.05	601	234	224	205	0.0000	0.0096	0.0366
0.1	601	233	219	202	0.0019	0.0194	0.0430
0.2	597	230	216	195	0.0075	0.0254	0.0583
0.4	596	228	211	181	0.0113	0.0356	0.0906
0.6	593	226	199	156	0.0151	0.0610	0.1552
0.8	592	227	190	143	0.0132	0.0811	0.1930
1	590	226	205	136	0.0151	0.0481	0.2148

*Data was shown in the mean with 3 times testing

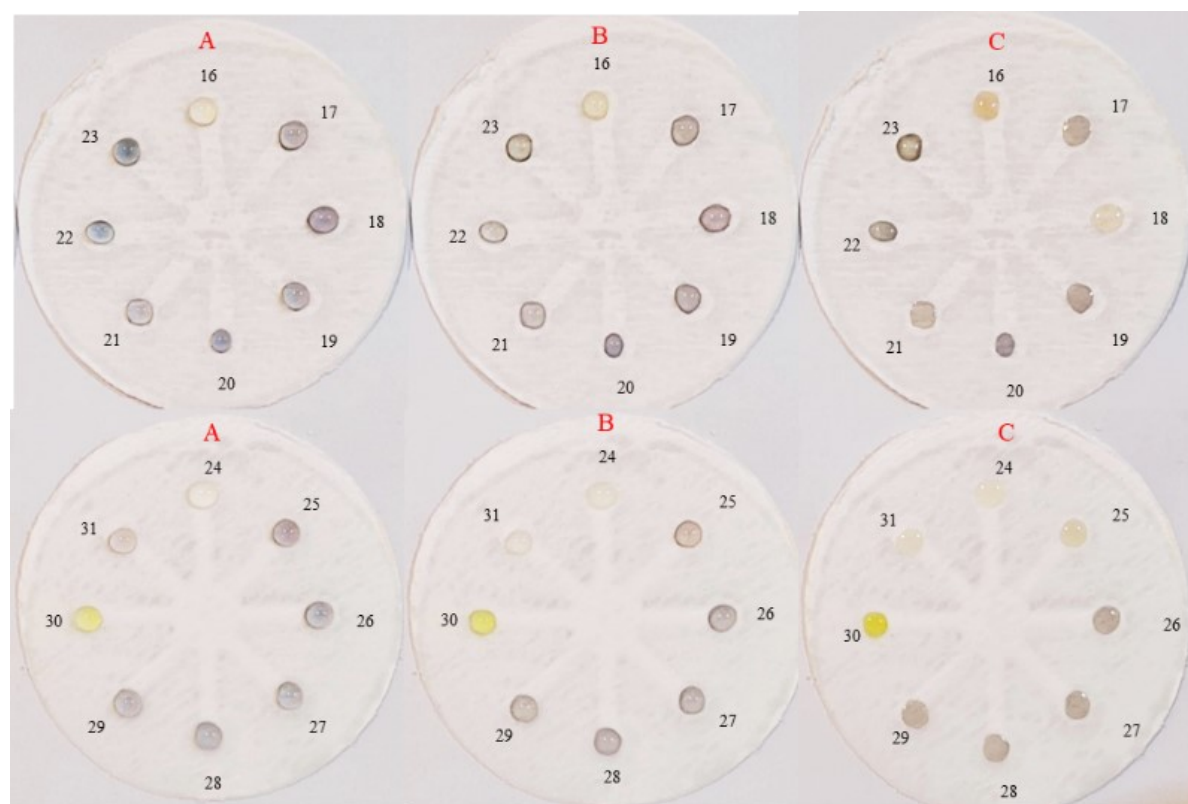
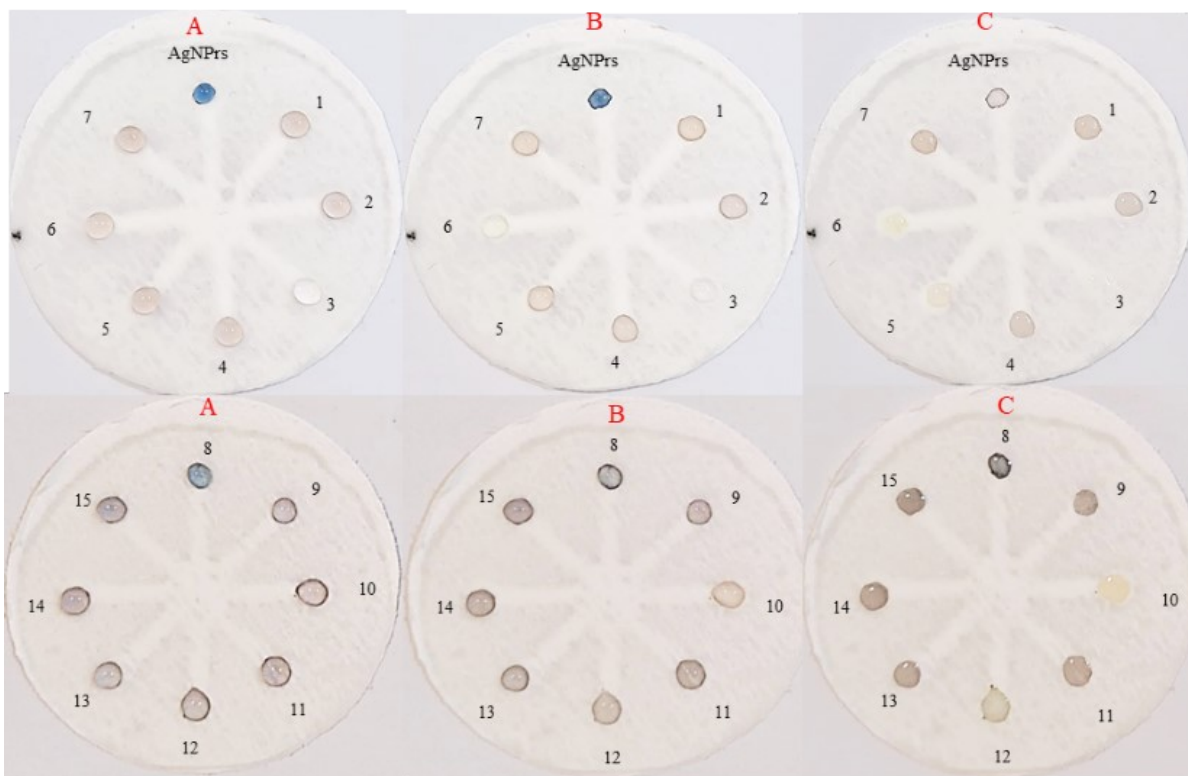


