Electronic Supplementary Material (ESI) for RSC Advances.

SUPPLEMENTARY TABLES

Table S1 2^{6-2} Fractional factorial design matrix and analytical results (% recovery) of each metal ion. These factors include mass of the sorbent (MS), sample pH, preconcentration flow rate (PFR) eluent concentration (EC), eluent volume (EV) and eluent flow rate (EFR).

Runs	MS	EV	EFR	pH	PFR	EC	Co	Cr	Mn	Ni	Ti
1	30	0.5	0.5	5	5	1	50.4	55.6	60.6±	48.2±	46.9±
2	30	0.5	0.5	10	5	3	51.2	66.7	63.2±	50.2±	45.9±
3	30	0.5	1.5	5	10	3	55.6	78.6±	67.8±	61.1±	58.8±
4	30	0.5	1.5	10	10	1	56.1	86.5±	69.6±	65.5±	59.9±
5	30	2	0.5	5	10	3	61.6	69.8±	73.8±	56.9±	61.8±
6	30	2	0.5	10	10	1	62.6	79.3±	76.3±	62.8±	63.7±
7	30	2	1.5	5	5	1	71.0	87.0±	87.4±	74.9±	73.3±
8	30	2	1.5	10	5	3	72.9	93.4±	88.1±	81.9±	79.5±
9	100	0.5	0.5	5	10	1	67.3	68.2±	79.5±	61.6±	55.4±
10	100	0.5	0.5	10	10	3	68.3	70.6±	80.0±	65.0 ±	57.6±
11	100	0.5	1.5	5	5	3	76.7	84.4±	86.4±	67.2±	86.9±
12	100	0.5	1.5	10	5	1	78.7	91.3±	91.0±	72.8±	89.9±
13	100	2	0.5	5	5	3	89.3	92.3±	85.7±	74.3±	75.4±
14	100	2	0.5	10	5	1	90.0	95.1±	88.5±	75.1±	77.7±
15	100	2	1.5	5	10	1	96.4	95.8±	97.0±	96.1±	94.3±
16	100	2	1.5	10	10	3	97.2	97.0±	98.1±	97.7±	96.9±
17	65	1.25	1	7.5	7.5	2	88.7	83.5±	86.2±	77.1±	74.6±
18	65	1.25	1	7.5	7.5	2	88.5	83.7±	86.1±	77.1±	74.5±
19	65	1.25	1	7.5	7.5	2	88.5	83.7±	86.1±	77.2±	74.7±

Table S2 List of experiments in the central composite design (actual values) and analytical results (% recovery) of each metal ion

Run	MS	EV	EFR	Co	Cr	Mn	Ni	Ti
1	30	1	1	48.23	50.13	54.01	47.38	50.13
2	100	1	1	88.74	83.44	90.22	73.87	85.48
3	30	2	1	61.23	65.91	69.43	54.63	66.01
4	100	2	1	94.87	95.91	96.83	97.13	96.65
5	30	1	1	52.18	68.16	70.98	63.76	64.77
6	100	1	1	98.80	98.93	99.03	98.28	97.78
7	30	1	2	67.58	58.13	61.47	55.65	59.08
8	100	1	2	96.18	94.13	95.09	93.81	95.67
9	65	1	1	96.81	78.38	81.60	73.43	83.18
10	65	2	1	89.73	97.94	98.34	97.87	98.00
11	65	1	2	97.58	67.82	70.77	65.11	68.34
12	65	2	2	77.58	88.83	90.01	86.06	87.98
13	65	1	1	95.62	95.66	96.38	96.48	95.88
14	65	1	1	95.58	95.68	96.35	96.51	95.85
15	65	1	1	95.61	95.71	96.40	96.47	95.90

Table S3 Column regeneration

Analytes	No. of cycles		
	1	**22**	**45**
Co	99.2±0.6[a]	98.7±1.1	96.2±1.4
Cr	97.9±1.3	97.6±1.3	97.1±1.1
Mn	98.6±0.8	97.9±0.8	95.3±1.2
Ni	100.3±0.2	99.4±1.0	97.1±0.5
Ti	100.7±0.4	98.3±1.4	97.9±0.4

