Gas Chromatography Multiresidue Method for Enantiomeric Fraction Determination of Psychoactive Substances in Effluents and River Surface Waters

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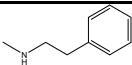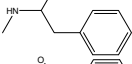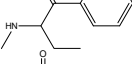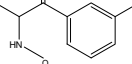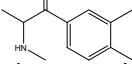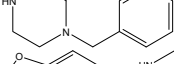
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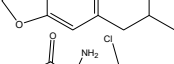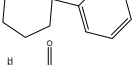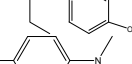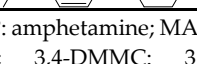[5] UCIBIO, REQUIMTE, Laboratory of Toxicology, Faculty of Pharmacy, University of Porto, R. Jorge Viterbo Ferreira, n° 228, 4050-313 Porto, Portugal

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1. MATERIALS AND METHODS

Table S1. Chemical structures, pKa and Log K$_{ow}$ of the selected PAS.

PAS	Chemical structure	pKa	Log K$_{ow}$
AMP		9.9	1.76
MAMP		9.87	2.07
BPD		7.14	1.32
3-MMC		-	1.76
3,4-DMMC		-	2.25
1-BP		9.59	1.35
MDMA		9.9	2.15
NK		6.78	1.94
BTL		7.7	1.54
1,4-MPP		8.98	1.29

PAS: Psychoactive substances; AMP: amphetamine; MAMP: methamphetamine; BPD: buphedrone; 3-MMC: 3-methylmethcathinone; 3,4-DMMC: 3,4 dimethylmethcathinone; 1-BP: 1-benzylpiperazine; MDMA: 3,4-methylenedioxy-N-methylamphetamine; NK: norketamine; BTL: butylone; 1,4-MPP: 1-(4-metoxyphenyl)-piperazine;

2. METHOD PARAMETERS AND VALIDATION

Table S2. Range of concentrations (ng L^{-1}) of the method calibration curve.

PAS	Calibration curve concentration (ng L^{-1})					
AMP	**50**	**100**	**125**	**150**	250	300
MAMP	50	100	125	150	300	
BPD	125	175	200	225	375	425
3-MMC	250	375	425	500	575	
3,4-DMMC	250	300	375	500	625	
1-BP	250	300	325	500	625	
MDMA	75	125	175	225	300	375
NK	75	100	125	150	200	250
BTL	75	125	175	250	300	375
1,4-MPP	75	100	150	175	250	

PAS: Psychoactive substances; AMP: amphetamine; MAMP: methamphetamine; BPD: buphedrone; 3-MMC: 3-methylmethcathinone; 3,4-DMMC: 3,4 dimethylmethcathinone; 1-BP: 1-benzylpiperazine; MDMA: 3,4-methylenedioxy-N-methylamphetamine; NK: norketamine; BTL: butylone; 1,4-MPP: 1-(4-metoxyphenyl)-piperazine;

