Electronic Supplementary Material (ESI) for Analytical Methods.
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Table S1

Design matrix and responses for FFD.

		Variables for FFD						Responses	
Run	**Block**	**pH**	**APDC amount (%w/v)**	**Chelating Treatment Temperature (°C)**	**Chelating Treatment Time (min)**	**Sample Flow Rate ($mL.min^{-1}$)**	**Elution Flow Rate ($mL.min^{-1}$)**	**Peak Area of Cr(III)**	**Peak Area of Cr(VI)**
1	1	0	0	0	0	0	0	598.4	572.3
2	1	-1	-1	-1	-1	-1	-1	571.5	263.9
3	1	+1	+1	-1	+1	+1	-1	572.1	584.2
4	1	-1	-1	+1	-1	-1	-1	552.3	280.7
5	1	+1	+1	+1	-1	+1	+1	514.0	347.6
6	1	-1	-1	-1	-1	+1	+1	480.1	204.6
7	1	+1	+1	-1	-1	-1	-1	582.3	335.1
8	1	-1	-1	+1	-1	+1	+1	474.6	220.6
9	1	+1	-1	+1	+1	+1	-1	615.2	613.5
10	1	0	0	0	0	0	0	582.3	560.5
11	1	-1	+1	+1	+1	-1	+1	526.9	517.9
12	1	0	0	0	0	0	0	560.8	548.6
13	1	+1	-1	+1	+1	-1	+1	512.4	515.0
14	1	-1	+1	+1	-1	-1	-1	571.5	414.1
15	1	+1	-1	-1	+1	-1	+1	517.8	430.0
16	1	-1	-1	-1	+1	+1	-1	560.8	530.8
17	1	+1	+1	+1	+1	+1	-1	624.1	685.9
18	1	-1	+1	-1	+1	-1	+1	490.9	530.8
19	1	+1	+1	-1	-1	+1	+1	501.6	305.4
20	2	-1	+1	+1	-1	-1	+1	507.0	346.9
21	2	+1	+1	+1	-1	+1	-1	587.6	424.0
22	2	0	0	0	0	0	0	566.1	584.2
23	2	-1	-1	-1	+1	+1	+1	521.7	435.7
24	2	+1	-1	+1	+1	-1	-1	614.5	596.1
25	2	-1	-1	+1	-1	+1	-1	566.2	275.8
26	2	+1	+1	+1	+1	+1	+1	520.5	602.0
27	2	-1	+1	-1	-1	+1	-1	582.1	337.6
28	2	0	0	0	0	0	0	544.6	566.4
29	2	+1	+1	-1	-1	-1	+1	513.1	319.3
30	2	-1	-1	+1	+1	+1	+1	514.0	513.0
31	2	+1	-1	-1	-1	-1	+1	467.4	212.8
32	2	-1	+1	-1	+1	-1	-1	570.9	578.1
33	2	+1	+1	-1	+1	+1	+1	498.2	529.3
34	2	-1	-1	+1	-1	-1	+1	474.8	216.5
35	2	+1	-1	-1	-1	+1	-1	565.2	264.7
36	2	-1	-1	-1	+1	-1	-1	566.7	536.4
37	2	0	0	0	0	0	0	571.5	590.1
38	2	+1	+1	+1	+1	-1	-1	625.2	679.1

Table S2

Analysis of variance (ANOVA) for FFD.