[a]Average ± standard deviation

Table S4 Effect of various in22122terfering cations on the preconcentration and determination of Co, Cr, Mn, Ni and Ti using online μ-SPE-ICP-MS method: Concentration of interfering ion = 200 μg L^{-1}

Analyte	Recovery (%)					
	Ag(I)	Cd(II)	Cu(II)	Fe(II)	Pb(II)	Zn(II)
Co	97.2±2.2[a]	96.8±2.4	97.2±2.2	97.3±1.3	97.8±2.4	98.0±0.9
Cr	98.0±1.2	97.3±1.1	98.1±2.1	97.0±1.5	97.1±2.1	99.1±1.5
Mn	98.9±1.4	99.1±0.87	98.3±1.2	97.8±3.3	98.3±1.2	95.4±1.2
Ni	97.4±2.4	96.9±1.8	97.1±1.5	96.4±1.1	96.3±0.8	96.8±1.1
Ti	98.2±2.1	98.1±2.4	96.9±2.4	97.2±2.1	98.9±1.2	95.9±3.0

[a]Average ± standard deviation

SUPPLEMENTARY FIGURES

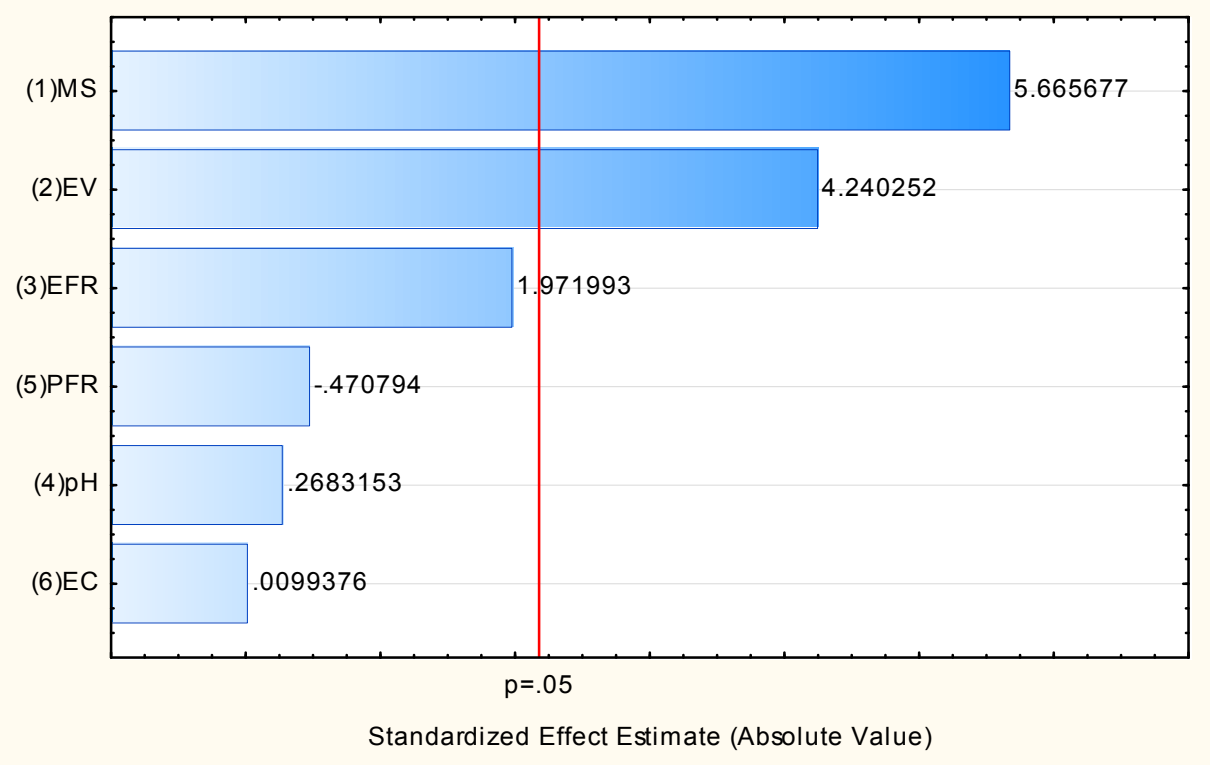

Fig. S1 Pareto chart of standardized effects for variables in the separation and preconcentration of Co: EC= eluent concentration (mol L^{-1}) and SFR=sample flow rate (mL min^{-1})

