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Spectrofluorimetric determination of acetone in water samples with solid-phase extraction and a new benzaldehyde derivative

P. Michel, J.-L. Boudenne, B. Coulomb, F. Robert-Peillard*

Aix Marseille Univ, LCE, Marseille, France

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ABSTRACT

A new method is described for acetone ($C(CH_3)_2O$) determination in water samples. The method is based on the reaction with 4-(dimethylamino)benzaldehyde (DMAB) in dimethyl sulfoxide (DMSO) in slightly basic medium, resulting in a highly fluorescent compound with fluorescent wavelengths undisturbed by other common fluorescent compounds. Experimental conditions were optimized (reagents concentrations, reaction time) to reach optimal sensitivity. For the analysis of aqueous samples, a preconcentration step of acetone by solid-phase extraction (SPE) followed by an elution step in DMSO was optimized using Isolute ENV + columns. A highly satisfactory low detection limit of $0.014 \mu M$ ($0.8 \mu g L^{-1}$) was achieved by combining these two steps, with a linear range from 0.048 to $5 \mu M$ and relative standard deviations between 5.7% and 6.9% . The protocol was validated on complex real water samples such as river water and wastewater, and our fluorimetric method with DMAB was in good agreement with the reference LC-UV method with DNPH.

1. Introduction

Acetone is the simplest ketone with a wide range of sources, uses and interests. Natural sources include forest fires, the oxidation or photodegradation of natural humic substances [1] and all the natural living and growing processes of plants, insects and animals [2]. Acetone is also one of the main oxidation products of hydrocarbons in the troposphere and is commonly present in precipitation and surface water samples, regardless of season [3]. All sources of acetone together account for around 40 million tons released worldwide into the environment each year [4]. Anthropogenic sources include agriculture, industry, transport, chemical production, waste burning, or landfill sites off-gassing (estimated at about 1 Mt/y) [4,5].

The main applications of acetone are as a solvent and as a raw material for important chemical compounds such as bisphenol A or methyl methacrylate [6]. Acetone can thus be found into the aquatic environment via wet deposits, industrial or domestic wastewater discharges or landfill leachates. It is one of the most frequently found water-borne organic compounds in the United States and has been found in groundwater at various contaminated sites, along with other hazardous pollutants [7]. The EPA-regulated level for acetone varies from site to site, depending on the future use of the groundwater resource. Nevertheless, discharge limits for acetone concentration have been regulated

in the parts-per-billion (ppb) or even parts-per-million (ppm) range [7]. Its presence in groundwater can lead to the shedding in drinking waters and the setting of guideline values, as indicated by the state of Massachusetts (USA) (6.3 mg L^{-1} ($110 \mu M$)) [8].

The determination of acetone in aqueous samples can be relevant for a variety of applications. The many uses of this chemical make it a good candidate for monitoring industrial discharges into natural waters or for monitoring drinking water quality. Acetone has also been used for various biomarker studies in body fluids such as blood, plasma, urine and exhaled air, and applications for the diagnosis of diabetes, obstructive sleep apnea syndrome, heart failure severity or general human exposure monitoring have been reported [9–11]. Significant interest was also described in the field of wastewater reuse, where accurate quantification of acetone is necessary to guarantee the safety and quality of drinking water generated by the water treatment process. Indeed, acetone is one of the organic compounds that can pass through reverse osmosis treatment membranes and increase the concentration of total organic carbon in the treated water, thus adversely affecting the quality of the water sample [12,13]. It is therefore important to develop efficient analytical methods for the determination of acetone in a wide range of aqueous samples.

Chromatographic methods are the most widely used for acetone determination, particularly when other ketones or aldehydes are

* Corresponding author.

E-mail address: fabien.robert-peillard@univ-amu.fr (F. Robert-Peillard).

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targeted. Gas chromatography [14–16] and liquid chromatography [17–19] with different detectors have been implemented for this purpose, generally with pre-column derivatization reagents such as dinitrophenylhydrazine (DNPH) for HPLC or benzylhydroxyamines for GC methods. These methods are usually highly selective, with detection limits between 1 and 100 nM, but require expensive and bulky instruments.