	Peak Area of Cr(III)					Peak Area of Cr(VI)				
Factor	**SS[a]**	**df[b]**	**MS[c]**	**F-Value**	**p-Value**	**SS**	**df**	**MS**	**F-Value**	**p-Value**
Blocks	565.5	1	565.5	0.0792	0.7822	27.2	1	27.2	0.0681	0.7977
A-pH	178.1	1	178.1	0.0250	0.8766	179.2	1	179.2	0.4482	0.5134
B-APDC amount (%w/v)	63673.0	1	63673.0	8.9207	**0.0092**	1417.7	1	1417.7	3.5456	0.0792
C-Chelating Temperature (^oC)	22565.9	1	22565.9	3.1615	0.0957	1778.7	1	1778.7	4.4483	0.0521
D-Chelating Time (min)	527317.0	1	527317.0	73.8778	**<0.0001**	3624.5	1	3624.5	9.0647	**0.0088**
E-Sample Flow Rate ($mL.min^{-1}$)	326.1	1	326.1	0.0457	0.8336	33.4	1	33.4	0.0835	0.7765
F-Elution Flow Rate ($mL.min^{-1}$)	41517.2	1	41517.2	5.8166	**0.0291**	52264.8	1	52264.8	130.71	**<0.0001**
AB	11.4	1	11.4	0.0016	0.9686	1188.5	1	1188.5	2.9725	0.1052
AC	0.3	1	0.3	0.00005	0.9946	569.6	1	569.6	1.4245	0.2512
AD	1957.5	1	1957.5	0.2742	0.6081	106.8	1	106.8	0.2671	0.6128
AE	499.6	1	499.6	0.0699	0.7950	44.6	1	44.6	0.1115	0.7431
AF	1654.4	1	1654.4	0.2318	0.6371	104.5	1	104.5	0.2612	0.6167
BC	663.4	1	663.4	0.0929	0.7647	271.3	1	271.3	0.6785	0.4231
BD	3912.8	1	3912.8	0.5482	0.4705	1269.3	1	1269.3	3.1745	0.0951
BE	238.5	1	238.5	0.0334	0.8574	2.00	1	2.00	0.0050	0.9445
BF	173.9	1	173.9	0.0244	0.8781	1.14	1	1.14	0.0029	0.9580
CD	2527.3	1	2527.3	0.3541	0.5607	2262.7	1	2262.7	5.6588	**0.0311**
CE	530.9	1	530.9	0.0744	0.7888	28.6	1	28.6	0.0715	0.7928
CF	1605.8	1	1605.8	0.2250	0.6421	541.5	1	541.5	1.3543	0.2627
DE	449.5	1	449.5	0.0630	0.8053	29.4	1	29.4	0.0736	0.7898
DF	2969.4	1	2969.4	0.4160	0.5287	0.05	1	0.05	0.0001	0.9915
EF	40.2	1	40.2	0.0056	0.9411	0.39	1	0.39	0.0010	0.9753
Curvature	104573.8	1	104573.8	587.6068	**<0.0001**	3970.1	1	3970.1	27.410	**<0.0001**
Residual	2491.5	14	177.9657			2027.7	14	144.8		
LOF	1905.3	10	190.5289	1.300	0.4308	910.6	10	91.1	0.3260	0.9314
Pure Error	586.2309	4	146.5577			1117.1	4	279.3		
Total SS	780442.9	37				71743.6	37			

[a] Sum of Square

[b] Degree of Freedom

[c] Mean Square

Table S3

Design matrix and responses for CCD.

		Variables for CCD				Responses	
Run	**Block**	**APDC amount (%w/v)**	**Chelating Treatment Temperature (°C)**	**Chelating Treatment Time (min)**	**Elution Flow Rate (mL min^{-1})**	**Peak Area of Cr(VI)**	**Peak Area of Cr(III)**
1	1	0	0	0	0	591.1	569.9
2	1	-1	+1	-1	-1	563.1	584.5
3	1	+1	+1	+1	-1	609.7	656.3
4	1	-1	-1	+1	-1	570.9	559.7
5	1	+1	+1	-1	+1	511.9	345.4
6	1	-1	+1	+1	+1	527.3	496.2
7	1	+1	-1	-1	-1	581.8	383.2
8	1	0	0	0	0	561.6	544.1
9	1	-1	-1	-1	+1	479.2	222.0
10	1	0	0	0	0	583.3	564.5
11	1	+1	-1	+1	+1	517.8	534.9
12	1	0	0	0	0	562.8	584.5
13	2	-1	-1	+1	+1	502.5	500.9
14	2	+1	+1	+1	+1	536.7	559.9
15	2	+1	-1	-1	+1	505.6	330.5
16	2	0	0	0	0	578.7	560.2
17	2	+1	+1	-1	-1	580.2	395.6
18	2	-1	+1	-1	+1	474.6	212.5
19	2	+1	-1	+1	-1	570.9	641.8
20	2	0	0	0	0	572.4	582.9
21	2	0	0	0	0	586.4	586.6
22	2	-1	+1	+1	-1	598.9	570.5
23	2	0	0	0	0	564.7	564.3
24	2	-1	-1	-1	-1	558.5	275.7
25	3	0	+2	0	0	558.5	540.9
26	3	+2	0	0	0	574.0	619.2
27	3	0	0	-2	0	482.3	127.7
28	3	0	0	+2	0	542.9	668.1
29	3	0	0	0	0	573.4	558.9
30	3	0	-2	0	0	524.8	231.9
31	3	-2	0	0	0	525.8	370.8
32	3	0	0	0	0	588.0	584.5
33	3	0	0	0	0	571.8	592.2
34	3	0	0	0	-2	614.4	660.7
35	3	0	0	0	0	562.6	564.3
36	3	0	0	0	+2	483.9	505.1

Table S4

Analysis of variance (ANOVA) for CCD.