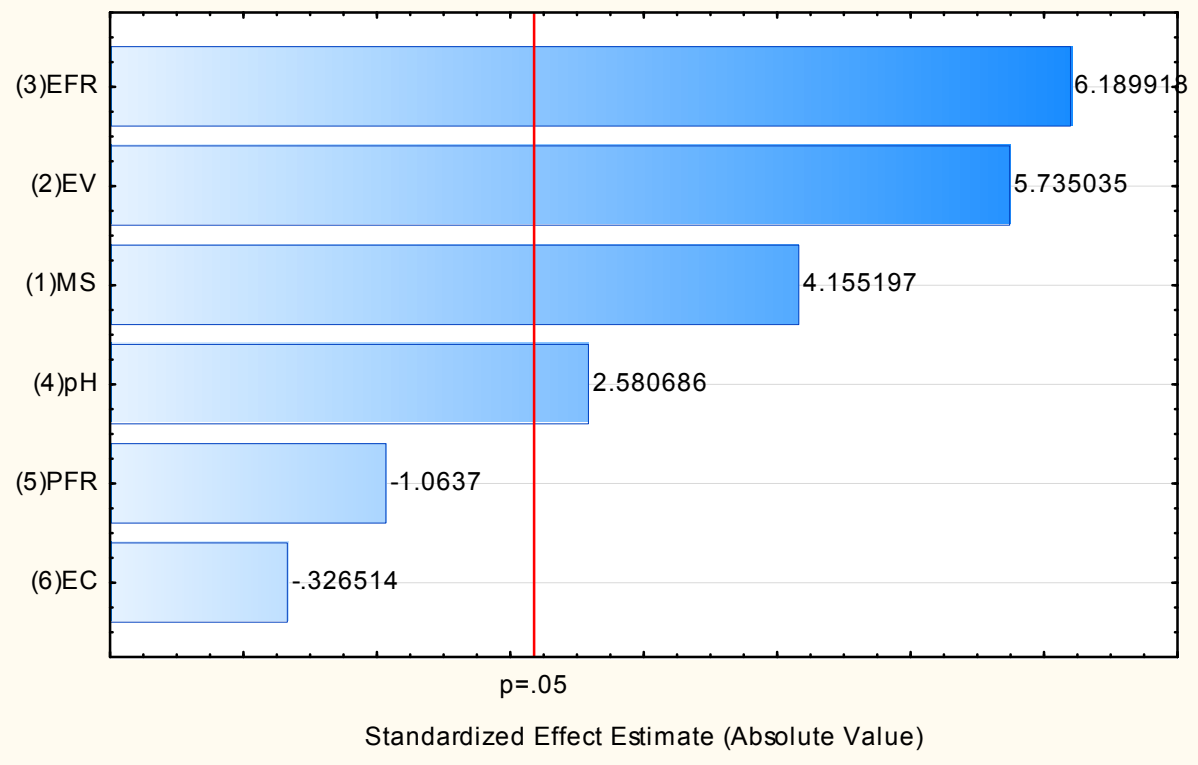

Fig. S2 Pareto chart of standardized effects for variables in the separation and preconcentration of Cr: EC= eluent concentration (mol L^{-1}) and SFR=sample flow rate (mL min^{-1})