Fig. S1. The photograph shows PCS colorimetric response decorated with T-AgNPrs for individual identification of various control ions in the absence of DES at different reaction times **(A)** after 5 minutes, **(B)** after 30 minutes, and **(C)** after 60 minutes: T-AgNPrs, (1) T-AgNPrs+As⁵⁺, (2) T-AgNPrs+ B⁺, (3) T-AgNPrs+Fe³⁺, (4) T-AgNPrs+Ca²⁺, (5) T-AgNPrs+ Te⁴⁺, (6) T-AgNPrs+V³⁺, (7) T-AgNPrs+ Sr²⁺, (8) T-AgNPrs+ W⁶⁺, (9) T-AgNPrs+ Co²⁺, (10) T-AgNPrs+Zr⁴⁺, (11) T-AgNPrs+ Na⁺, (12) T-AgNPrs+ Mo⁶⁺, (13) T-AgNPrs+ Al³⁺, (14) T-AgNPrs+ Ba²⁺, (15) T-AgNPrs+ Cr³⁺, (16) T-AgNPrs+ Pt⁴⁺, (17) T-AgNPrs+ Bi³⁺, (18) T-AgNPrs+ Sn²⁺, (19) T-AgNPrs+ Mn²⁺, (20) T-AgNPrs+ Pb²⁺, (21) T-AgNPrs+ Ni²⁺, (22) T-AgNPrs+ Cs⁺, (23) T-AgNPrs+ Si⁴⁺, (24) T-AgNPrs+ Hg²⁺, (25) T-AgNPrs+ Se⁴⁺, (26) T-AgNPrs+ k⁺, (27) T-AgNPrs+ Li⁺, (28) T-AgNPrs+ Zn²⁺, (29) T-AgNPrs+ Mg²⁺, (30) T-AgNPrs+ Pd²⁺, (31) T-AgNPrs+ Cu²⁺ with volume ratio (1:1:1).

