

Table S1. Comparative analytical performance characteristics of the proposed FI–FDSE–FAAS method with other selected on–line SPE–FAAS methods for metal determination.

Sorbent / Support	Modifier / Ligand	Eluent	PT (s)	SC (mL)	c_L ($\mu\text{g L}^{-1}$)	RSD (%)	EF	Ref.
Copper								
Silica gel	2-[N,N'-bis(2,3-dihydroxybenzaldimin)] aminoethylamine	HCl	60	5.0	0.52	-	21.5	[30]
Chloromethylated polystyrene	PPDOT	HNO ₃	240	10.0	0.56	2.0	41	[31]
Amberlite XAD–16	EBBR	HNO ₃	200	34.0	1.0	2.3	50	[32]
Silica gel	Dithizone	HNO ₃	50	5.4	0.2	1.7	42.6	[33]
Oasis-HLB	DDTC	MeOH	90	15.0	0.1	2.7	195	[12]
Amberlite XAD-1180	CAS	HNO ₃	210	19.6	1.0	1.2	56	[34]
Sty–DVB beads	Cu(II) –salen–OMe	HNO ₃	30	2.0	0.51	3.85	5.8	[35]
Nobias chelate PA–1	-	HNO ₃	120	20.0	0.26	2.6	106	[15]
Bamboo charcoal	-	HCl	60	7.6	0.60	0.26	39	[36]
HypersepSCX	-	HCl	150	15.0	0.47	2.5	93	[8]
Bond Elut Plexa PCX	-	HCl	90	18.0	0.5	2.7	95	[10]
Strata–X	DDTC	MeOH	90	15.6	0.20	3.2	185	[18]
Sol–gel PCL–DMS–CL polyester fabric disks	APDC	MIBK	90	18.0	0.15	2.2	250	**
Nickel								
PTFE–turnings	APDC	MIBK	60	13.5	0.5	2.8	170	[37]
Amberlite XAD–4	2–Aminothiophenol	HCl	180	21.0	0.8	1.9	43	[38]
Sol–gel SiO ₂ –Al ₂ O ₃ –Sb ₂ O ₅ mixed oxide	-	HCl	126	20.0	0.48	8.4	77.5	[39]
EVA turnings	-	HCl	120	10.0	3.78	4.38	46	[40]
HypersepSCX	-	HCl	150	15.0	0.68	3.3	77	[8]
Sol–gel PCL–DMS–CL polyester fabric disks	APDC	MIBK	90	18.0	0.41	2.9	130	**
Zinc								
PTFE–turnings	APDC	MIBK	30	9.0	0.3	3.2	65	[37]
Chelating resin poly(2-thiozylmethacrylamide-co-divinylbenzene-co-2-acrylamido-2-methyl-1-propane sulfonic acid	-	HNO ₃	135	12.6	2.2	1.2	40	[41]
Moringa Oleifera seeds	-	HNO ₃	600	60.0	0.9	-	23	[42]

Dowex 1X8 resin	Zincon	HNO ₃	120	6.4	0.67	5.0	10	[43]
Bamboo charcoal	-	HNO ₃	60	7.6	0.36	1.6	30	[36]
Sol-gel PCL-DMS-CL polyester fabric disks	APDC	MIBK	30	6.0	0.12	3.5	49	**
Lead								
Nobias chelate PA-1	-	HNO ₃	120	20.0	1.0	3.30	98	[15]
HypersepSCX	-	HCl	150	15.0	2.1	3.1	97	[8]
Bond Elut Plexa PCX	-	HCl	90	18.0	1.8	3.1	95	[10]
Oasis HLB	DDTP	MeOH	90	12.0	0.92	2.6	180	[14]
Strata-X	DDTC	MeOH	90	15.6	1.6	2.9	140	[18]
Sol-gel PDMDPS polyester fabric disks	APDC	MIBK	90	15.6	1.8	3.1	140	[24]
Sol-gel PCL-DMS-CL polyester fabric disks	APDC	MIBK	90	18.0	1.62	2.5	185	**
Cadmium								
Silica gel	2-[N,N'-bis(2,3-dihydroxybenzaldimin)] aminoethylamine	HCl	60	5.0	0.65	-	12.3	[30]
Amberlite XAD-4	2-Aminothiophenol	HCl	180	21.0	0.3	3.1	99	[38]
Nobias chelate PA-1	-	HNO ₃	120	20.0	0.1	2.20	105	[15]
HypersepSCX	-	HCl	150	15.0	0.14	2.8	92	[8]
Bond Elut Plexa PCX	-	HCl	90	18.0	0.1	2.9	90	[10]
Oasis HLB	DDTP	MeOH	90	12.0	0.09	2.9	155	[14]
Strata-X	DDTC	MeOH	90	15.6	0.18	2.7	72	[18]
Sol-gel PDMDPS polyester fabric disks	APDC	MIBK	90	15.6	0.4	3.3	38	[24]
Sol-gel PCL-DMS-CL polyester fabric disks	APDC	MIBK	90	18.0	0.49	3.2	36	**

**, This work; PT, preconcentration time; SC, sample consumption; c_L, detection limit; RSD, relative standard deviation; EF, enhancement factor; PTFE, polytetrafluoroethylene; APDC, ammonium pyrrolidine dithiocarbamate; MIBK, methyl isobutyl ketone; EVA, ethyl vinyl acetate; PPDOT, 1-phenyl-1,2-propanedione-2-oxime thiosemicarbazone; EBBR, eriochrome blue black R; DDTC, sodium diethyldithiocarbamate; CAS, chrome azurol S; Sty-DVB, styrene divinylbenzene; OMe, 2,2'-[ethane-1,2-diylbis(nitrilo(E)methylidene)]bis(6-allyl-4-methoxyphenol); DDTP, diethyldithiophosphate; PDMDPS, poly(dimethyldiphenylsiloxane).