	Peak Area of Cr(III)					Peak Area of Cr(VI)				
Factor	**SS**	**df**	**MS**	**F-Value**	**p-Value**	**SS**	**df**	**MS**	**F-Value**	**p-Value**
Blocks	122.6	2	61.3	0.267	0.7686	140.2	2	70.1	0.8599	0.4390
Model	79455.6	14	56751.29	247.033	**<0.0001**	48769.7	14	3483.6	42.72	**<0.0001**
A-APDC amount (%w/v)	64045.3	1	64045.3	278.783	**<0.0001**	2320.2	1	2320.2	28.4558	**<0.0001**
B-Chelating Temperature (^oC)	589.9	1	589.9	2.568	0.1256	1388.3	1	1388.3	17.0260	**0.0006**
C-Chelating Time (min)	418497.9	1	418497.9	1821.682	**<0.0001**	3773.0	1	3773.0	46.2726	**<0.0001**
D-Elution Flow Rate ($mL.min^{-1}$)	30721.6	1	30721.6	133.728	**<0.0001**	29354.9	1	29354.9	360.0162	**<0.0001**
AB	387.4	1	387.4	1.686	0.2096	6.0	1	6.0	0.0734	0.7893
AC	2803.0	1	2803.0	12.201	**0.0024**	293.3	1	293.3	3.5976	0.0732
AD	261.4	1	261.4	1.138	0.2995	86.2	1	86.2	1.0567	0.3169
BC	83.8	1	83.8	0.365	0.5531	699.5	1	699.5	8.5790	**0.0086**
BD	0.7	1	0.7	0.003	0.9565	38.1	1	38.1	0.4677	0.5023
CD	982.3	1	982.3	4.276	0.0525	133.0	1	133.0	1.6318	0.2168
A^2	10964.7	1	10964.7	47.728	**<0.0001**	936.1	1	936.1	11.4810	**0.0031**
B^2	206218.1	1	206218.1	897.648	**<0.0001**	1793.6	1	1793.6	21.9968	**0.0002**
C^2	58573.7	1	58573.7	254.966	**<0.0001**	6943.0	1	6943.0	85.1507	**<0.0001**
D^2	388.0	1	388.0	1.689	0.2093	1004.6	1	1004.6	12.3205	**0.0023**
Residual	4364.87	19	229.73			1549.21	19	81.54		
LOF	2244.37	10	224.44	0.95	0.5336	306.43	10	30.64	0.2200	0.9862
Pure Error	2120.50	9	235.61			1242.78	9	138.09		
Total SS	799005.1	35				50459.2	35			

Model statistics

	Peak Area of Cr(III)	Peak Area of Cr(VI)
R^2	0.9931	0.9640
R^2_{adj}	0.9906	0.9483
R^2_{pred}	0.9796	0.9227

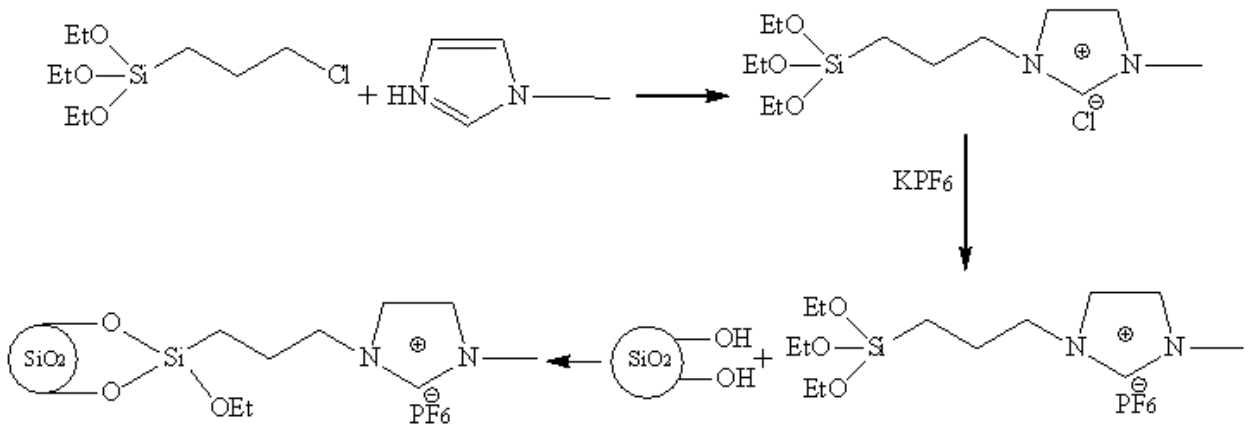
Figure captions

Fig. S1. Schematic diagram for synthesis of N-methylimidazolium–hexafluorophosphate functionalized silica.

Fig. S2. Pareto chart of standardized effects of the main parameters on peak area of Cr(III) (a) and Cr(VI) (b). The vertical dashed line indicated the level of significance at $p = 0.05$.