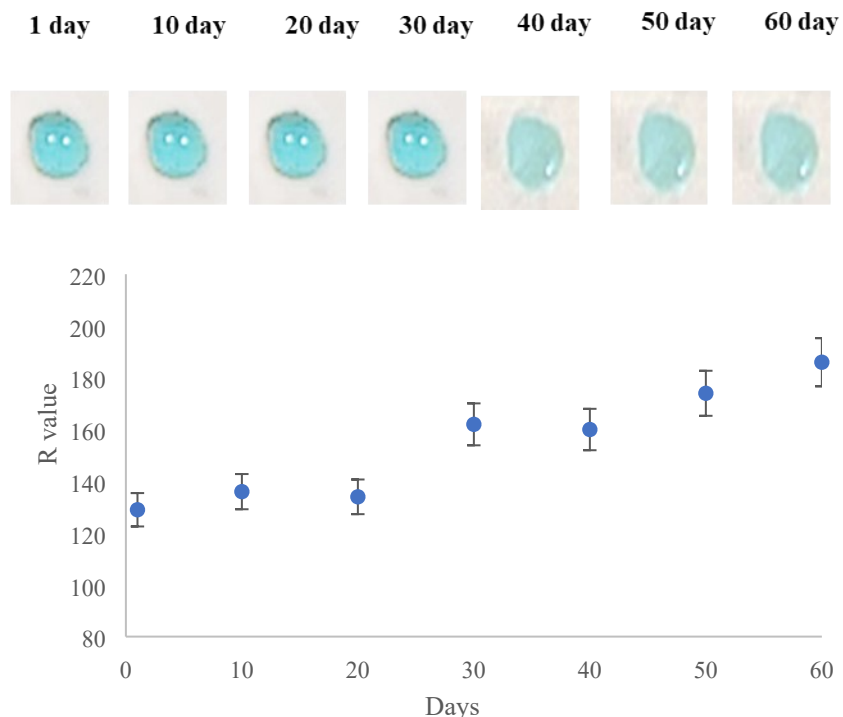


Fig. S2. The stability of the DES-PCS for Co²⁺ detection. The PADs were stored at room temperature (25°C ± 2 °C) for 60 days.