Simple, fast, and inexpensive methods have been proposed for the selective determination of acetone, based on spectroscopic measurements which are ideal for this purpose. These methods are based on the derivatization reaction of acetone with benzaldehyde derivatives such as vanillin [20,21] or salicylaldehyde [22,23]. Unfortunately, these methods have so far had only limited applications, due to their inadequate sensitivity (10–100 μM range), the need for heating and the use of highly basic solutions.

In this paper, we have developed a new method for acetone determination based on the reaction with 4-(dimethylamino)benzaldehyde (DMAB) in dimethyl sulfoxide (DMSO) under slightly basic conditions, yielding a highly fluorescent compound with fluorescent wavelengths free from interferences of other common fluorescent compounds. For analysis of aqueous samples, a pre-concentration step by solid-phase extraction (SPE) and an elution in DMSO were implemented. The method was compared with a reference HPLC method for the analysis of real samples such as natural water and wastewater.

2. Material and methods

2.1. Chemicals and reagents

All solvents and reagents used were of analytical grade. Ultra-pure demineralized water, obtained from a Millipore MilliQ purification system (Millipore, USA, resistivity $>18\text{M}\Omega\text{ cm}$), was used to prepare all solutions. 20 mM acetone stock solutions were prepared by diluting the appropriate amount of acetone (Honeywell Riedel-de Haen, Germany) in ultra-pure water or in dimethyl sulfoxide (DMSO, Sigma-Aldrich, USA) and stored at $+4\text{ }^\circ\text{C}$. These stock solutions were then diluted in their respective solvent to obtain the calibration range solutions. DMAB reagent solutions were prepared by dissolving the appropriate amount of 4-(dimethylamino)benzaldehyde (Sigma-Aldrich, USA) in DMSO. DNPH reagent solution was prepared by dissolving the appropriate amount of 2,4-dinitrophenylhydrazine (Sigma-Aldrich, USA) in a mixture of acetonitrile (MeCN) and HCl 2 mM (50 %/50 % v/v). Vanillin, benzaldehyde, anisaldehyde and 9-anthracenecarboxaldehyde reagent solutions (130 mM) were prepared by dissolving the appropriate quantities of the respective standards (Sigma Aldrich, USA) in ultra-pure water. KOH reagent solution (0.4 M) was prepared by dissolving the right amount of potassium hydroxide (Fischer Scientific, USA) in ultra-pure water.

2.2. Solid-phase extraction

Solid-phase extraction (SPE) was semi-automatically performed for optimum flow rate control, using a multi-syringe pump (BU-4S, Crison Instruments, Spain) controlled by AutoAnalysis Station 5.0 software (Sciware Systems, Spain). A 10 mL syringe (Hamilton, Switzerland) was used for the retention and elution steps. Oasis HLB (100 mg, Waters Corporation, USA), Isolute® ENV+ (200 mg, Biotage, Sweden), Hyper-Sep Retain PEP (200 mg, Thermo Fisher, USA), Discovery DSC-Si, Supelclean Envi-Carb, Supelclean Envi-Florisil (respectively 500 mg, 500 mg and 1000 mg, Merck, Germany) and Interchim Recovery REC18 (200 mg, Interchim, France) cartridges were activated and conditioned according to the manufacturer's recommendations.

2.3. Fluorescence measurements

Fluorescence measurements were carried out using a Clario Star Plus

microplate reader (BMG Labtech, Germany) equipped with a linear variable filter monochromator and excitation and emission filter wheels. The reader was controlled with the Clario Star Reader Control software v5.70 coupled with MARS Data Analysis software, both developed by BMG Labtech. Top fluorescence detection was performed in black 96-well flat-bottom polystyrene microplates (Corning, USA) from the top of the microplate wells at $\lambda_{\text{ex}} = 470\text{ nm}$ and $\lambda_{\text{em}} = 600\text{ nm}$.

2.4. Protocol for acetone determination in aqueous samples

40 mL of sample or aqueous acetone standard solution was percolated through Isolute® ENV + cartridge (200 mg) at 4 mL min^{-1} . The cartridge was then washed with a first fraction of 600 μL of DMSO at 2 mL min^{-1} , and acetone was then eluted with a second fraction of 120 μL of DMSO recovered in a microplate well. 220 μL of 11.5 g L^{-1} DMAB reagent solution and 10 μL of 0.4 M KOH solution were then added in this well. The plate was shaken at room temperature for 10 min in the microplate reader prior to fluorescence measurement at $\lambda_{\text{ex}} = 470\text{ nm}$ and $\lambda_{\text{em}} = 600\text{ nm}$. The SPE cartridge was cleaned by percolating 10 mL of DMSO. All experiments were performed in duplicate.