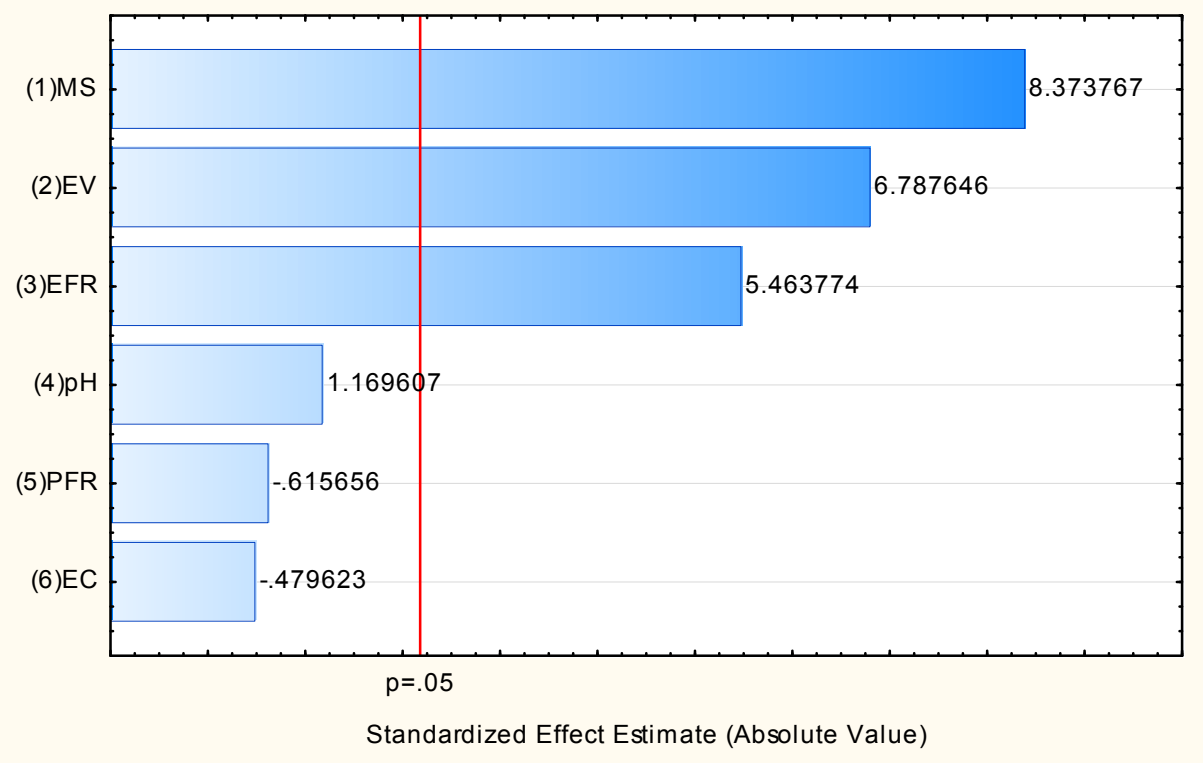

Fig. S3 Pareto chart of standardized effects for variables in the separation and preconcentration of Mn: EC= eluent concentration (mol L^{-1}) and SFR=sample flow rate (mL min^{-1})