Fig. S3. Normal probability plot of studentized residuals for the refined quadratic models of Cr(III) (a) and Cr(VI) (b).

Fig. S4. 3-D graphical representation of the peak area of (A) Cr(III) and (B) Cr(VI) complexes with APDC: (a) APDC concentration–chelation treatment temperature, (b) APDC concentration–chelation treatment time, (c) APDC concentration–elution flow rate, (d) chelation treatment temperature–chelation treatment time, (e) chelation treatment temperature–elution flow rate, and (f) chelation treatment time– elution flow rate.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O
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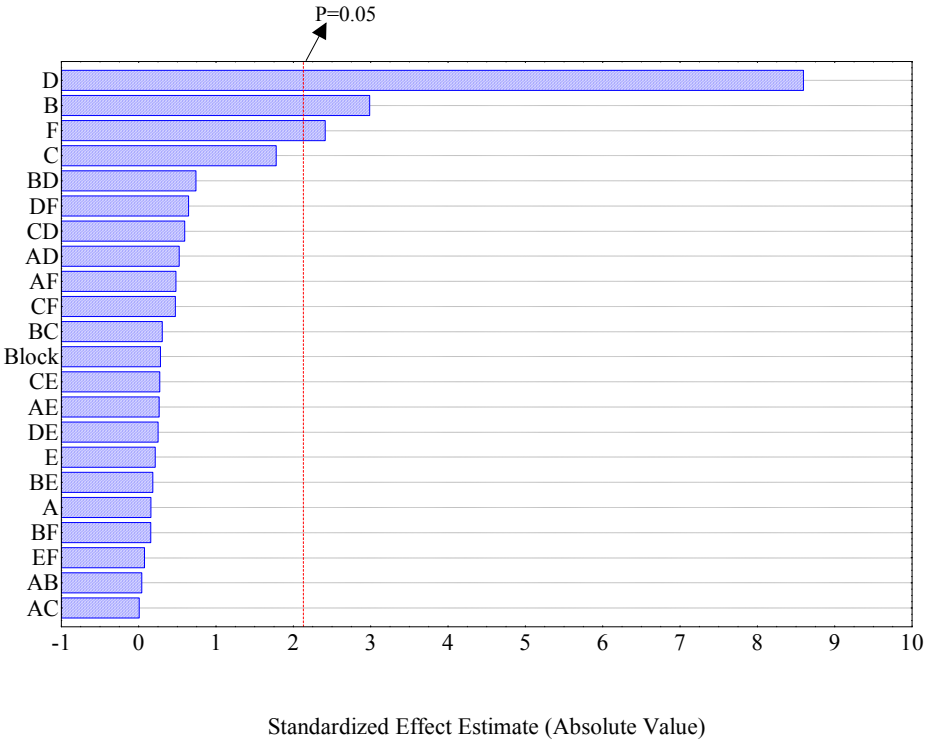
Figure S1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A
BF
EF
AB
AC
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3
4
5
6
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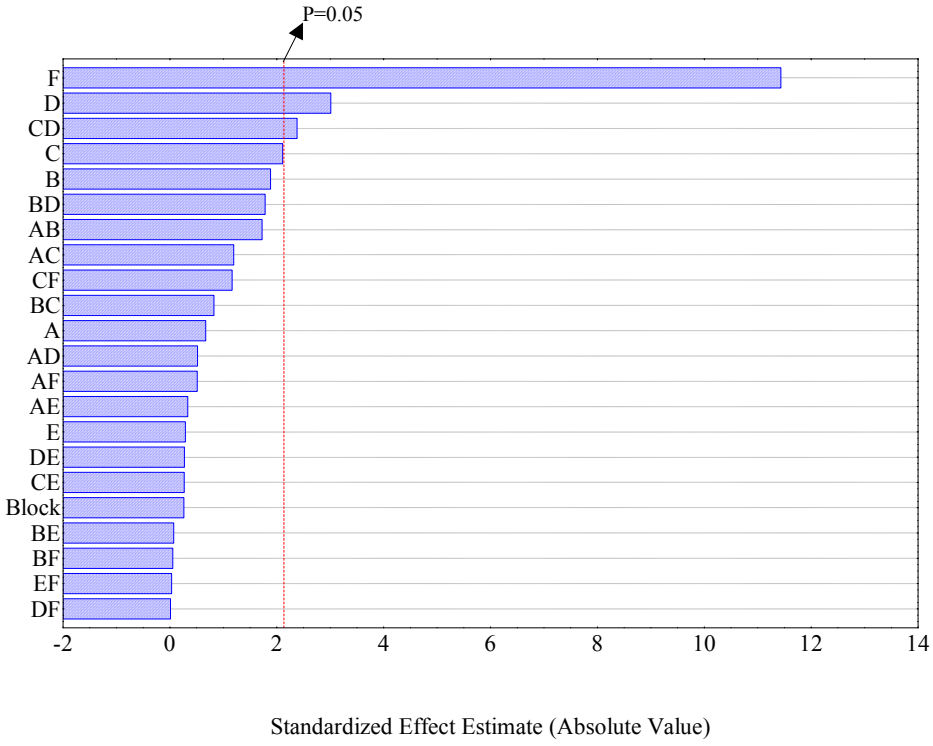
8
9
10
Standardized Effect Estimate (Absolute Value)