2.5. Validation on real samples

Wastewater samples were taken at the inlet (before any treatment) and at the outlet of the Rognes wastewater treatment plant, near Marseille (Provence Alpes-Côte d'Azur region, south-east France). Natural water samples were collected from the Arc River (Aix-en-Provence, France). Samples were collected in high-density polyethylene bottles and stored at $+4\text{ }^\circ\text{C}$ until analysis. Prior to analysis, raw water samples were filtered first with a $1.2\text{ }\mu\text{m}$ pore size glass fiber filter, then with a $0.45\text{ }\mu\text{m}$ pore size cellulose acetate filter. Samples were analyzed both by the fluorimetric assay described above and by pre-column derivatization High Performance Liquid Chromatography with UV detection (HPLC-UV). HPLC equipment consisted of a L-2130 gradient pump and a L-2400 UV detector set at 360 nm (Hitachi, Japan). Pre-column derivatization was performed manually in a vial using DNPH reagent following the procedure adapted from Liggio et al. [24]. Briefly, DNPH reagent was purified just prior to the derivatization reaction on a C18 SPE column after dissolution of the DNPH reagent at 3 g L^{-1} in MeCN/HCl 2 mM (1/1 v/v). The solution was passed twice over the SPE column to remove impurities from the DNPH reagent. For derivatization, 5 mL of sample or aqueous standard solution at pH 2.7 was mixed with 50 μL of the DNPH reagent and the solution was stirred at room temperature for 1 h. 99 μL of this solution was then injected in the HPLC system. Separation was carried out on a 25 cm long and 4.6 mm inner diameter column packed with 5 μm C18 particles. The mobile phase was a mixture of acetonitrile (A) and HCl 2 mM (B) at 75 %/25 % (v/v) (A)/(B) and the flow rate was 1 mL min^{-1} . The retention time of the acetone derivative with this configuration was 6.5 min, and the detection limit for acetone was calculated at $0.25\text{ }\mu\text{M}$ (blank+3 σ).

3. Results and discussions

3.1. Reaction between acetone and aldehyde-derivatives

The aldol reaction between acetone and aromatic aldehydes under basic conditions to form dibenzalacetone derivatives has been known for decades. From an analytical point of view, this reaction has been implemented mainly with vanillin and salicylaldehyde to measure acetone concentrations in water through the absorbance of the dibenzalacetone derivatives. In our preliminary experiments, we first tested four aromatic aldehydes using a standard protocol in a transparent microplate to assess the detection limits of these methods (Table 1). Standard reagents such as salicylaldehyde and vanillin exhibited poor sensitivities. Regarding salicylaldehyde, the result could be explained by the moderate heating conditions that were limited by the microplate

Table 1

Acetone detection limits in water after derivatization with selected aromatic aldehydes. Reactions carried out in a transparent microplate: 200 μL standard solution + 25 μL aldehyde solution 100 mM + 50 μL NaOH 10 M, 10 min shaking at 40 $^{\circ}\text{C}$.

Aldehyde	Maximum absorbance wavelength (nm)	Detection limit (μM)
Benzaldehyde	340	1.3
Salicylaldehyde	470	>500
Vanillin	430	160
Anisaldehyde	390	3.4
9-Anthracenecarboxaldehyde	500	20

reader, and deliberately chosen below 40 $^{\circ}\text{C}$ for reasons of practical convenience (for a potential on-site measurement method). The detection limit obtained with vanillin was higher than in the original paper by Amlathe and Gupta [20], but in line with that recently obtained by Kozaeva et al. [21]. Benzaldehyde provided the lowest detection limit, but the maximum absorbance wavelength was too low for application in complex and colored samples such as wastewater samples or natural water samples, which may contain natural or anthropogenic organic molecules that could interfere with absorbance or fluorescence measurements at these wavelengths [25]. The other aldehydes tested have detection limits that are too high for the purpose of measuring acetone in drinking water, natural water or wastewater. For these types of samples, fluorescence measurements are preferable, as their sensitivities and selectivities are generally better than those obtained by absorbance measurements.

