

Streamlined Method for EPA 1694: Pharmaceuticals and Personal Care Products in Water

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Introduction:

EPA Method 1694 is a non-regulatory screening method for the analysis of pharmaceuticals and personal care products (PPCPs) in environmental samples, including water [1]. The method uses SPE and LC-MS/MS to analyze 73 PPCPs in drinking water, surface water and treated wastewater. The PPCPs include common prescription drugs, over-the-counter medicines, dietary supplements and consumer products. The method divides the PPCPs into four groups based on their physicochemical properties. Water samples are extracted via two SPE procedures (pH 2 and pH 10) and LC-MS/MS analysis is carried out with four separate methods that use different HPLC columns, mobile phases, gradients and ionization modes (ESI⁺ and ESI⁻). Fortunately, modifications to EPA 1694 are allowed if they provide performance equal to or better than that specified in the official method.

This poster outlines a streamlined analytical method for EPA 1694. The SPE procedure was optimized to achieve acceptable recoveries of the PCPPs using a single extraction step rather than the multiple extraction procedures outlined in the original EPA method. Water samples are extracted using a highly cross-linked polymeric SPE cartridge (Enviro-Clean[®] HL DVB) without any pH adjustment. LC-MS/MS analysis uses a single HPLC column (Selectra[®] DA) and two methods (ESI⁺ and ESI⁻) rather than the two HPLC columns and four methods outlined in EPA 1694. The recovery and RSD values obtained were found to be within the method requirements for the vast majority of PPCPs. Overall, this streamlined approach significantly reduces the analysis time while still achieving comparable results to the original EPA method.

Experimental:

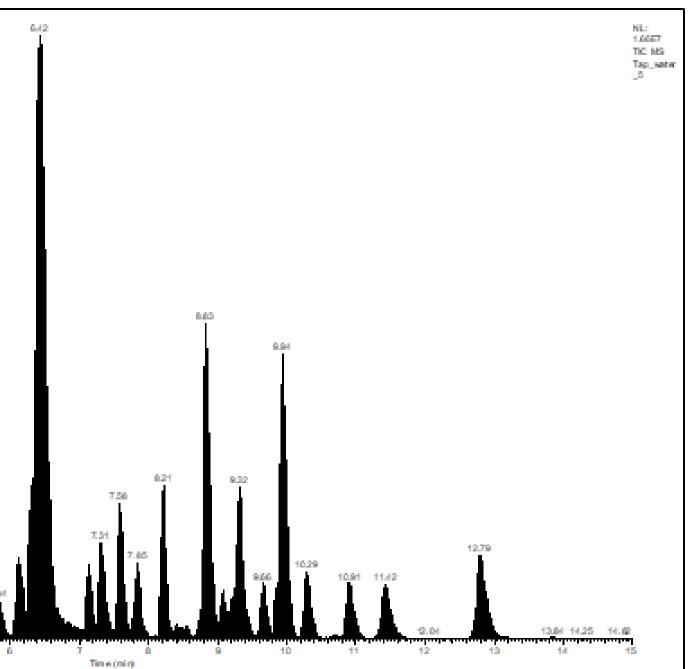
Product	Part Number	Description
SPE cartridge	ECHLD156-P	ENVIRO-CLEAN® HL DVB 500 mg, 6 mL cartridge
SPE manifold	VMF016GL	16 position glass block manifold
Transfer tubes	VMFSTFR12	Large volume sample transfer tubes

	Instrumentation
HPLC system	Thermo ScientificTM DionexTM UltimateTM 3000
MS system	Thermo ScientificTM TSQ VantageTM (MS/MS)
HPLC column	UCT Selectra [®] DA, 100 \times 2.1 mm, 3 μ m (p/n: SLDA100ID21-3UM)
Guard column	UCT Selectra [®] DA, 10 \times 2.0 mm, 3 μ m (p/n: SLDAGDC20-3UM)
Guard column holder	p/n: SLDGRDHLDR
Column temperature	30°C
Flow rate	300 μL/min
Injection volume	5 μ L (ESI ⁺ method) or 10 μ L (ESI ⁻ method)

LC-MS/MS Parameters:

	Method 1 (E				
Fime (min)	Mobile Phase A (%) Water + 0.1% Formic Acid	Mobile Phase B (%) Methanol + 0.1% Formic Acid			
0	98	2			
1	60	40			
4	60	40			
6	30	70			
10	30	70			
12	0	100			
15	0	100			
15.1	98	2			
20	98	2			
90 20 20 20 20 20 20 20 20 20 2	430 5.45 5.45 7.45				
10	5.09 5.79 4.69 1.00 2.43 2.02 3.45				