Table S3. Quality control (QC) concentrations (ng L^{-1}) used for determination of accuracy, intra and inter-precision and recovery of the method.
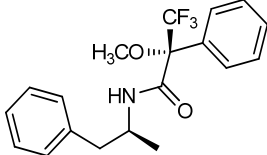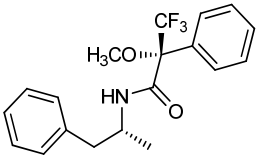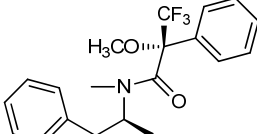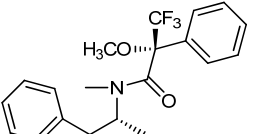
QC concentration (ng L^{-1})										
PAS	AMP	MAMP	BPD	3-MMC	3,4-DMMC	MDMA	NK	BTL	1,4-MPP	1-BP
QC1	100	75	150	300	300	125	100	100	87.5	300
QC2	137.5	112.5	212.5	350	350	175	175	175	125	350
QC3	225	175	300	500	575	325	300	300	200	575
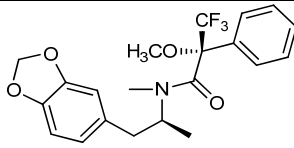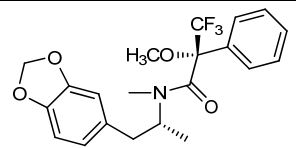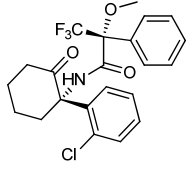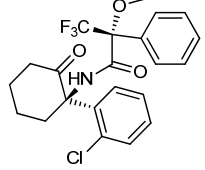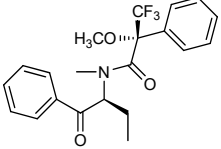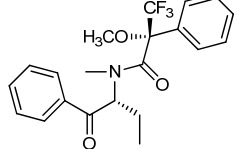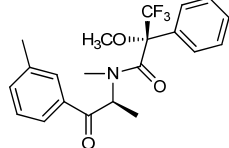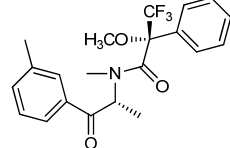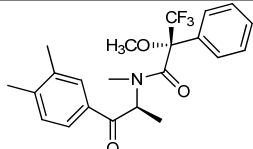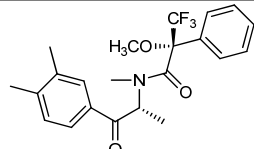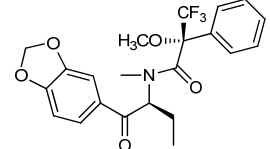
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3. RESULTS AND DISCUSSION

3.1. Derivatization method for diastereomers and derivatives formation

Table S4. Products of the reaction of the enantiopure derivatization reagent (R)-MTPA-Cl with AMP and AMP-type substances, SCAT, NK and PP.

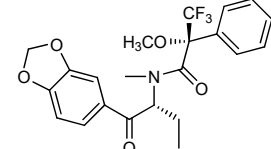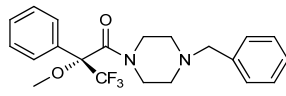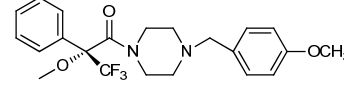|			
	MDMA	(R)-N-((S)-1-(benzo[d][1,3]dioxol-5-yl)propan-2-yl)-3,3,3-trifluoro-2-methoxy-N-methyl-2-phenylpropanamide	(R)-N-((R)-1-(benzo[d][1,3]dioxol-5-yl)propan-2-yl)-3,3,3-trifluoro-2-methoxy-N-methyl-2-phenylpropanamide
Norketamine diastereomers	NK	(R)-N-((S)-1-(2-chlorophenyl)-2-oxocyclohexyl)-3,3,3-trifluoro-2-methoxy-2-phenylpropanamide	(R)-N-((R)-1-(2-chlorophenyl)-2-oxocyclohexyl)-3,3,3-trifluoro-2-methoxy-2-phenylpropanamide
Cathinones diastereomers	BPD	(R)-3,3,3-trifluoro-2-methoxy-N-methyl-N-((S)-1-oxo-1-phenylbutan-2-yl)-2-phenylpropanamide	(R)-3,3,3-trifluoro-2-methoxy-N-methyl-N-((R)-1-oxo-1-phenylbutan-2-yl)-2-phenylpropanamide
	3-MMC	(R)-3,3,3-trifluoro-2-methoxy-N-methyl-N-((S)-1-oxo-1-(m-tolyl)propan-2-yl)-2-phenylpropanamide	(R)-3,3,3-trifluoro-2-methoxy-N-methyl-N-((R)-1-oxo-1-(m-tolyl)propan-2-yl)-2-phenylpropanamide
	3,4-DMMC	(R)-N-((S)-1-(3,4-dimethylphenyl)-1-oxopropan-2-yl)-3,3,3-trifluoro-2-methoxy-N-methyl-2-phenylpropanamide	(R)-N-((R)-1-(3,4-dimethylphenyl)-1-oxopropan-2-yl)-3,3,3-trifluoro-2-methoxy-N-methyl-2-phenylpropanamide
	BTL	(R)-N-((S)-1-(benzo[d][1,3]dioxol-5-yl)-1-oxobutan-2-yl)-3,3,3-trifluoro-2-methoxy-N-methyl-2-phenylpropanamide	(R)-N-((R)-1-(benzo[d][1,3]dioxol-5-yl)-1-oxobutan-2-yl)-3,3,3-trifluoro-2-methoxy-N-methyl-2-phenylpropanamide
Piperazine Derivatives	1-BP/ 1,4-MPP	(R)-1-(4-benzylpiperazin-1-yl)-3,3,3-trifluoro-2-methoxy-2-phenylpropan-1-one	(R)-3,3,3-trifluoro-2-methoxy-1-(4-(4-methoxybenzyl)piperazin-1-yl)-2-phenylpropan-1-one