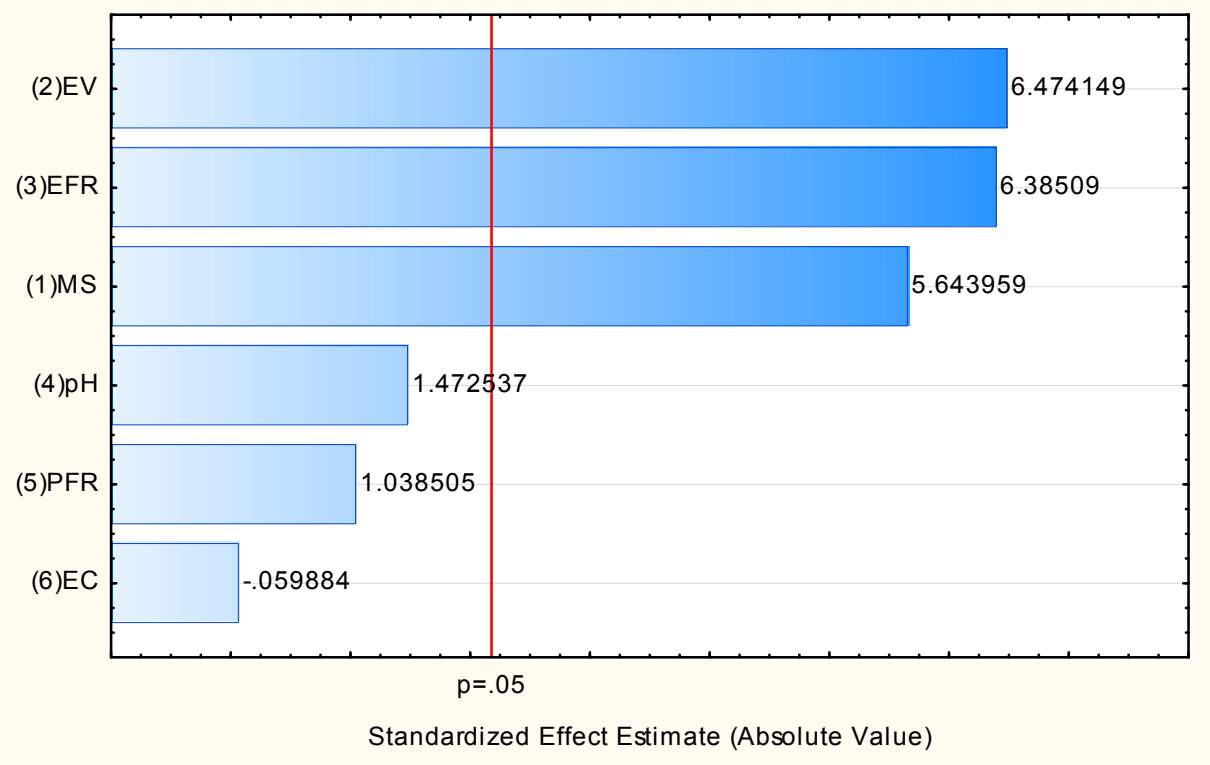

Fig. S4 Pareto chart of standardized effects for variables in the separation and preconcentration of Ni: EC= eluent concentration (mol L^{-1}) and SFR=sample flow rate (mL min^{-1})