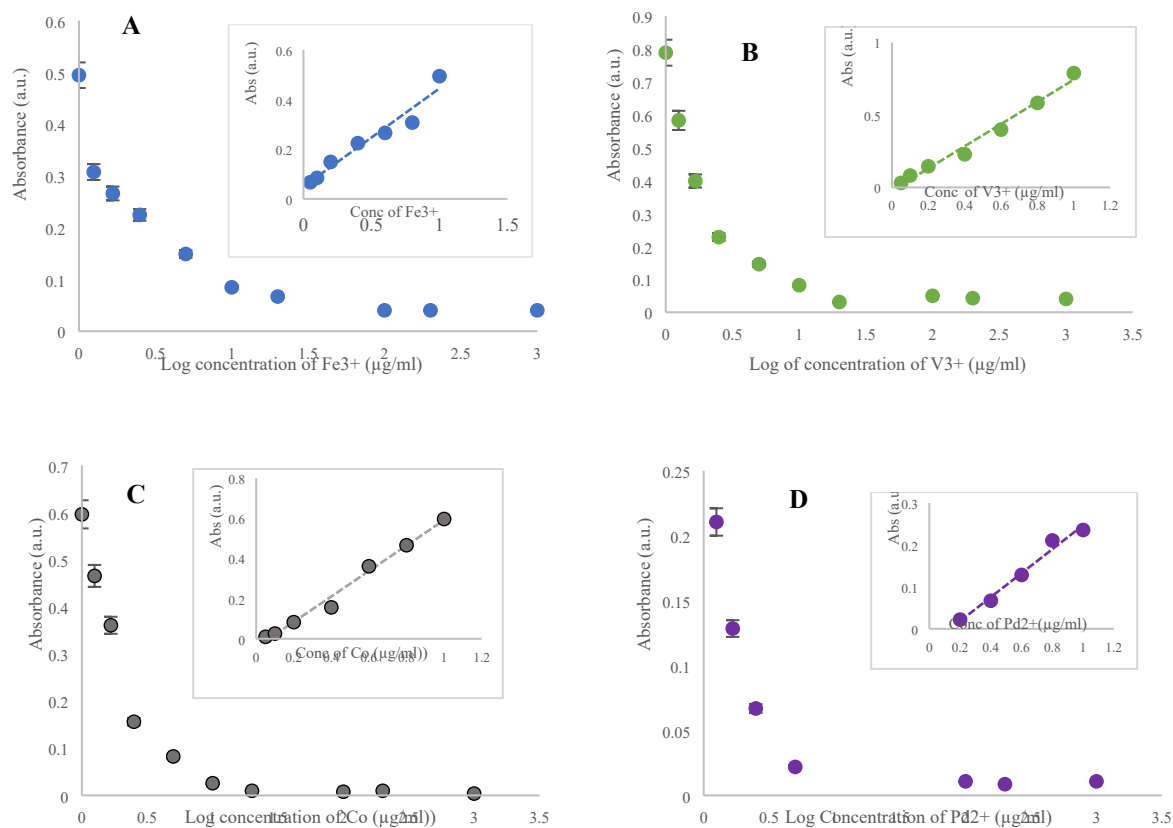


Fig. S3. The calibration curve indicated the correlation between the value of RGB-based absorbance and the different concentrations of **(A)** Fe (III), **(B)** V (III), **(C)** Co (II), and **(D)** Pd (II) ions.