AMP: amphetamine; MAMP: methamphetamine; BPD: buphedrone; 3-MMC: 3-methylmethcathinone; 3,4-DMMC: 3,4 dimethylmethcathinone; 1-BP: 1-benzylpiperazine; MDMA: 3,4-methylenedioxy-N-methylamphetamine; NK: norketamine; BTL: butylone; 1,4-MPP: 1-(4-metoxyphenyl)-piperazine;

3.2. Application of the method

Table S5. Water temperature and physico-chemical parameters (pH, EC and TDS) of Douro estuarine water samples.

Sampling point	T (°C)	pH	EC (µS cm-1)	TDS (mg L-1)
S1	19	8.05	17.02	9.05
S2	21	8.30	16.90	8.89
S3	25	8.08	17.4	8.93
S4	24	8.32	16.86	8.90
S5	25	7.94	17.25	9.39

T: temperature; pH: potential of hydrogen; EC: electrical conductivity; TDS: total dissolved solids;

Table S6. Concentration and enantiomeric fraction (EF) for target PAS in effluent and Douro River estuarine water samples.

PAS	WWTPA		WWTPB		Estuarine water samples	
	Conc. (ng L-1)	EF	Conc. (ng L-1)	EF	Conc. (ng L-1)	EF
AMP (*R*)	<LOQ	n.d.	<LOD	n.d.	< LOQ (*S1*)	n.d.
AMP (*S*)	<LOD		<LOD		< LOQ (*S1*)	
MAMP (*S*)	57.30	≅1	<LOQ	n.d.	< LOQ (*S1, S4*)	n.d.
MAMP (*R*)	<LOD		<LOD		< LOD	
BPD D1	<LOQ	n.d.	<LOD	n.d.	< LOQ (*S3, S4*)	n.d.
BPD D2	<LOD		<LOD		< LOD	
3-MMC D1	<LOD	n.d.	<LOD	n.d.	< LOD	n.d.
3-MMC D2	<LOD		<LOD		< LOD	
3,4-DMMC D1	<LOQ	n.d.	<LOD	n.d.	< LOD	n.d.
3,4-DMMC D2	<LOD		<LOD		< LOD	
MDMA (*R*)	<LOQ	n.d.	<LOD	n.d.	< LOQ (*S5*)	n.d.
MDMA (*S*)	<LOQ		<LOD		< LOD	
NK D1	<LOD	n.d.	<LOD	n.d.	< LOD	n.d.
NK D2	<LOD		<LOD		< LOD	
BTL D1	<LOD	n.d.	<LOD	n.d.	< LOD	n.d.
BTL D2	<LOD		<LOD		< LOD	
BP	<LOD	-	<LOD	-	< LOD	-
1-MPP	<LOD	-	<LOD	-	< LOD	-