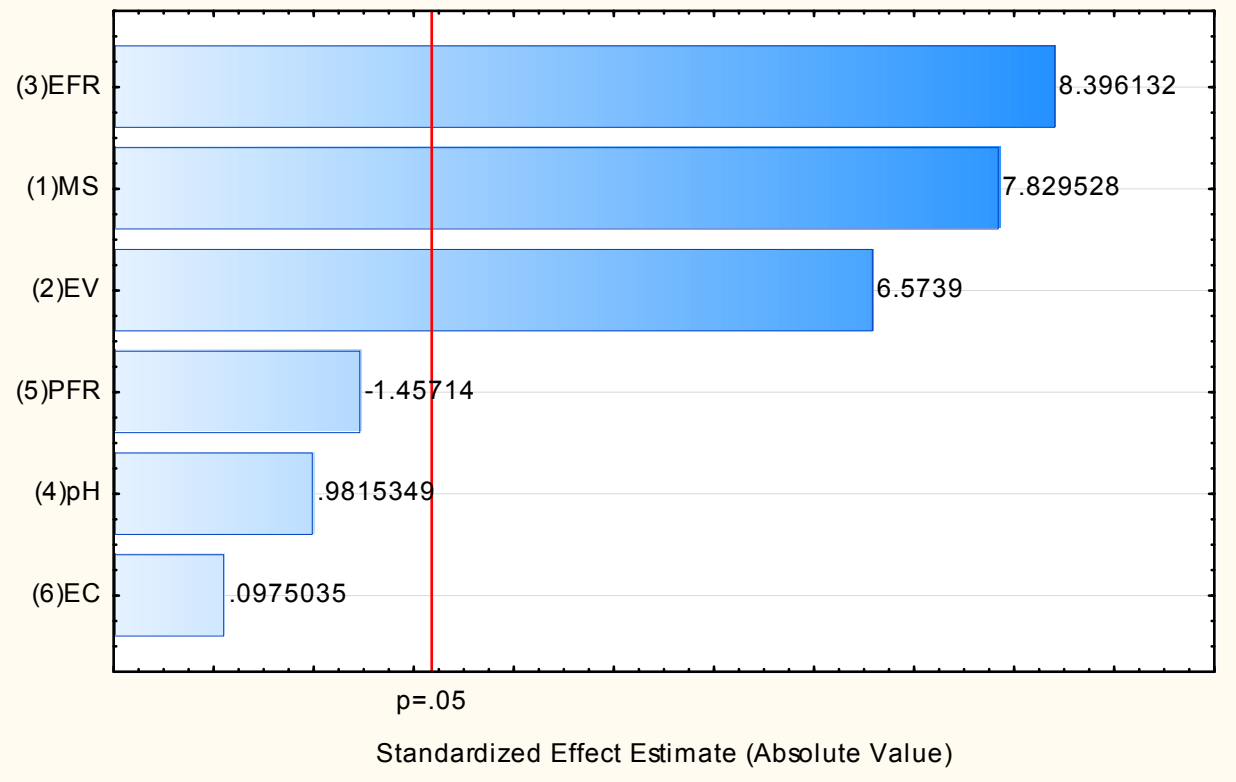

Fig. S5 Pareto chart of standardized effects for variables in the separation and preconcentration of Ti: EC= eluent concentration (mol L^{-1}) and SFR=sample flow rate (mL min^{-1})

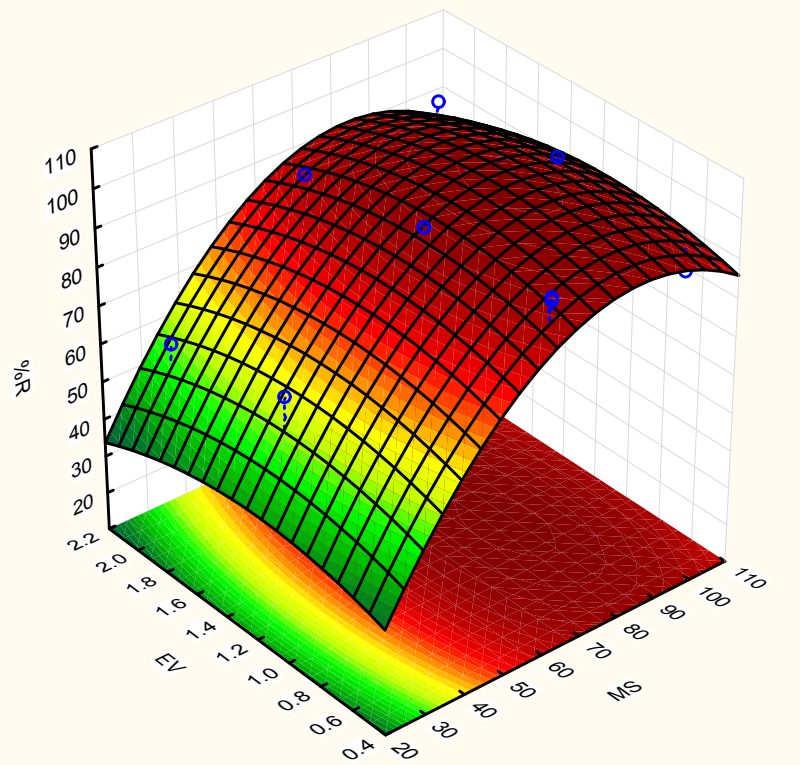

Fig. S6. Response surface for percentage recovery of cobalt, as function of mass of the sorbent (MS), mg and eluent volume (EV), mL at constant eluent flow rate (EFR) of 1.0 mL min^{-1}