3.2. Detection of acetone with DMAB in DMSO

The fluorescence properties of condensation products of acetone and some aromatic aldehydes bearing amino groups have already been documented for other applications, such as chelating probes [26] and photoinitiators for 3D printing [27]. 4-(dimethylamino)benzaldehyde (DMAB) and 4-(diphenylamino)benzaldehyde were tested for their ability to react with acetone under conditions similar to those for other aromatic aldehydes. As these aldehydes have limited solubility in water, tests were performed in various organic solvents (methanol, acetonitrile, DMSO, DMF), with absorbance and fluorescence measurements over a wide range of wavelengths. Only fluorescence measurement tests with DMAB in DMSO provided a significant difference between a blank solution and an acetone solution (fluorescence spectra in Fig. S1), so we decided to further investigate this reaction (Fig. S2). The excitation and

emission wavelengths for these optimization tests were set at 450 nm and 590 nm, respectively.

Preliminary studies showed us that KOH was slightly more soluble in DMSO than NaOH, so we decided to focus on this base for the optimization of the detection conditions. KOH must be solubilized in water, which proved detrimental to the reaction when the volume fraction of water in DMSO exceeded 5 % (Fig. S3). In the standard protocol used in microplate experiments, we used the following conditions for all experiments: 200 μL of a standard solution in DMSO, 50 μL of a DMAB solution in DMSO, 10 μL of a KOH solution in water, and a reaction time of 10 min. The influence of the concentration of the KOH solution is illustrated in Fig. 1. Moderate concentrations of KOH (<2 M) gave a higher fluorescence response and a better signal/Blank ratio, and the relative standard deviation (RSD) was much better at low KOH concentration. This can be explained by the low solubility of KOH in DMSO, which probably disturbs fluorescence measurements when the KOH concentration is too high in the final DMSO mixture. Lower concentrations of KOH resulted in a weaker fluorescence signal, and we therefore used a 0.4 M KOH solution for further experiments with acetone standard solutions in DMSO.

DMAB concentration also has a strong influence on fluorescence measurements (Fig. 2). A high DMAB concentration is required to obtain a significant fluorescence signal, with the highest signal obtained in the presence of 50 g L^{-1} DMAB. Higher DMAB concentrations resulted in higher blank fluorescence, and we kept this concentration for subsequent experiments. Regarding reaction time, 10 min was chosen to obtain a satisfactory fluorescence response with a reasonable reaction time. Increasing the temperature to 45 $^{\circ}\text{C}$ had no significant influence on fluorescence responses and reaction kinetics (data not shown). The detection limit of acetone in DMSO under optimized experimental conditions was 0.3 μM .

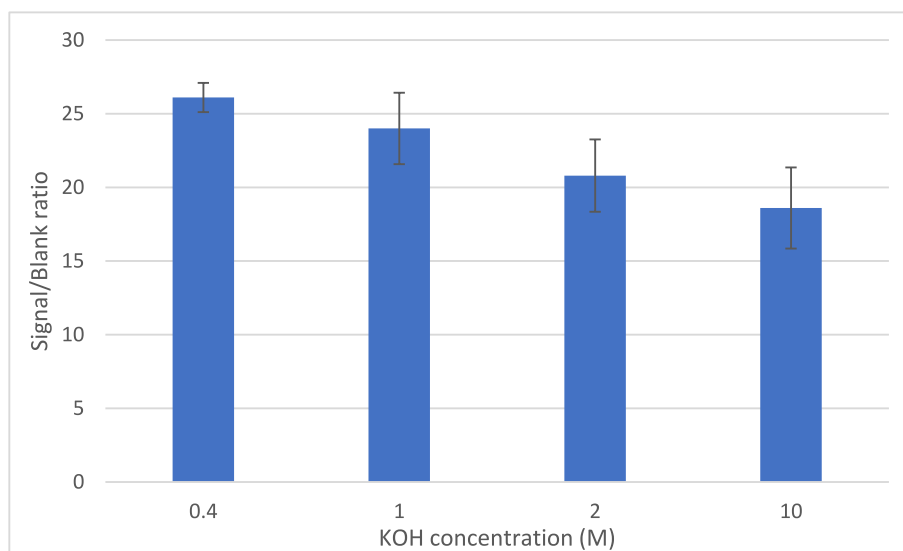


Fig. 1. Influence of the concentration of the KOH solution on the fluorescence responses measured after a 10 min reaction time. Protocol: 200 μL standard solution in DMSO + 50 μL DMAB 50 g L^{-1} in DMSO + 10 μL KOH solution in water, 10 min shaking at room temperature. Signal/Blank ratio is given for a standard solution at 20 μM , blank was measured with pure DMSO.

