Semi-Targeted Screening of Pharmaceutically-Related Contaminants in the Thames Tideway using LC-HRMS

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Overview

The occurrence of pharmaceutically-related contaminants within the environment continues to be a research area which generates great interest. The full environmental effects of chronic exposure of such pollutants have yet to be fully understood. As such more knowledge is sought on the presence of these contaminants within the environment.

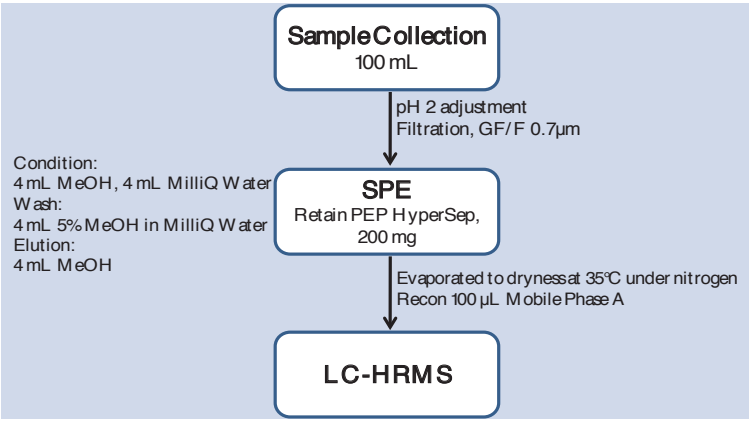
Traditionally, a targeted multi-residue analytical approach is applied to the analysis of environmental waters. A consequence of this can be a somewhat limited estimation of the true breadth of occurrence of pharmaceutically-related drug residues within such waters. Recent advances have seen non-targeted methods proposed as valid alternatives to the traditional approach.

A 'semi-targeted' analytical approach is presented herein for the detection of a range of over-the-counter, prescribed and illicit drugs in environmental waters using mixed mode solid phase extraction (SPE) and liquid chromatography-high resolution mass spectrometry (LC-HRMS). The potential to perform retrospective non-target analysis is also presented.

Experimental

A broad analytical screening method, shown in Figure 1, was developed using a selection of structurally diverse species which represented a variety of compounds classes, functional groups, pK_a and log *P* values as well as reported environmental occurrences.

FIGURE 1
Schematic showing developed semi-targeted analytical approach.



LC-HRMS was performed using a Thermo Scientific QExactive™ (Thermo Scientific, Bremen, Germany), and the chromatographic and MS conditions are detailed in Table 1.

TABLE 1. LC-HRMS conditions.

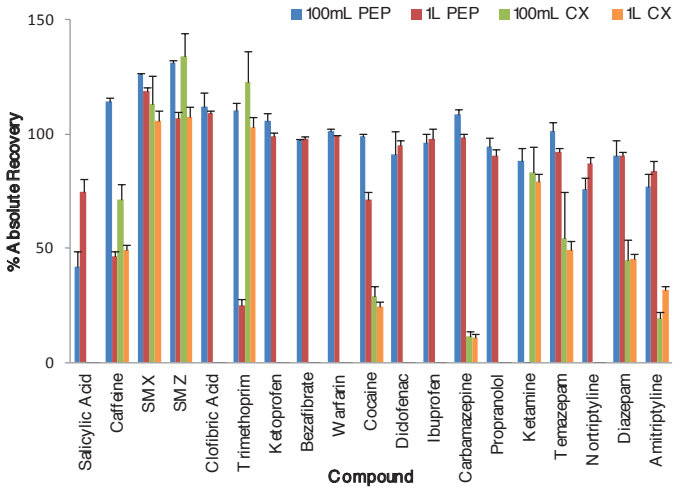
	Column	Thermo Scientific Accucore™ 2.6 C18 (150 x 2.1 mm)	
LC	Mobile Phase	A: 90:10 Water + 10mM Ammonium Acetate : Acetonitrile B: 20:80 Water + 10 mM Ammonium Acetate:Acetonitrile	
	Injection volume	20 µL	
	Flow Rate	400 µl/min	
HRMS	Capillary Temp (C)	350	
	Heater Temp (C)	300	
	Spray Voltage	+ve. 4.5 kV	-ve. 3 kV
	Capillary Voltage	+ve. 52.5 V	-ve. 52.5 V
	Tube Lens Voltage	+ve. 135 V	-ve. 135 V
	Resolution	50,000 FWHM	
	Scan Range	m/z: 100-1000	
	AGC Target	1,000,000	
	Max. Inject Time	100 ms	
	Fragmentation Mode	HCD (20eV)	

Results & Discussion

1. SPE Method Development

The recoveries of compounds were evaluated for two different mixed-mode SPE sorbents across a range of pH (2-9). Figure 2 shows that optimized absolute recoveries for the majority of compounds were obtained using the Retain PEP-functionalised polystyrene-divinylbenzene sorbent with a 100 mL sample when adjusted to pH 2.