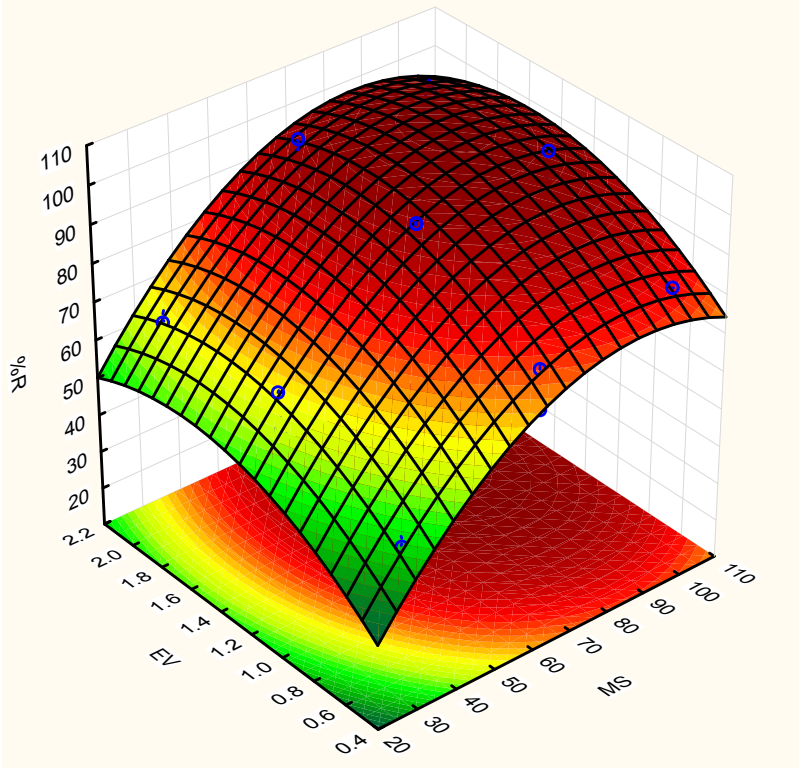

Fig. S7. Response surface for percentage recovery of chromium, as function of mass of the sorbent (MS), mg and eluent volume (EV), mL at constant eluent flow rate (EFR) of 1.0 mL min^{-1}

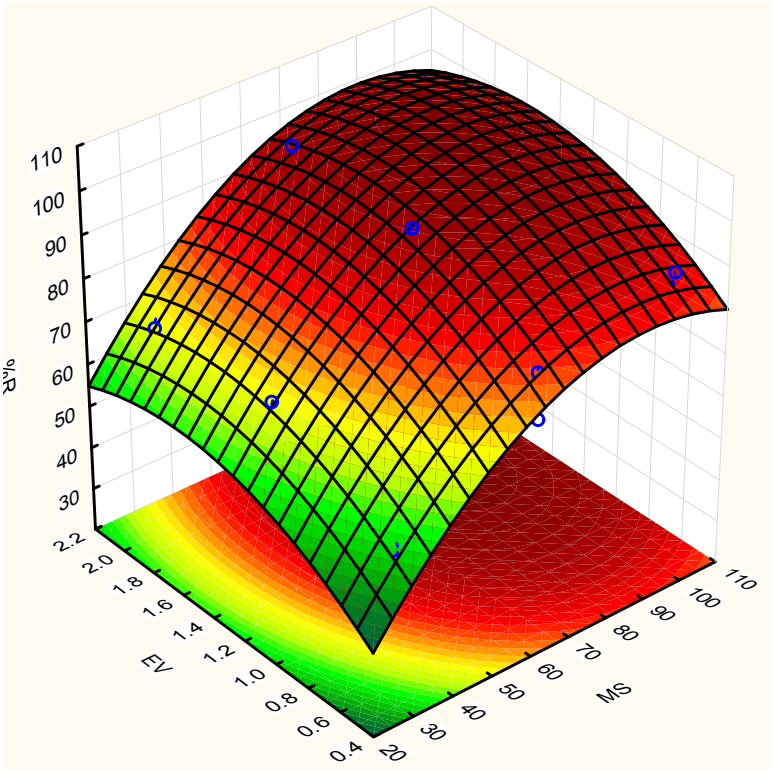

Fig. S8. Response surface for percentage recovery of manganese, as function of mass of the sorbent (MS), mg and eluent volume (EV), mL at constant eluent flow rate (EFR) of 1.0 mL min^{-1}