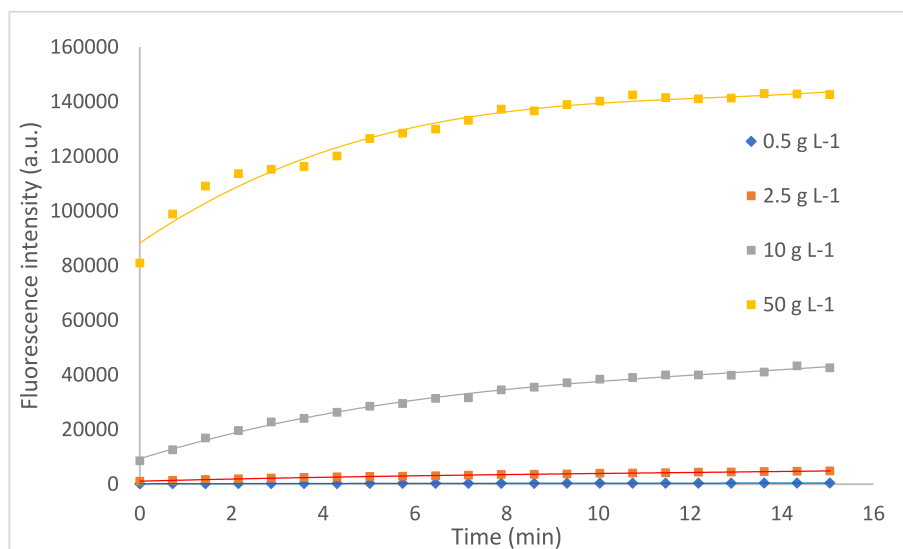


Fig. 2. Influence of the concentration of the DMAB solution on the reaction of acetone and DMAB in DMSO. Protocol: 200 μL sample in DMSO +50 μL DMAB in DMSO +10 μL KOH 0.4 M.

3.3. Interference studies

The reaction between DMAB and acetone (reaction product drawn on Fig. S2) is highly specific to acetone, as it requires two α -carbons with readily accessible hydrogens that can be deprotonated by the strong base added to the reaction medium. The reaction in DMSO took place under mild conditions (low base concentration of, room temperature), and we anticipated that this might favor the selectivity of the reaction for acetone over other carbonyl compounds or other chemical groups. The fluorescence responses of various compounds were therefore compared with acetone using the optimized protocol (Fig. 3). Other ketones, aldehydes, carboxylic acids, esters, amino acids, amines and pyrrole showed significantly weaker responses than acetone. Amino acids, amines and pyrrole were tested because DMAB (also known as Ehrlich's reagent) is often used for the detection of this type of compounds under acidic conditions with spectrophotometric measurements

[28]. No response was observed under our experimental conditions. We can thus conclude that the selectivity of our method for acetone is excellent.

3.4. Solid-phase extraction (SPE) of acetone

As the detection reaction between acetone and DMAB only gave satisfactory results in DMSO, the idea was to extract acetone from an aqueous sample on a SPE column and then elute the acetone in DMSO to implement the optimized protocol with DMAB. Several commercial columns (most of them with potential affinity for polar compounds) were tested for acetone retention first (Table 2). Isolute ENV+ and Oasis HLB were the most effective at retaining acetone, probably due to the structure of their polymers which favors retention of polar analytes. Isolute ENV+ was selected as optimal for acetone retention because loading flow rates can also be high on this type of column (typically 4–7

