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

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1. Introduction

University cafeterias are popular meeting places for students and staff. For this category of restaurant, as far as we know, no comprehensive evaluation of indoor air quality has been made. This work describes a short case study on a thorough monitoring programme carried out in a university cafeteria. The study included the detailed organic and inorganic characterisation of particulate matter < 10 µm (PM_{10}) 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.

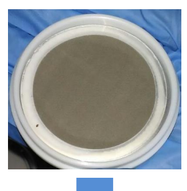
2. Methods

Indoor Sampling

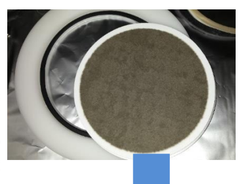
Outdoor Sampling

PM_{10} sampling & analysis

Teflon filters



Quartz filters



Organic & elemental carbon (**OC & EC**) by a thermo-optical technique

Elements by PIXE

Organic speciation by GC-MS

3. Results

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 [1]. 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.

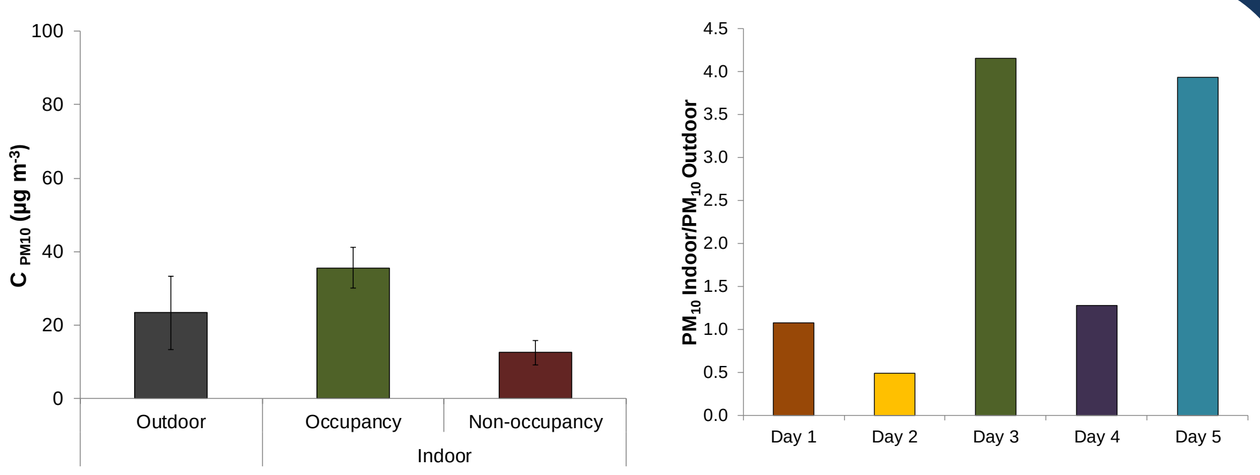


Fig. 1. PM_{10} levels in the cafeteria and outside and indoor/outdoor ratios

Table 1. Concentrations (ng m^{-3}) of some organic compounds in PM_{10}

	Indoor occupancy	Indoor non-occupancy (night-time)	Indoor non-occupancy (Sunday, daytime)	Outdoor daytime	I/O (occupancy)
Parsol MCX	12.6±6.6	2.93	11.2	0.10±0.14	122
Oxidised Irgafos 168	7±10	bdl	bdl	8±18	1.0
Nicotinic acid	8.6±5.3	4.67	6.84	bdl	-
Tetrahydrocannabinol	4.8±9.5	bdl	bdl	-	-
Ethylene brassylate	18.4±6.2	6.77	6.24	-	-
Methyl dihydrojasmonate	46±29	55.1	55.9	-	-
Piperonyl butoxide	9.3±3.7	4.25	6.68	-	-
Amgard TMCP	1.6±1.2	bdl	4.24	-	-
Acetyl tributyl citrate	4.0±1.6	1.78	2.82	-	-
5-oxo-L-proline	19±14	bdl	1.24	-	-

bld – below detection limit

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 (Table 1). 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 (THQ) [2] that represents the noncarcinogenic effects due to the inhalation of particle-bound metals during the occupancy period was higher than the acceptable level (Σ THQ > 1) (Fig. 2). The cumulative cancer risk for both carcinogenic metals and PAHs was lower than the acceptable level (10^{-4}).

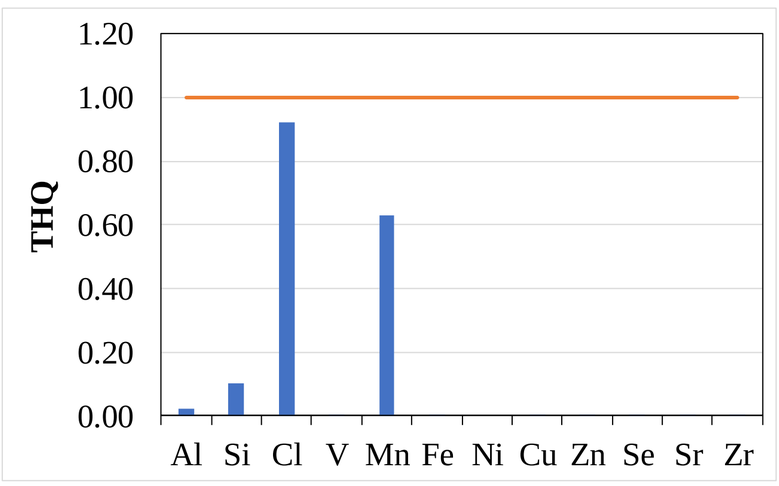


Fig. 2. Mean risks from inhalation exposure to noncarcinogenic PM_{10}-bound metals for the cafeteria workers during the occupancy period. The horizontal line represents the USEPA health-based guideline level.

4. Conclusions

- Concentrations of most pollutants were much higher indoors than outdoors
- More than 80% of the particles were generated indoors
- PM_{10} included components of personal care products, plasticisers and psychoactive drugs
- Cancer risk associated with inhalation of metals and PAHs was found to be negligible

References

[1] Othman, M., Latif, M.T., Matsumi, Y., 2019. The exposure of children to $PM_{2.5}$ and dust in indoor and outdoor school classrooms in Kuala Lumpur City Centre. Ecotoxicol. Environ. Saf. 170, 739-749.

[2] Slezakova K., Morais S. and Pereira M.C. 2014. Trace metals in size-fractionated particulate matter in a Portuguese hospital: exposure risks assessment and comparisons with other countries. Environ. Sci. Pollut. Res. 21, 3604-3620.

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