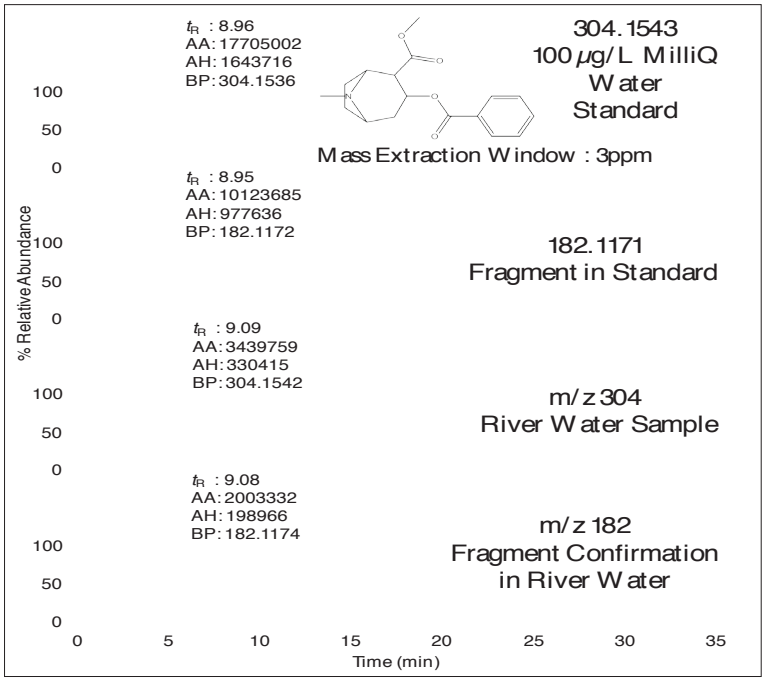
FIGURE 2. Absolute recoveries obtained using a mixed mode PS-DVB sorbent (PEP) and a mixed mode cation exchange sorbent (CX) with a sample adjusted to pH 2.



2. 'Semi-Targeted' Screening of Real Samples

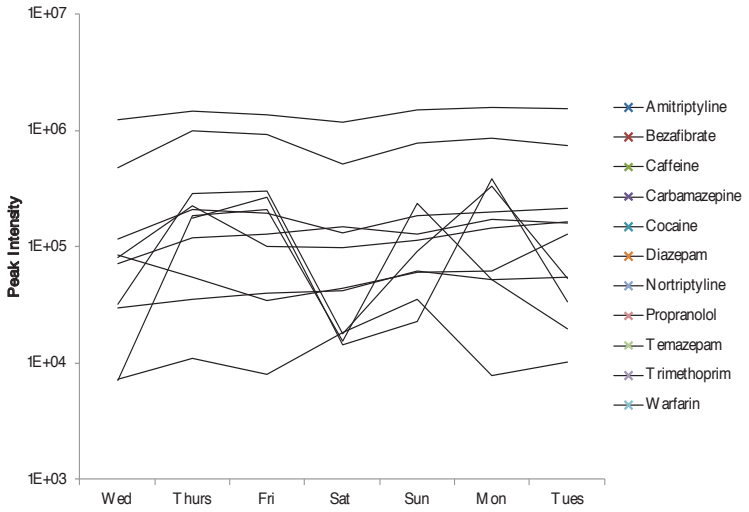
The developed analytical method was applied to the analysis of both Thames river water and influent wastewater. The presence of an analyte was confirmed by comparison with a reference standard. For example, cocaine is shown in Figure 3.

FIGURE 3. Cocaine confirmation. t_R: retention time; AA: Peak Area; AH: Peak Height; BP: Base Peak accurate mass.



