Development of a new microextraction methodology coupled to high-resolution techniques for estimating the variability of atmospheric aerosol water-soluble organic matter

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Objectives :

The extraction of water soluble organic matter (WSOM) from atmospheric aerosols typically rely on water-based extraction of filters assisted by ultrasound or mechanical agitation [1]. Large volumes of water are used to guarantee full extraction of the WSOM, which will be further concentrated by means of solid-phase extraction (SPE) methods. However, these SPE methods are prone to loss of analytes. In this work, we developed a Teflon® based device to extract aerosol WSOM from filter samples using low volumes of water: from 5.8 mL up to 17.4 mL, against the traditional approach. At a first stage, a standard reference urban air particulate matter sample (NIST®SRM®1648a) was used for the development of this new methodology. An uniform experimental design was used to optimize the extraction conditions. Moreover, each aerosol WSOM sample was analysed using advanced analytical techniques, including excitation-emission matrix (EEM) fluorescence spectroscopy and two-dimensional comprehensive liquid chromatography online (LC × LC) coupled to diode array and fluorescence detectors [2].

Methods and Results:

Proposed apparatus

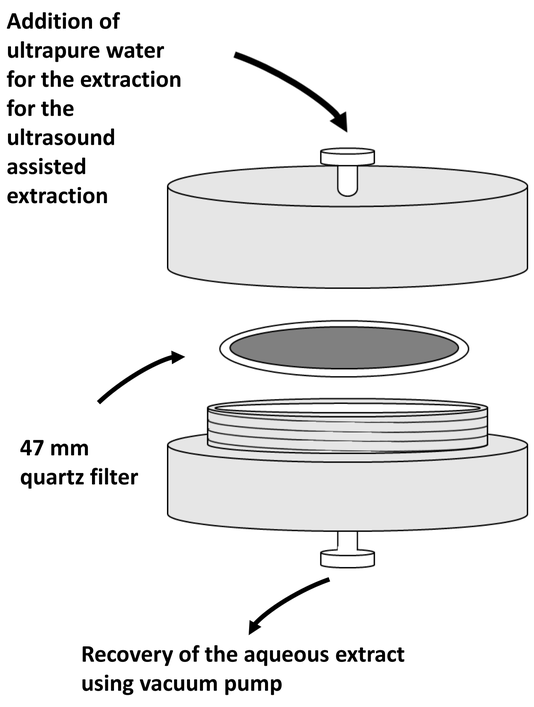

Fig 1: Schematic representation of the proposed Teflon® based apparatus

Experimental design for finding the optimum extraction conditions using the proposed apparatus

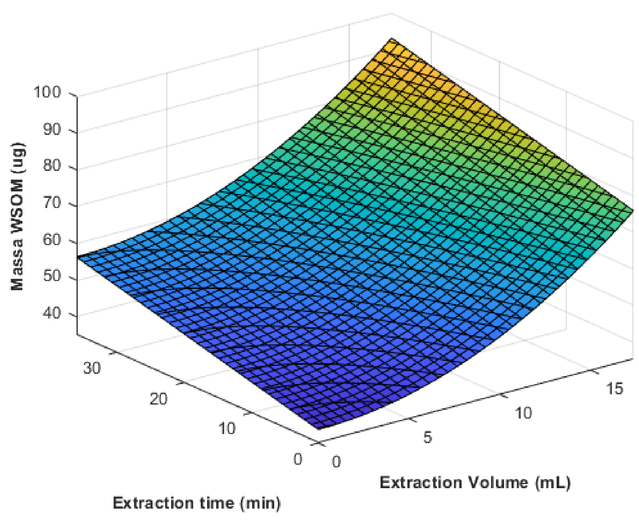

Fig 2: Response surface plot showing the effect of the experimental variables time of extraction and water volume on the amount of WSOM extracted from the urban air particulate matter. The amount of NIST®SRM®1648a is held constant at 2 mg. This model was obtained using a quadratic regression to the uniform experimental design data.

Multidimensional analysis of WSOM

Two-dimensional Liquid Chromatography

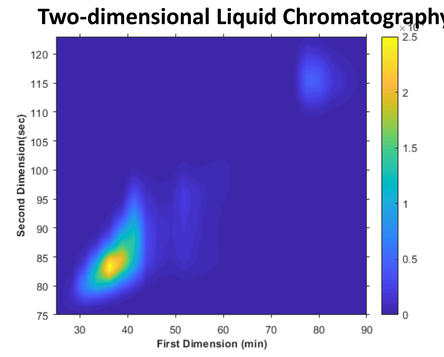

Fig 3: PALC × SEC – FLD (ex: 320 nm; em: 410 nm) chromatogram of aerosol WSOM

Excitation-Emission Fluorescence Spectroscopy

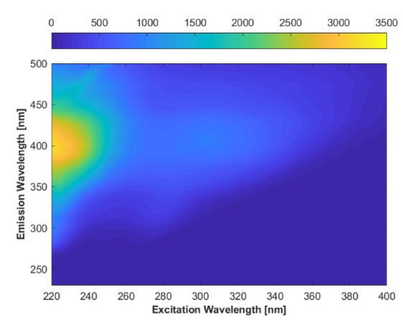

Fig 4: Fluorescence excitation-emission spectrum of aerosol WSOM

Ongoing and future work:

Fig 5: Schematic representation of the methodology for the extraction and isolation of the whole aerosol WSOM

Conclusions:

- **The developed methodology is simple and allows an efficient extraction of the whole atmospheric aerosol WSOM.**
- **The method also has the benefit of being compatible with lower extraction volumes, which can be of great worth for filters with lower load of air particles.**
- **Currently, a new WSOM isolation method based on solid-phase microextraction principles and magnetite nanoparticles is being developed, which will allow to enhance the amount of WSOM that is extracted from low ambient aerosol mass samples, thus helping to achieve a better understanding of atmospheric WSOM characteristics on short timescales (< 24h).**

Acknowledgments:

Thanks are due to FCT/MCTES for the financial support to CESAM (UIDP/50017/2020+UIDB/50017/2020), through national funds. This work is supported by the project AMBIEnCE (PTDC/CTA-AMB/28582/201) funded by FEDER, through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), and by national funds (OE), through FCT/MCTES. FCT/MEC and the European Social Fund are also acknowledged for a PhD grant (PD/BD/142931/2018), and an Exploratory Research Project (IF/00798/2015/CP1302/CT0015, Investigator FCT Contract IF/00798/2015). Surface Ocean-Lower Atmosphere Study (SOLAS) is also acknowledged for endorsing the AMBIEnCE project.

References:

[1] Antoine S. Almeida, Rita M. P. Ferreira, Artur M. S. Silva, Armando C. Duarte, Bruno M. Neves, and Regina M. B. O. Duarte.; Structural Features and Pro-Inflammatory Effects of Water-Soluble Organic Matter in Inhalable Fine Urban Air Particles, Environmental Science & Technology 2020 54 (2), 1082-1091

[2] Pedro F. Brandão, Armando C. Duarte, Regina M.B.O. Duarte., Comprehensive multidimensional liquid chromatography for advancing environmental and natural products research, Trends in Analytical Chemistry. 2019. 116. 186-197.