(a)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EF
DF
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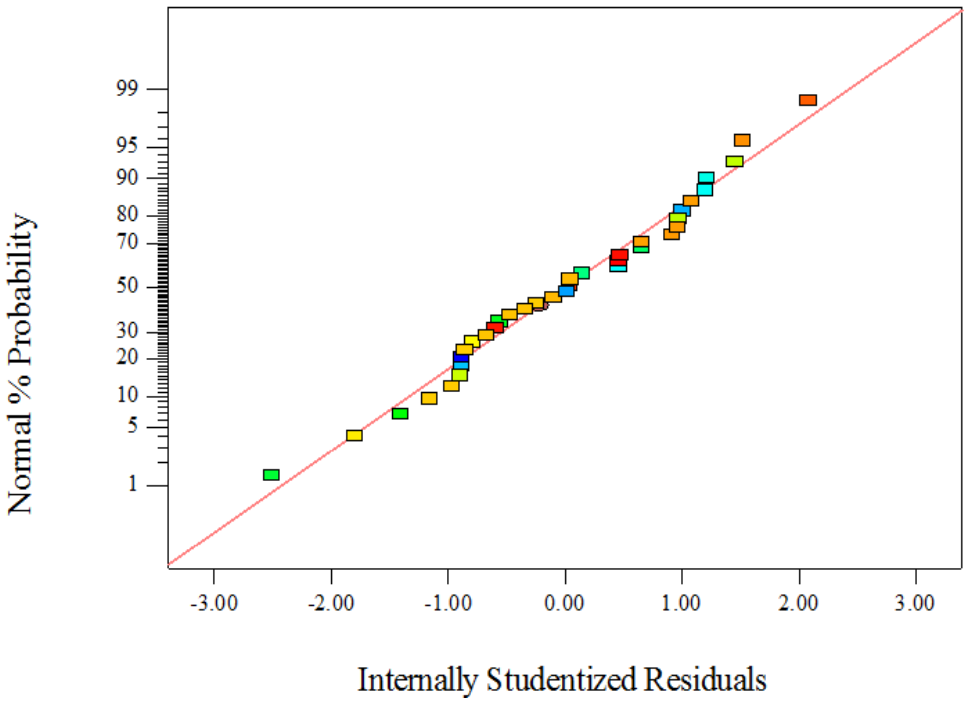
4
6
8
10
12
14
Standardized Effect Estimate (Absolute Value)

(b)

Figure S2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90
80
70
50
30
20
10
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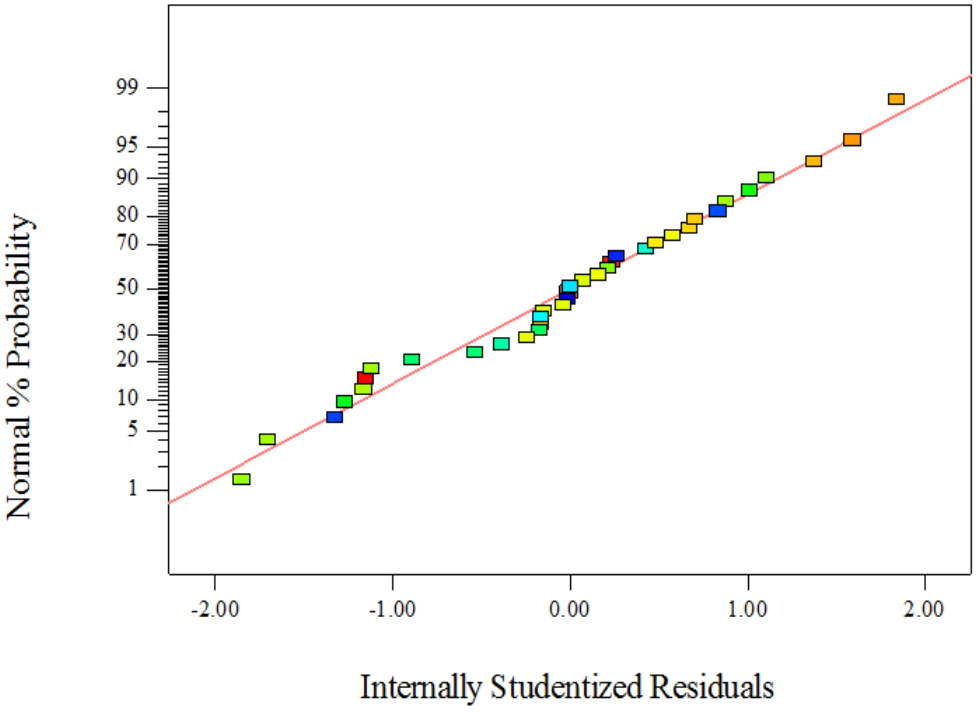
1.00
2.00
3.00
Internally Studentized Residuals