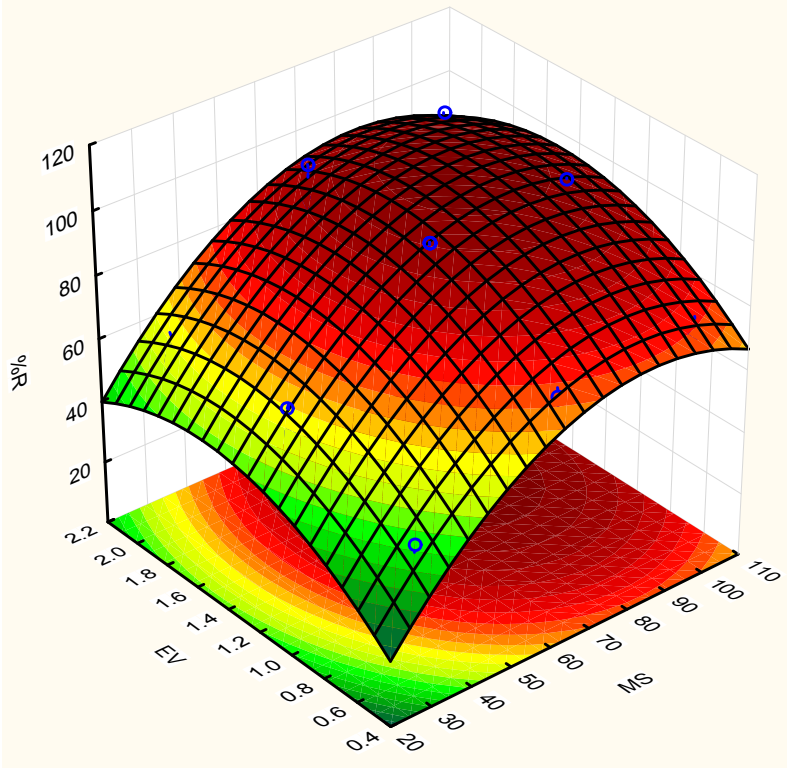

Fig. S9. Response surface for percentage recovery of nickel, as function of mass of the sorbent (MS), mg and eluent volume (EV), mL at constant eluent flow rate (EFR) of 1.0 mL min^{-1}

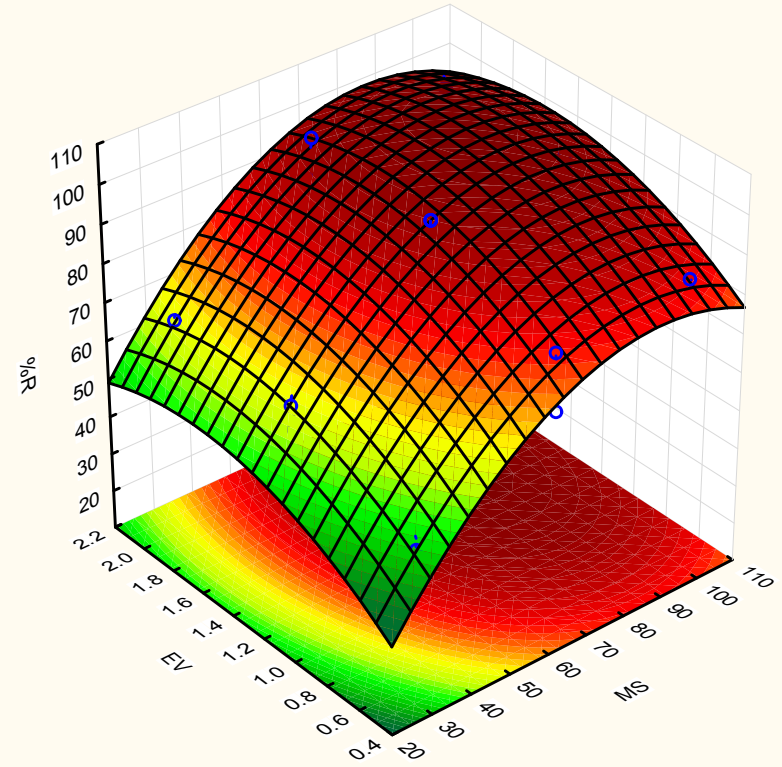

Fig. S10. Response surface for percentage recovery of titanium, as function of mass of the sorbent (MS), mg and eluent volume (EV), mL at constant eluent flow rate (EFR) of 1.0 mL min^{-1}