	Method 2 (ESI ⁻)				
Time (min)	Mobile Phase A (%) Water + 10mM NH4OAc	Mobile Phase B (%) Acetonitrile				
0	90	10				
3	0	100				
6	0 100					
6.1	90	10				
11	90	10				
95 90 165 100 75 70 65 60 90 95 90 95 90 45 40 45 36 30 25 30 25 20 15		1.20 1.21 1.21 1.23				



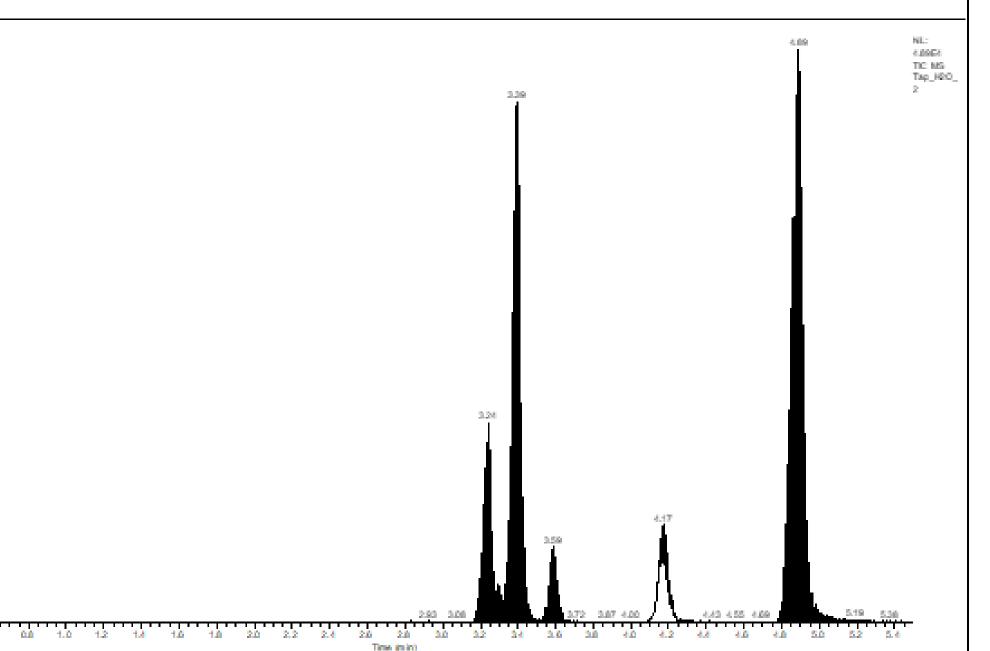


Figure 2: TIC chromatogram of the ESI⁻ analytes in an extracted tap water sample

SPE Procedure

Sample Pretreatment

- No sample pH adjustment required
- Add 80 mg/L of sodium thiosulfate (residual chlorine)
- Add 500 mg/L tetrasodium EDTA (metal chelation)

SPE Conditioning

- 10 mL acetone
- 10 mL DI water

Sample Extraction

- Attach large volume transfer tube to SPE cartridge
- Apply water sample at 5-10 mL/min

SPE Rinse

- Remove large volume transfer tube
- Rinse SPE cartridge with 10 mL DI water
- Dry cartridge for 10 minutes (full vacuum)