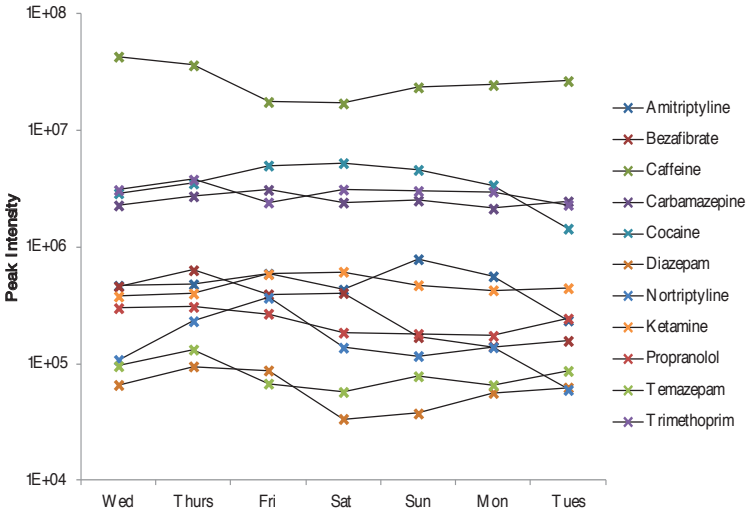
Week-long qualitative studies of both river water and influent showed that the majority of the targeted compounds were present, shown in Figures 4 and 5 respectively. A quantitative analysis is now in preparation.

FIGURE 4. Weekly variation of identified compounds in Thames river water.



Levels of the majority of compounds remain consistent across the week, with the biggest fluctuations being observed in river water, in particular for cocaine and diazepam. It can also been seen that levels were approximately ten fold higher in influent for several compounds.

FIGURE 5. Weekly variation of identified compounds in influent wastewater.



3. Mephedrone in the Environment

Using the above approach, it was also possible to identify the illicit drug, mephedrone (4-methylmethcathinone) in both river and wastewater.

FIGURE 6. Chromatograms indicating the presence of the illicit drug mephedrone within river water and influent wastewater.

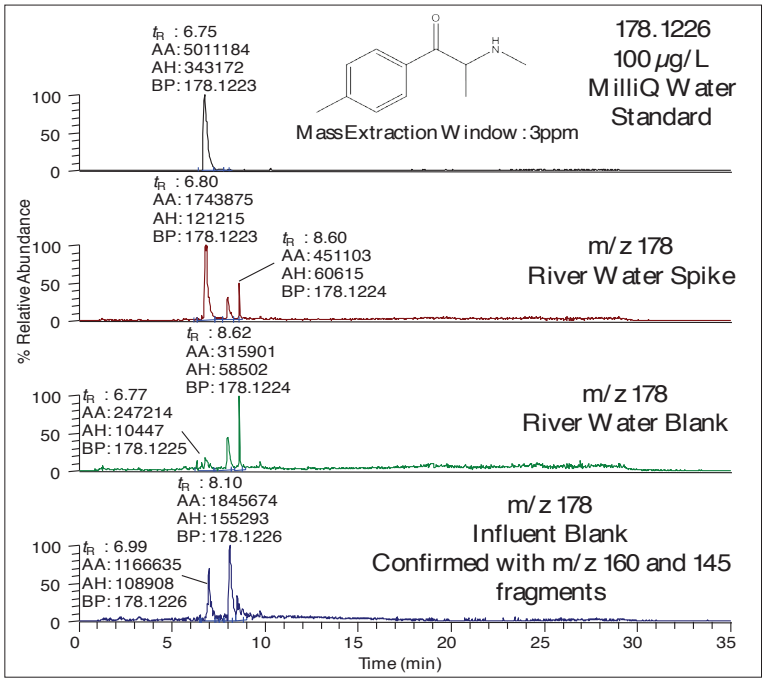


Figure 6 shows the presence of mephedrone in river water, along with an unknown peak at 8.6 min which has the same accurate mass as mephedrone. Comparing a spiked sample with a blank sample it is clear that the intensity of the mephedrone peak increases accordingly whereas the unknown peak stays constant, confirming the presence of mephedrone within the river water. Mephedrone was also detected in influent water, with confirmatory fragment ions (m/z 160.1117 and 145.0883). Again, an unknown peak was present at a similar retention time to that observed in river water. Therefore, this shows that even with HRMS, that the optimization of separation conditions is still very important. Ongoing efforts aim to apply this method in a quantitative analysis of both sample types once a complete analyte list is determined based on actual occurrence data.

Conclusion

A developed 'semi-targeted' analytical method was used to confirm the presence of several medicinal and illicit species in both river water and influent wastewater. The potential of non-target retrospective analysis was also highlighted with the detection of the illegal drug mephedrone within environmental waters.

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