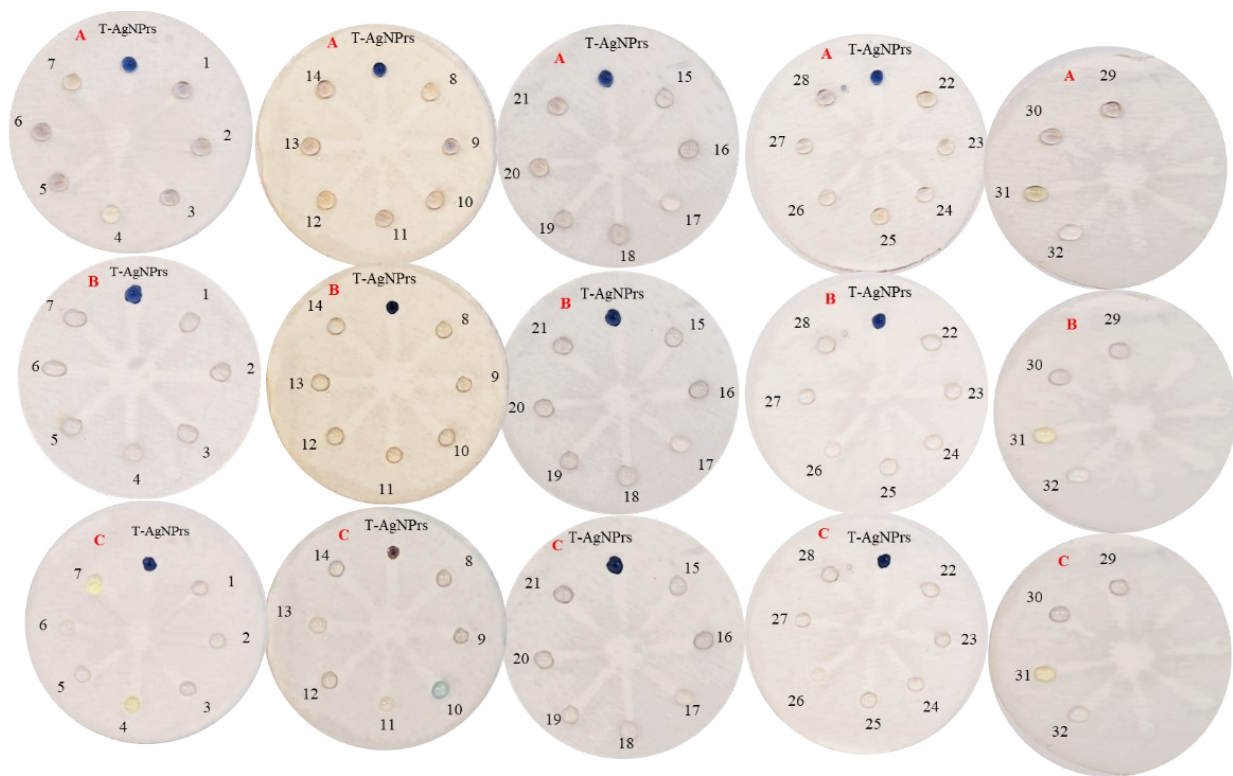


Fig. S4. The digital images of DES-PCS colorimetric response for individual identification of various ions human urine samples by the Spike method at three distinct incubation reaction times **(A)** after 5 minutes, **(B)** after 30 minutes, and **(C)** after 60 minutes: (1) T-AgNPrs+DES, (2) T-AgNPrs+DES+ As^{5+} , (3) T-AgNPrs+ DES+ B^+ , (4) T-AgNPrs+ DES+ Fe^{3+} , (5) T-AgNPrs+DES+ Ca^{2+} , (6) T-AgNPrs+DES+ Te^{4+} , (7) T-AgNPrs+DES+ V^{3+} , (8) T-AgNPrs+DES+ Sr^{2+} , (9) T-AgNPrs+DES+ W^{6+} , (10) T-AgNPrs+DES+ Co^{2+} , (11) T-AgNPrs+DES+ Zr^{4+} , (12) T-AgNPrs+DES+ Na^+ , (13) T-AgNPrs+DES+ Mo^{6+} , (14) T-AgNPrs+DES+ Al^{3+} , (15) T-AgNPrs+DES+ Ba^{2+} , (16) T-AgNPrs+DES+ Cr^{3+} , (17) T-AgNPrs+DES+ Pt^{4+} , (18) T-AgNPrs+DES+ Bi^{3+} , (19) T-AgNPrs+DES+ Sn^{2+} , (20) T-AgNPrs+DES+ Mn^{2+} , (21) T-AgNPrs+DES+ Pb^{2+} , (22) T-AgNPrs+DES+ Ni^{2+} , (23) T-AgNPrs+DES+ Cs^+ , (24) T-AgNPrs+DES+ Si^{4+} , (25) T-AgNPrs+DES+ Hg^{2+} , (26) T-AgNPrs+DES+ Se^{4+} , (27) T-AgNPrs+DES+ k^+ , (28) T-AgNPrs+DES+ Li^+ , (29) T-AgNPrs+DES+ Zn^{2+} , (30) T-AgNPrs+DES+ Mg^{2+} , (31) T-AgNPrs+DES+ Pd^{2+} , (32) T-AgNPrs+DES+ Cu^{2+} with volume ratio (1:1:1).