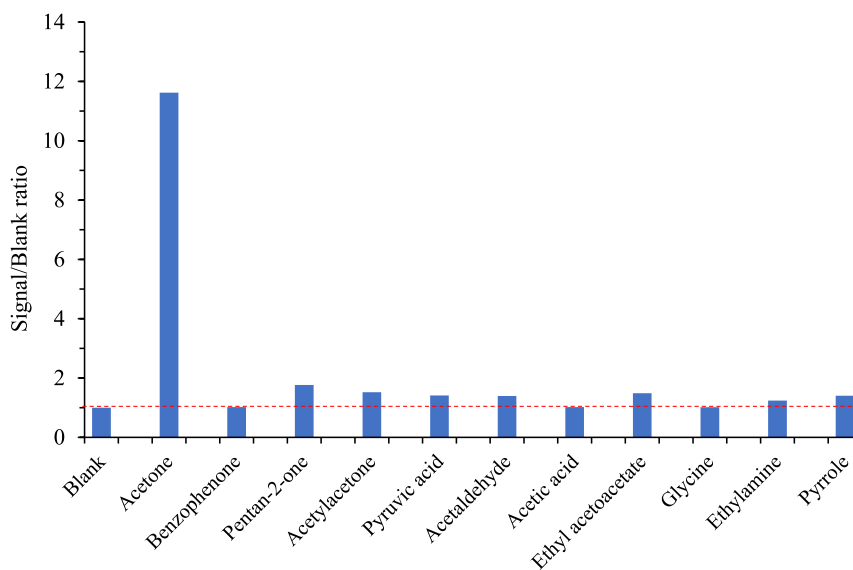


Fig. 3. Interference study for the detection of acetone with DMAB in DMSO, all standard solutions tested were at 10 μM in DMSO. Protocol: 200 μL sample in DMSO +50 μL DMAB 50 g L⁻¹ in DMSO +10 μL KOH 0.4 M.

Table 2

Retention rate of acetone on various SPE sorbents (n = 3). Protocol: percolation at 1 mL min⁻¹ of 5 mL acetone 50 μM in H₂O; Detection in water with benzaldehyde: 200 μL sample + 50 μL Benzaldehyde 5 g L⁻¹ in H₂O + 10 μL NaOH 10 M, 10 min shaking at 40 °C, measurement at 340 nm.

Column	Retention
Discovery® DSC-Si	89 ± 2 %
HyperSep™ Retain PEP	65 ± 4 %
Interchim REC18	22 ± 1 %
Isolute ENV+	97 ± 2 %
Oasis HLB	95 ± 1 %
Supelclean ENVI-carb	89 ± 2 %
Supelclean LC-Florisil	27 ± 1 %

mL min⁻¹ according to the manufacturer). The loading flow rate was then optimized between 1 and 6 mL min⁻¹. The optimal flow rate on a 200 mg ENV + column was found to be 4 mL min⁻¹ (Fig. 4), but higher flow rates seem possible for larger volume of samples if lower detection limits are required.

Elution with DMSO was then carried out by fine fractionation of the DMSO eluate (in 120 μL fractions) in the wells of a microplate, in order to easily and accurately detect eluted acetone with an adapted DMAB protocol (Fig. 5). The maximum acetone peak occurred in the sixth fraction for flow rates above 1 mL min⁻¹, and a 2 mL min⁻¹ flow rate was selected for this elution step. Two fraction collection options were compared: collection of the most concentrated fraction in a small volume (120 μL between 600 μL and 720 μL), or collection of a larger volume (600 μL, between 480 μL and 1080 μL). As shown in Table S1, the variabilities and detection limits are close for both collection volumes. We thus opted for collection of a small volume, which was also more convenient for direct collection in the wells of the microplate used for fluorescence measurements (see protocol in section 2.4.).

For the final protocol, the first five 120 μL fractions (600 μL) were thus discarded and the sixth fraction was collected in a microplate well.

3.5. Analytical features of the global procedure

For the global procedure with SPE, the fluorescence wavelengths were slightly shifted from the peaks of the fluorescence spectra to 470 nm for excitation and 600 nm for emission. Potential interferences from the matrix of the real samples tested (river water and wastewater) were

minimized at these wavelengths compared with the fluorescence peaks of the acetone/DMAB derivative (450/590 nm). Comparison of the fluorescence spectra of the acetone/DMAB derivative and the sample matrix of an inlet wastewater sample is presented in Fig. S5. Excitation was thus set at 470 nm, and emission at 600 nm. Higher emission wavelengths could be selected, but we decided not to exceed this wavelength as a decrease in the fluorescence signal could impair the measurement, and this is the maximum emission wavelength of some microplate readers.

The analytical features of the optimized protocol with SPE and microplate detection at these wavelengths with DMAB are described in Table 3 (calibration curve in Fig. S4).