Elution

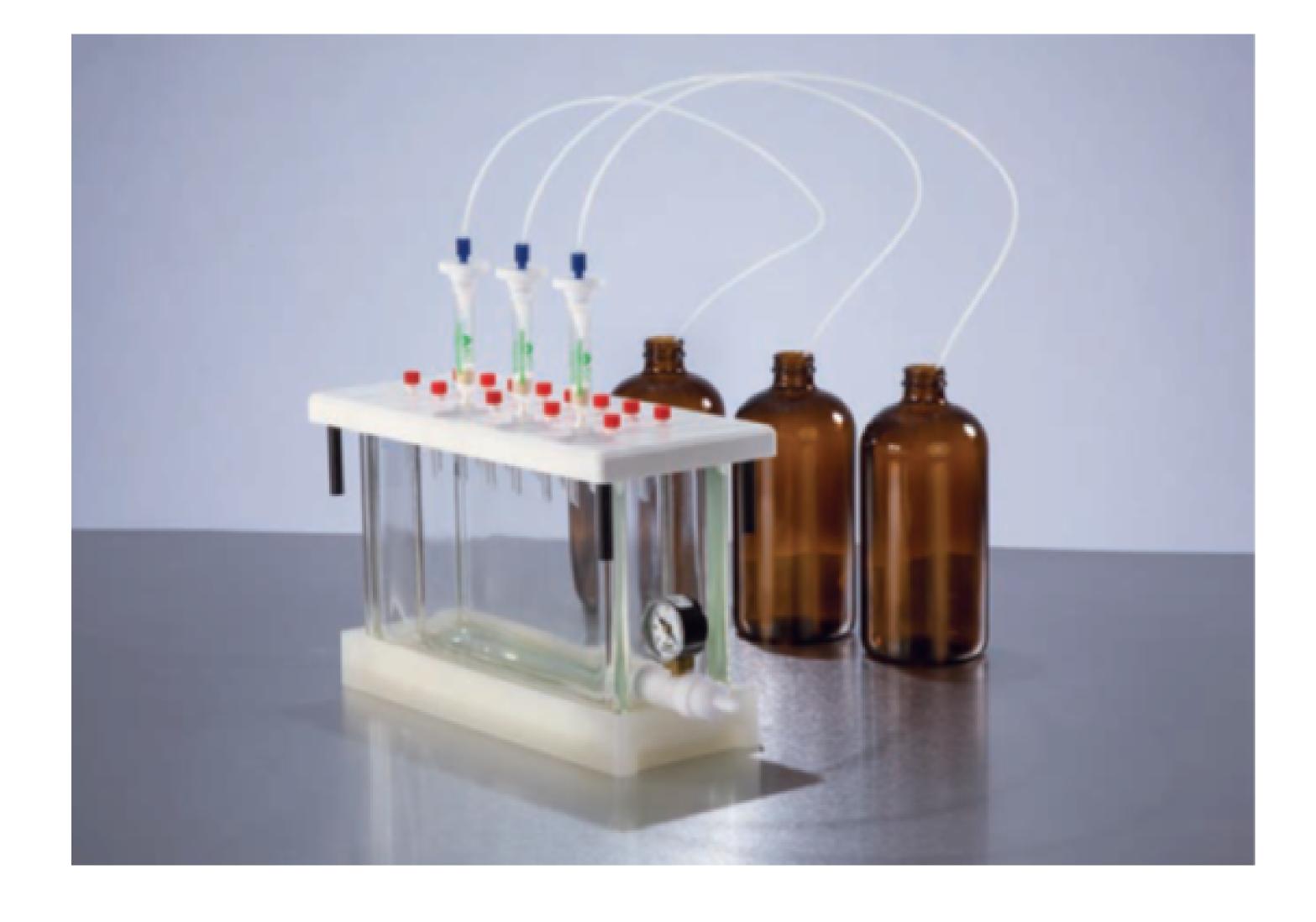
10 mL methanol/acetone (1:1, v/v)

Concentration

- Evaporate to near dryness at 40-50°C (N₂)
- Reconsitute in 1 mL methanol
- Transfer to autosampler vial

Results:

Analyte	Fortification Level (ng)	EPA 1694 IP	R* Criteria RSD (%)	Deionized Water Becovery (%)	Results (n = 6) RSD (%)	Tap Water Resu Recovery (%)	lts (n = 6) RSD (%)
Acetaminophen	1500	Recovery (%) 55 - 108	30 (%)	Recovery (%)	RSD (%) 7.8	Recovery (%) 111.5	RSD (%)
Albuterol	1500	55 - 120	30	82.0	2.6	83.9	2.0
Ampicillin	75	6 - 180	70	88.8	7.3	70.8	24.1
Anhydrotetracycline	250	8 - 127	30	59.3	8.4	61.9	6.0
Azithromycin	75	36 - 108	30	68.5	4.5	92.5	6.8
Caffeine	750	55 - 111	30	106.9	3.0	110.0	3.4
Carbadox	75	36 - 130	30	100.0	4.1	97.2	4.8
Carbamazepine	75	23 - 123	30	112.4	2.8	105.5	2.0
Cefotaxime	300	9 - 168	36	110.7	8.5	90.6	13.9
Chlortetracycline	100	49 - 155	31	63.2	5.9	67.0	5.5
Cimetidine	30	6 - 108	47	42.1	8.0	26.9	8.4
Ciprofloxacin	240	55 - 108	30	105.7	3.4	107.7	2.3
Clarithromycin	75	8 - 139	30	79.6	7.6	94.3	5.7
Cloxacillin	150	6 - 180	30	95.4	1.1	97.6	3.8
Codeine	150	37 - 116	30	95.6	3.3	107.9	2.2
Cotinine	75	55 - 112	30		1		2.2
I				100.3	1.3	106.6	<u> </u>
Demeclocycline	250	6 - 180	30	68.1	4.4	61.8	3.7
Digoxigenin	300	8 - 165	30	112.3	7.6	108.1	4.0
	750	6 - 133	45	99.6	8.9	102.0	6.5
Diltiazem	15	13 - 108	48	102.5	4.0	112.0	2.6
Dimethylxanthine	7500	55 - 124	30	72.9	3.9	112.9	2.8
Diphenhydramine	30	53 - 108	30	73.8	4.1	80.0	7.9
Doxycycline	100	24 - 149	30	76.1	5.5	66.6	2.8
Enrofloxacin	150	55 - 113	30	74.1	6.5	67.0	9.8
Erythromycin	15	N/A	N/A	126.0	15.8	131.2	7.5
Erythromycin anhydrate	15	55 - 142	30	69.2	7.3	94.5	4.9
Iumequine	75	39 - 180	30	97.8	1.2	98.4	2.4
Iuoxetine	75	54 - 112	30	117.3	13.0	105.8	5.9
Gemfibrozil	75	55 - 108	30	99.8	4.0	107.7	8.8
buprofen	750	55 - 108	30	103.8	1.6	101.5	1.8
_incomycin	150	6 - 108	60	105.9	3.5	99.3	2.4
omefloxacin	150	19 - 180	33	89.5	4.2	83.5	8.0
Vetformin	1500	55 - 134	30	89.2	1.4	96.2	2.9
Viconazole	75	29 - 108	30	81.3	4.2	74.0	6.1
Minocycline	1000	6 - 159	30	52.6	12.4	42.1	10.2
Vaproxen	150	55 - 108	30	106.5	1.5	108.1	1.9
Norfloxacin	750	55 - 121	30	103.8	2.9	99.1	2.4
Ofloxacin	75	55 - 180	30	103.6	3.9	119.8	7.3
Ormetoprim	30	55 - 108	30	99.9	3.1	98.0	1.5
Dxacillin	150	6 - 180	30	94.5	0.5	97.8	4.4
Oxolinic acid	30	46 - 112	30	92.4	2.5	95.7	2.9
Dxytetracyline	100	55 - 165	30	82.9	5.7	65.7	4.4
Penicillin G	150	6 - 180	30	84.6	3.8	89.0	4.3
Penicillin V	150	6 - 180	30	99.1	2.7	102.5	4.0
Ranitidine	30	26 - 144	41	39.3	7.6	26.9	31.4
Roxithromycin	15	42 - 108	30	68.0	7.1	86.6	10.0
Sarafloxacin	660	18 - 180	32	86.3	4.5	77.0	10.9
Sulfachloropyridazine	75	55 - 180	30	68.6	4.5	83.6	5.6
Sulfadiazine	75	6 - 180	30	7.6	19.2	121.4	5.5
Sulfadimethoxine	15	55 - 108	30	83.9	3.7	76.8	6.3
Sulfamerazine	30	55 - 133	30	90.1	4.6	80.6	15.3
Sulfamethazine	30	55 - 128	30	103.2	3.2	104.5	5.3
Sulfamethizole	30	55 - 108	30	43.5	12.7	77.5	15.2
Sulfamethoxazole	30	55 - 108	30	119.6	12.3	110.2	16.2
Sulfanilamide	750	6 - 170	71	22.4	7.5	20.1	9.3
Sulfathiazole	75	45 - 108	30	79.0	5.6	110.4	2.7
Tetracycline	100	55 - 139	30	75.1	5.8	66.4	5.0
-hiabendazole	75	55 - 108	30	108.4	1.5	109.6	2.8
		55 - 108	30	108.4			3.7
Triclocarban	150				1.9	104.9	1
	3000	55 - 108	30	100.9	5.0	102.7	3.0
Frimethoprim	75	55 - 114	30	109.7	1.6	110.6	1.9
Tylosin	300	17 - 134	30	60.1	12.6	86.0	8.7
/irginiamycin	150	6 - 170	33	80.6	4.0	90.2	2.5
Warfarin	75	55 - 108	30	101.1	1.7	102.1	2.0



Conclusion:

This poster presents a simplified SPE method for the determination of a wide range of PPCPs in environmental water samples according to EPA Method 1694. Water samples are extracted using a single extraction procedure using UCT's Enviro-Clean[®] HL DVB polymeric SPE cartridge without any sample pH adjustment. LC-MS/MS analysis was conducted with a single HPLC column (Selectra DA[®]) using only two methods instead of the two HPLC columns and four methods outlined in the original EPA 1694 method. The recovery and RSD values obtained were found to be within the EPA Method 1694 requirements for the vast majority of the 64 PPCPs included in this study. Overall, the streamlined screening method outlined in this poster significantly speeds up the analysis of a PPCPs in water compared to the original EPA method. The method can also be used as a starting point for a custom PPCP method that is tailored to specific matrices or compounds. In this case, further optimization of the method can be carried out to optimize results.

References:

[1] EPA Method 1694: Pharmaceuticals and Personal Care Products in Water, Soil, Sediment, and Biosolids by HPLC/MS/MS, December 2007, EPA-821-R-08-002.

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