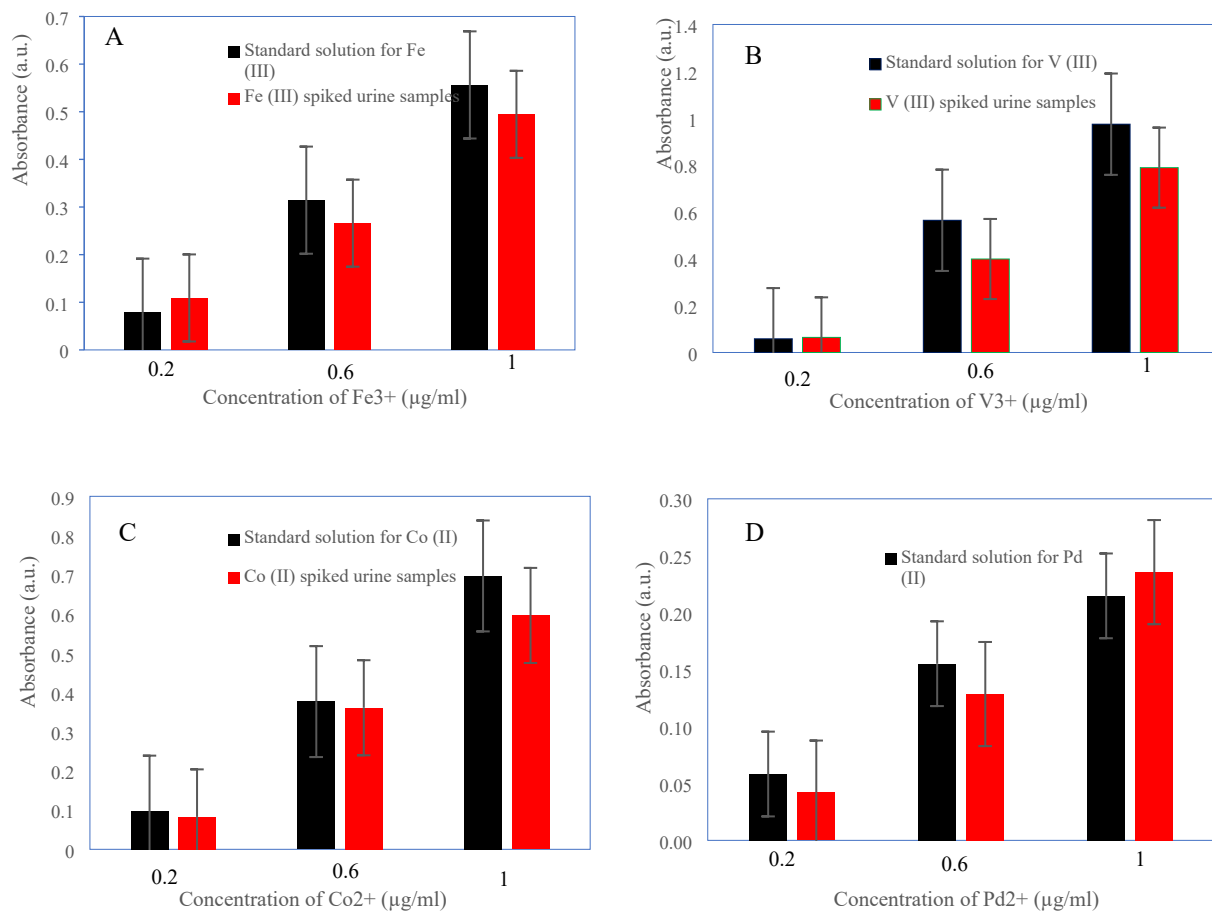


Fig. S5. Real samples colorimetric assay by DES-PCS with 0.2, 0.6, and 1 µg ml⁻¹ standard solution (black) and spiked urine samples analysis (red) for (A) Fe³⁺, (B) V³⁺, (C) Co²⁺, and (D) Pd²⁺ ions.