Organic composition of indoor/outdoor particles in an elementary school

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The impact of air pollution on school children's health is currently one of the key focus of international organisations. Children spend up to ten hours per day at school and the health impact of air pollutants is much higher for pupils than for adults in similar environments (Guo *et al*., 2010). Particulate matter is one of the most important pollutants in indoor air. In spite of the various studies performed worldwide to assess the pupils' exposure to indoor particles, only a few aimed at characterising their chemical composition and most of them were mainly focused on the elemental content (e.g. Almeida *et al*., 2011). Comparatively almost nothing is known about the organic matter in particulate matter, which can encompass irritant, carcinogenic and/or mutagenic compounds.

In this study, an intensive sampling campaign of indoor and outdoor airborne particulate matter (PM_{10}) was carried out in a primary school of Aveiro, Portugal, from February 28 to March 27, 2011, to investigate mass concentrations and organic composition and to evaluate the influence of outdoor air pollution on the indoor air. The organic speciation was performed by gas chromatography-mass spectrometry after multi-solvent extraction, fractionation of the organic extracts in a silica gel column and application of derivatisation techniques to the more polar compounds.

The weekly indoor PM_{10} concentrations during occupancy periods ranged from 75 to 145 μg m^{-3}, whereas much lower levels, from 20 to 62 μg m^{-3}, were registered outdoors. The dominant organic compound classes were acids, sugars, polyols and *n*-alkanes (Fig. 1). Polycyclic aromatic compounds were detected at indoor and outdoor concentrations of 893±650 and 830±421 pg m^{-3}, respectively, never exceeding the benzo[a]pyrene equivalent carcinogenic threshold of 1 ng m^{-3} set by the World Health Organisation.

It can be clearly seen that concentrations of most organic compounds were many times higher than their homologous outdoor levels. The ratio between indoor and outdoor (I/O) concentrations gives an indication whether the generation is from indoors or derived from the outdoor environment. Air exchange rates below 1 h^{-1}, such as those registered in this study, have been reported to give higher I/O ratios for particles (Rojas-Bracho *et al*., 2000).

Carbon preference indices of *n*-alkanes around 1, both indoors and outdoors, and the presence of biomass combustion tracers (e.g. levoglucosan, L, mannosan, M, and galactosan, G) in indoor particles suggest that infiltration of outdoor particulates leads to contamination of classrooms with vehicle emissions and biomass burning smoke likely coming from biofuel use in nearby restaurants and bakeries.

The L/M and L/(M+G) ratios are within the ranges reported for softwood burning (Fine *et al*., 2004). The input of this source is also confirmed by fluoranthene/(fluoranthene+pyrene) ratios > 0.5.

The indoor and outdoor concentrations of organic compounds were closely correlated (r^2=0.5-0.8). The slopes of the linear regressions indicate that 12-22% of the indoor levels are of outdoor origin.

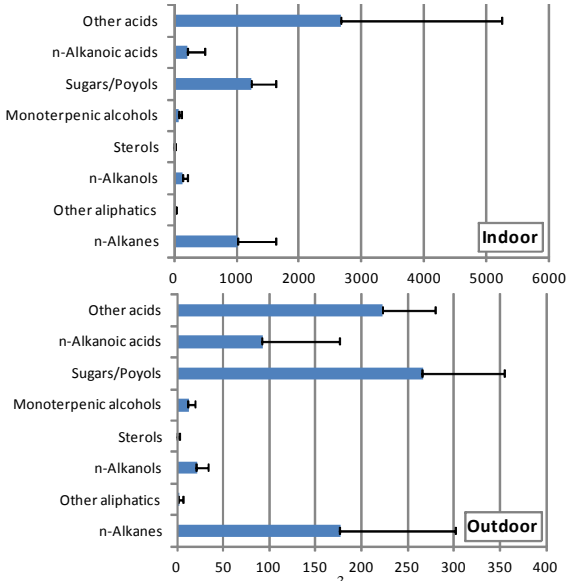

Figure 1. Concentrations (ng m^{-3}) of the main organic compound classes in PM_{10}.

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