The linear range is wide enough for the analysis of natural samples and can be easily adapted to a specific sample by changing the sample volume on the SPE column. A very low detection limits below 1 μg L⁻¹ was achieved thanks to the SPE preconcentration step and the sensitivity of DMAB detection in DMSO, which could be easily lowered with larger sample volume. This value is several hundred times lower than of other spectrometric methods based on reaction with benzaldehyde derivatives, and can even compete with chromatographic methods (Table 4). A chromatographic step requires more complex and expensive equipment, which is avoided in our method thanks to the selectivity of the derivatization reaction. SPE can easily be carried out manually, even for on-field analysis. Compared to other direct spectrometric methods, our DMAB method also avoids the use of highly basic and corrosive solutions, and all reactions can be performed at room temperature. An on-field analytical kit for acetone could thus be easily adapted from this method using inexpensive blue LED as the excitation source for fluorescence.

3.6. Validation on real samples

The optimized protocol was applied to three real samples and the results were compared with the LC method with DNPH derivatization (following the procedure adapted from Liggio et al. [24]) which is the most commonly used method for ketones and aldehydes (Table 5). 1 μM acetone was added to the river sample in order to reach the quantification range of the LC-UV method. Our fluorimetric method with DMAB was in good agreement with the LC-UV method with DNPH (errors between 6.3 and 13.8 %), even in very complex samples such as inlet wastewater samples. It should be noted that the SPE column had to be changed after duplicate analysis of this inlet wastewater samples,

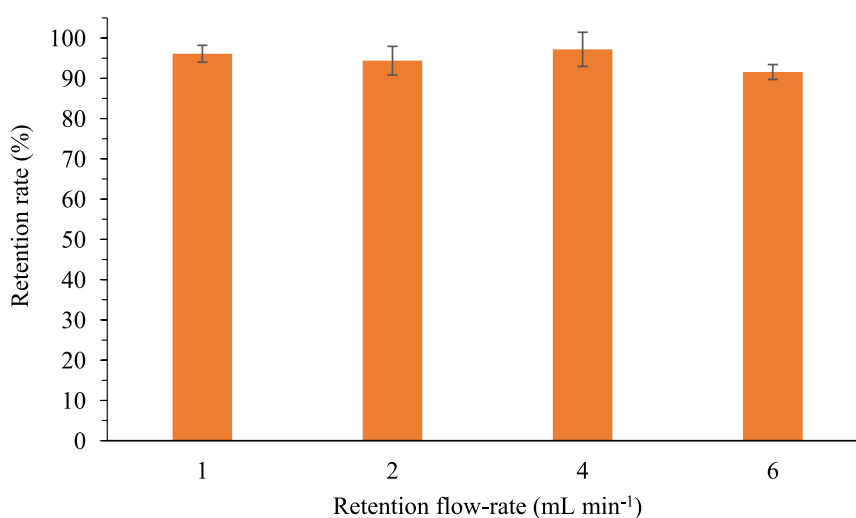


Fig. 4. Influence of flow rate on the retention of acetone on ENV + column. Protocol: percolation of 5 mL acetone 50 μM in H₂O; Detection in water with benzaldehyde (see Table 2).

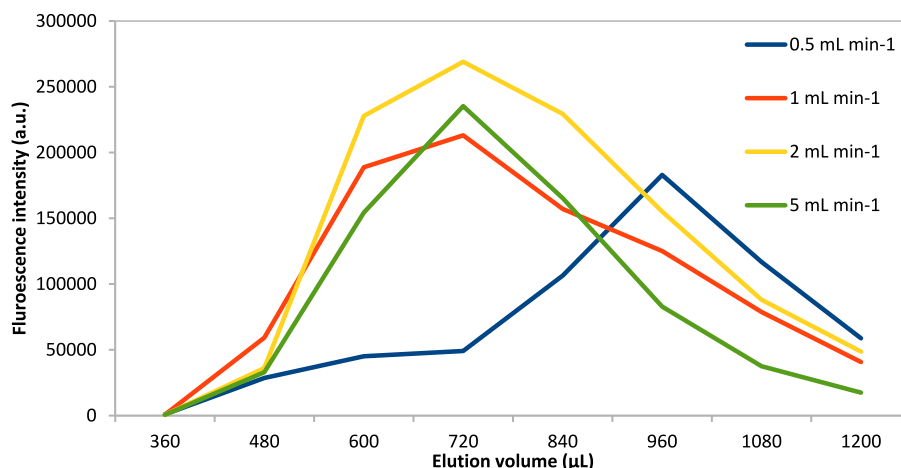


Fig. 5. DMSO elution profile of acetone retained on ENV + column at various elution flow rates. Protocol: percolation of 5 mL acetone 50 μM in H_2O ; Elution with DMSO, fractionation in 120 μL fractions, detection in DMSO fractions (part 2.4.).