(a)


Normal % Probability
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95
90
80
70
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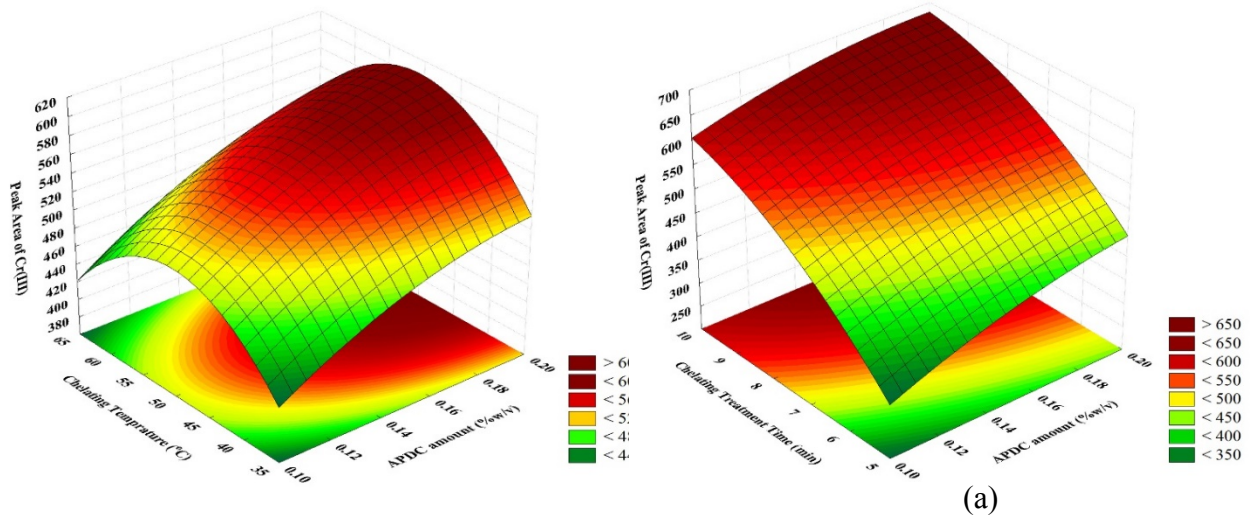
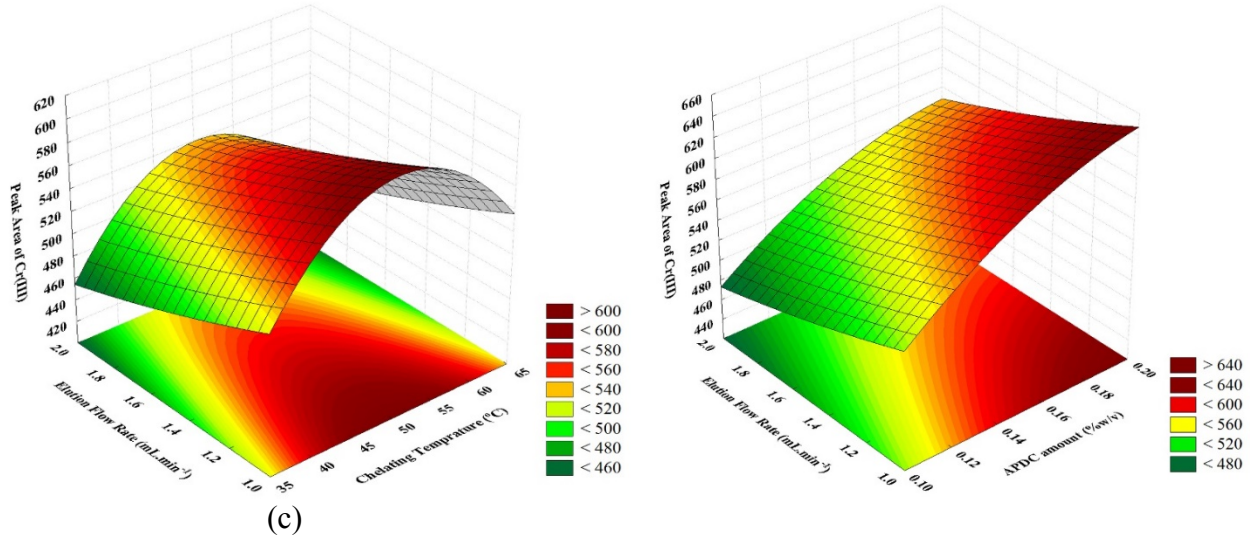
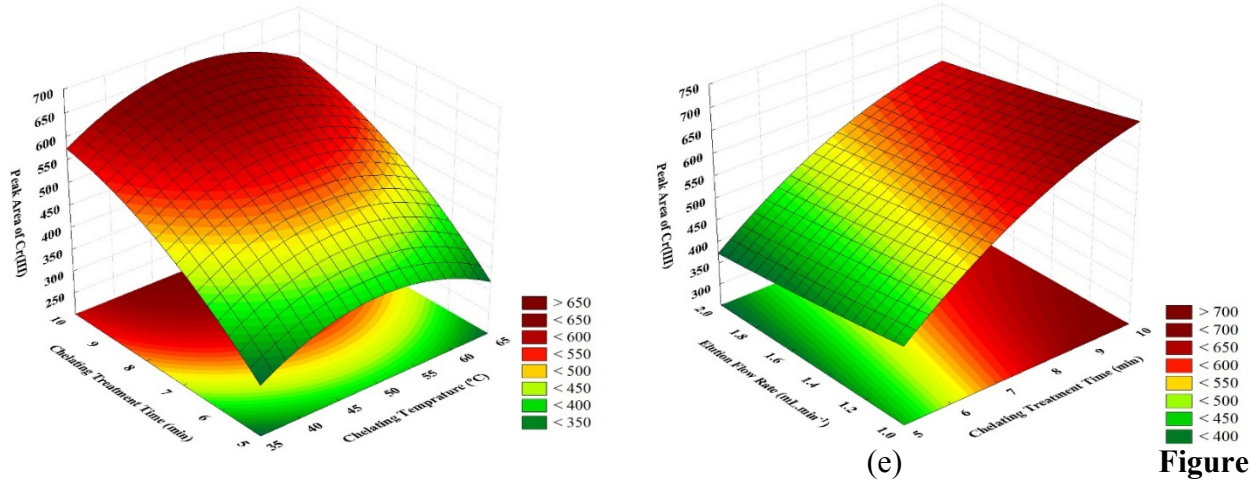
Internally Studentized Residuals

