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Particulate matter in the indoor air of a cafeteria: composition and health risks

Célia A. Alves[1]*, Estela D. Vicente[1], Margarita Evtyugina[1], Ana M. Vicente[1], Teresa Nunes[1], Franco Lucarelli[2], Giulia Calzolai[2], Silvia Nava[2], Ana I. Calvo[3], Carlos del Blanco-Alegre[3], Fernanda Oduber[3], Amaya Castro[3] and Roberto Fraile[3]

[1] Centre for Environmental and Marine Studies, Department of Environment, University of Aveiro, 3810-193 Aveiro, Portugal
[2] Department of Physics and Astronomy, Università di Firenze and INFN-Firenze, 50019 Sesto Fiorentino, Italy
[3] Department of Physics, IMARENAB University of León, 24071 León, Spain

**Corresponding email: celia.alves@ua.pt*

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1 Introduction

Indoor air quality (IAQ) in the workplace is important because employees are occupationally exposed on a regular basis to a variety of pollutants with potential impact on comfort, work-related health problems, sickness absence, and productivity (Śmiełowska et al., 2017). Restaurants not only have many of the same threats commonly observed in office buildings, but they also comprise several other pollutants given off by cooking appliances, refrigeration units, chemical degreasers and cleaning solvents. University cafeterias are popular meeting places for students and staff. For this category of restaurant, as far as we know, no comprehensive evaluation has been made. This paper describes and discusses a short case study on a thorough air quality monitoring programme carried out in a university cafeteria. Besides the measurement regulated gaseous pollutants, the work included the detailed organic and inorganic characterisation of PM_{10}, in order to understand which sources and processes contribute to the measured levels and to estimate the carcinogenic and non-carcinogenic risks associated with inhalation by employees and customers.

2 Materials/Methods

Particulate matter was continuously measured, indoors and outdoors, with optical monitors. Simultaneous PM_{10} sampling with high and low volume instruments, equipped with quartz and Teflon filters, respectively, was conducted during working hours and at night. The quartz filters were analysed for their carbonaceous content by a thermo-optical technique and for organic constituents by GC-MS (Alves et al., 2011). Water-soluble ions and elements were quantified in the Teflon filters by ion chromatography (Vicente et al., 2018) and PIXE (Lucarelli et al., 2014), respectively.

3 Results and Discussion

The indoor levels during the working hours largely exceeded those measured at night and outdoors (Fig. 1), suggesting the presence of multiple indoor sources. It was observed that more than 80% of the PM_{10} mass concentrations were generated indoors (Othman et al., 2019). Total carbon accounted for 36.0±5.8, 42.8±7.9 and 27.6±12.6%wt. of the PM_{10} mass indoors during the occupancy and non-occupancy hours, and in the outdoor air, respectively. On average, water-soluble ions represented PM_{10} mass fractions of 6.0, 15.8, 13.4, and 1.3% during occupancy, at night-time indoors, in the daytime period on the weekend inside the building, and at regular working hours outdoors, respectively.

Both indoors and outdoors, the elements with highest concentrations were Na, Mg, Al, Si, S, Cl, K, Ca and Fe. About 200 organic compounds were identified, some of which, are described as indoor aerosol constituents for the first time. Many of these are components of various cosmetics and other personal care products, but also of pesticides, drugs of abuse, plastics, building materials (e.g. flame retardants), cooking emissions, sweat, among others.

The total mean hazard quotient (Slezakova et al., 2014; and references therein) that represents the noncarcinogenic effects due to the inhalation of particle-bound metals during the occupancy period was higher than the acceptable level (>1). The cumulative cancer risk for both carcinogenic metals and PAHs was lower than the acceptable level (10^{-4}).

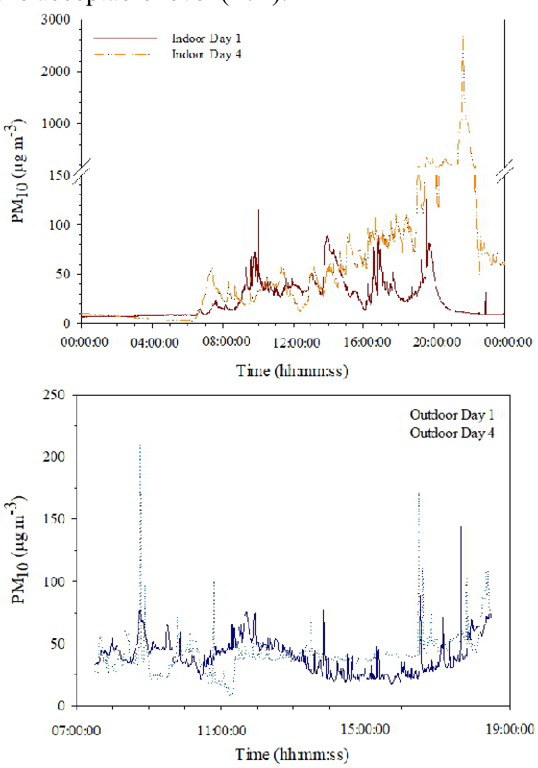

Figure 1: Examples of PM_{10} daily concentration profiles in the cafeteria and outdoors (Day 1 – Monday, Day 4 – Thursday).

4 Conclusions

PM_{10} in the cafeteria included, among others, metals, components of personal care products, plasticisers and psychoactive drugs. Although the cancer risk associated with inhalation of metals and PAHs was found to be negligible, the high PM_{10} levels encourage the adoption of strategies to control and minimise the emissions at their point sources, such as confining the cooking area and equipping the kitchen with a more efficient smoke exhaust system. Other measures could be the installation of appropriate ventilation and air cleaner systems in the dining room, the use of eco-labelled cleaning products, placing footwear sanitiser mats at the entrance, inspection of wall coverings and other building materials, minimising the use of plastics and compliance with prohibitions (e.g. smoking). At the official level, the implementation of regular inspection protocols is also essential.

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