Table 3

Analytical features of the protocol for acetone determination (volume of sample: 40 mL).

Detection limit	0.014 μM (0.8 $\mu\text{g L}^{-1}$)
Quantification limit	0.048 μM (2.8 $\mu\text{g L}^{-1}$)
Linear range	0.048–5 μM (2.8–300 $\mu\text{g L}^{-1}$)
Relative standard deviation at 0.2 μM (n = 6)	6.9 %
Relative standard deviation at 1 μM (n = 6)	5.7 %

Table 4

Comparison of various analytical methods for acetone detection in water.

Analytical method	LOD (μM)	Remarks on analytical procedure	Reference
Vanilin reaction/ Spectrophotometric detection	8.6	Derivatization 10 min in water bath 40 °C	[20]
LC-PR-CL ^a	0.03	Post-column photochemical reaction, analysis duration approx. 10 min	[19]
SPE/DNPH ^b reaction/LC- UV	0.005	Derivatization 60 min in water bath (40 °C)	[17]
SPME/PFBHA ^c reaction/ GC-MS	0.003	Total analysis duration approx. 150 min	[15]
SPME/TFEH ^d reaction/GC- MS	0.002	Derivatization 30 min in water bath (40 °C)	[16]
SPE/DMAB reaction/ Fluorimetric detection	0.014	Total analysis duration approx. 20 min at room temperature	This study

^a Liquid chromatography- Photochemical reaction – Chemiluminescence detection.

^b DNPH: 2,4-dinitrophenylhydrazine.

^c PFBHA: o-2,3,4,5,6-(pentafluorobenzyl)hydroxylamine.

^d TFEH: 2,2,2-trifluoroethylhydrazine.

probably due to clogging of the SPE sorbent by the high organic load of this sample. With other samples and standard solutions, the sorbent could be regenerated by passing 10 mL of DMSO after sample analysis.

Acetone could be detected by both methods in the micromolar range in the wastewater samples, which was not the case for other studies on acetone in wastewater [19]. This might be explained by a one-week delay between sampling and analysis of the wastewater samples, with potential production of acetone by bacterial metabolism processes [29].

4. Conclusions

In conclusion, this study has led to the development of a new

Table 5

Comparison of the results obtained on real water samples with our DMAB fluorimetric method compared to HPLC-UV detection after DNPH derivatization (LD: 0.25 μM), each experiment in duplicate.

Sample	Added (μM)	SPE-DMAB method (μM)	LC-UV (μM)	Error compared to the reference method
River water	–	0.14 \pm 0.01	< LD	–
	1	1.04 \pm 0.03	1.11 \pm 0.03	6.3 %
Outlet wastewater	–	0.58 \pm 0.03	0.50 \pm 0.01	13.8 %
	–	3.77 \pm 0.13	4.03 \pm 0.10	6.4 %

analytical method for acetone determination in water samples. Fluorimetric detection with DMAB was described for the first time, enabling sub-micromolar detection limits, much lower than other methods based on reactions with benzaldehyde derivatives. Solid-phase extraction of acetone had not been documented before either, and we proved that polystyrene-based polymeric sorbents could be effective for the pre-concentration and purification of acetone, even in complex aqueous matrixes. A very satisfactory detection limit of 0.014 μM (0.8 $\mu\text{g L}^{-1}$) was thus achieved by combining these two steps, and the protocol was validated on complex real water samples such as inlet wastewater. The analytical steps of the protocol could be easily carried out manually without expensive equipment, and an on-field analytical kit for the sensitive and selective detection of acetone could therefore be easily adapted from this method.

CRedit authorship contribution statement

P. Michel: Investigation. **J.-L. Boudenne:** Writing – review & editing, Supervision. **B. Coulomb:** Writing – review & editing, Supervision, Project administration, Funding acquisition. **F. Robert-Peillard:** Writing – review & editing, Writing – original draft, Investigation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.talanta.2024.126984>.

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