(b)

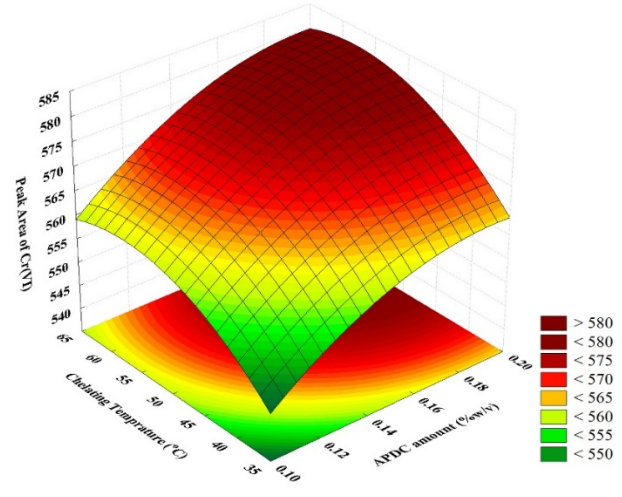
Figure S3


Peak Area of Cr(III)
Chelating Temprature (°C)
APDC amount (%w/v)
Chelating Treatment Time (min)
(b)
(a)


Peak Area of Cr(III)
Elution Flow Rate (mL.min⁻¹)
Chelating Temprature (°C)
APDC amount (%w/v)
(c)
(d)


Peak Area of Cr(III)
Chelating Treatment Time (min)
Chelating Temprature (°C)
Elution Flow Rate (mL.min⁻¹)
(f)
(e)

