Differential uptake kinetics of nitrogen dioxide on various pollen grains

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Keywords: uptake coefficient, allergy, pollution.

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The effects of gaseous pollutants on pollen structure, viability and allergenicity have been widely studied for many pollen species (cf. references for reviews). Despite such extensive works, there is no information available to compare the effects of pollutants between the pollen species. In this study, we used a chemical kinetic approach to compare the potential sensitiveness of pollen of different species to a NO_2 exposure.

Methods. Experiments were performed with desiccated pollens of birch, timothy grass and cypress and with freshly collected birch pollen. Those materials were exposed for 10 minutes to 5,000 ppmv of NO_2 in a closed cell. The gas phase concentration of the pollutant was measured online by FTIR spectroscopy. In a typical experiment, the NO_2 concentration in the cell decreased with different rates depending on the pollen nature and on the quantity of pollen exposed.

After exposure, pollen grains were deposited onto adhesive tape and surface analysis was carried out using a ToF-SIMS instrument with a pulsed Bi_3^+ primary ion beam (25 keV, 0.25 pA).

Results. For all pollen species, the uptake of NO_2 was fast as shown in figure 1. No reaction products have been detected in the gas phase by means of FTIR spectroscopy. For a fixed mass of pollen (about 65 mg), the following first order kinetic constants have been measured for desiccated pollens:

$k(\text{cypress})=0.0045\ s^{-1}$

$k(\text{timothy grass})=0.0021\ s^{-1}$

$k(\text{birch})=0.0007\ s^{-1}$

For the same experimental conditions, these values indicated for example that the NO_2 concentration decreases six times more rapidly in the presence of cypress pollen compared to birch.

Experiments with birch pollen, stored under desiccated conditions and freshly harvested, demonstrated that pollen freshness increased by a factor of two the kinetic of NO_2 uptake. Exposure done with pollen more or less dried have shown an increase of uptake with a higher water content of the pollen. As a result, we suggest that the observed increase with fresh pollen is explainable by higher water content.

Concerning ToF-SIMS analysis, two fragments were observed with higher intensities in the mass spectra of polluted pollens: m/z=46 (NO_2^-) and m/z=62 (NO_3^-), compared to the mass spectra of untreated pollen. Formation of HNO_3 by the reaction of NO_2 with water has probably occurred on the pollen surface. This confirmed the role of water in surface reactivity.

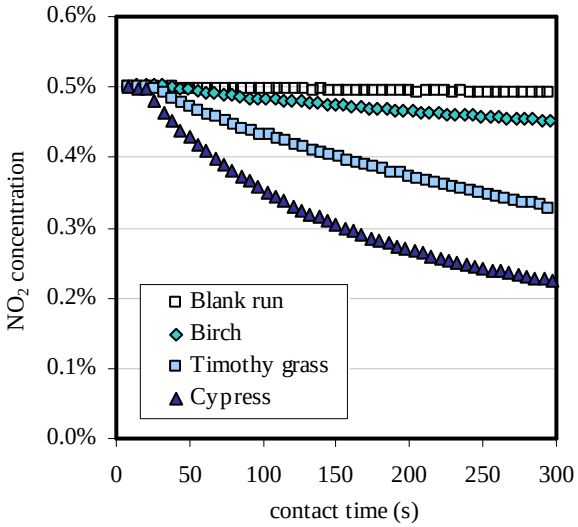

Figure 1. Decrease of NO_2 concentration for different species of pollen exposed (about 65 mg).

Conclusions. According to our experimental data, it is clear that pollen from different species have different behaviour regarding the uptake of NO_2. The sensitiveness of pollen to NO_2 is decreasing in the following manner: cypress > timothy grass > birch.

Fresh pollen appears to be much more sensitive to pollutants than desiccated one. Following reaction with NO_2, acidification of the pollen surface is expected with the possible formation of HNO_3.

This work was supported by the Région Nord Pas-de-Calais, the Ministère de l'Enseignement Supérieur et de la Recherche, CNRS, Université Lille 1, European Regional Development Fund (ERDF) and IRENI, Institut de Recherche en ENvironnement Industriel.

Bartra, J., Mullol, J., del Cuvillo, A., Dávila, F., 2007. J Investig Allergol Clin Immunol, 17, 3-8.

Kim, H., Bernstein, J.A., 2009. Current Allergy and Asthma Reports, 9, 128-133.

Riedl, M.A., 2008. Current Allergy and Asthma Reports, 8, 139-146.