S4A **Figure**



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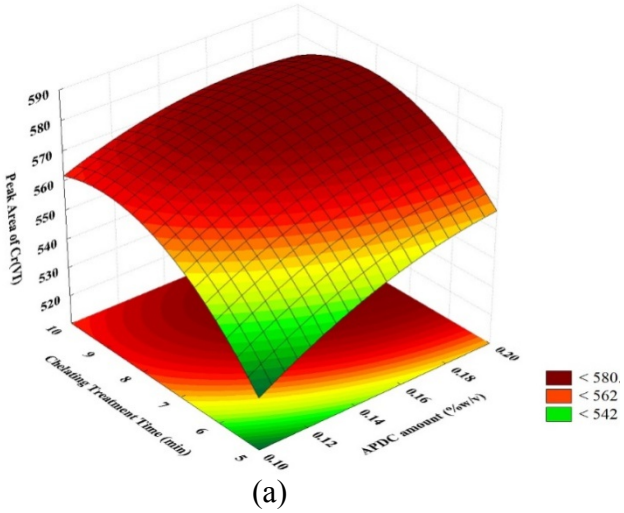

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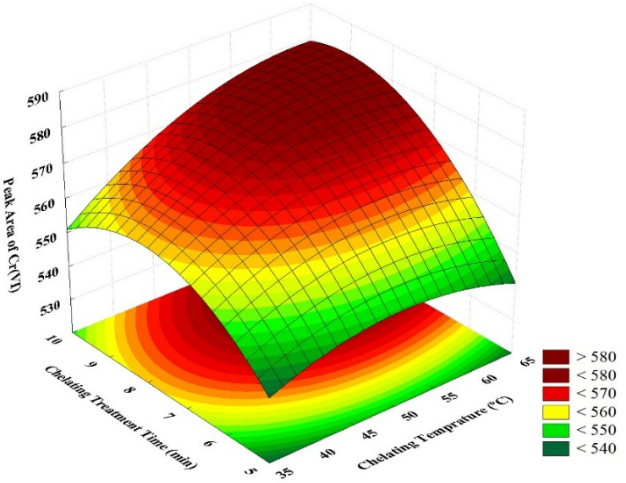

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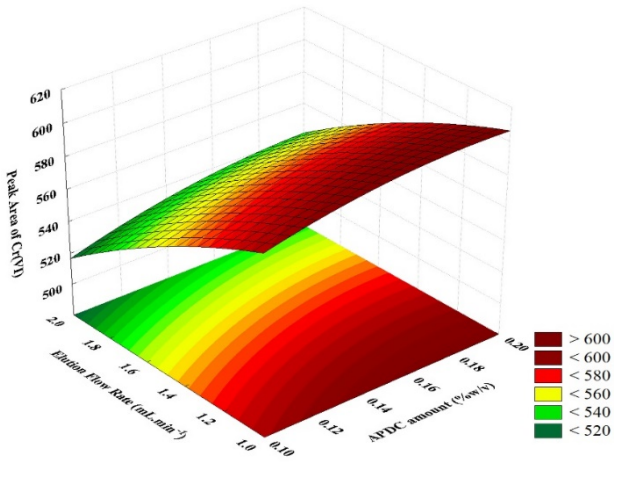

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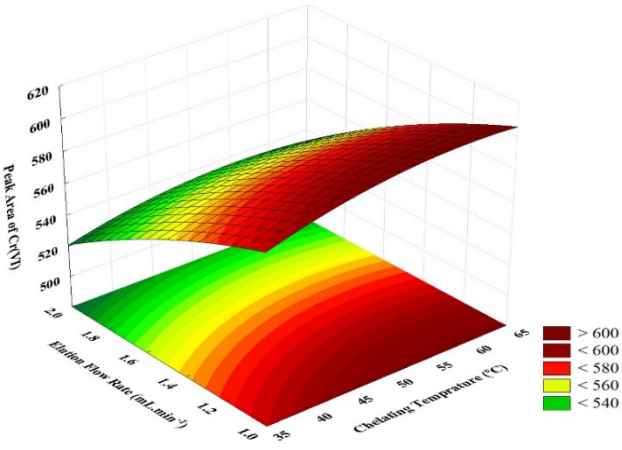

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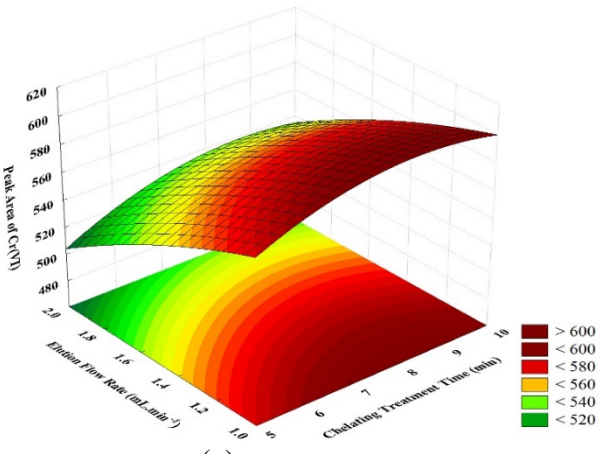

(f)

Figure S4B