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Analytical Characterization of Macromolecular Ice Nuclei from Birch Pollen Grains

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Heterogeneous ice nucleation has a major influence on various environmental processes such as cloud glaciation in the atmosphere affecting the Earth's radiation balance or cryobiological protection of organisms from cold damage. Substances triggering heterogeneous ice nucleation, so called ice-nucleating particles (INP) can be of various origins including primary biological particles (bacteria, fungi, plankton, pollen, etc.). Biological ice nucleation is an issue of current interest, since it triggers freezing at high temperatures e.g. the bacterium Pseudomonas syringe (Snomax®) induces freezing between -1.8 and -3.8°C [1]. For most biological INP (BINP) the detailed chemical structure as well as their influence on atmospheric processes is not yet investigated. Since 2001 it is known, that birch pollen are able to catalyze heterogeneous ice nucleation [2, 3]. However, not the whole pollen grain but macromolecules which can be washed off from the pollen's surface with water act as efficient INP [4].

We implement an array of analytical techniques to characterize these macromolecular INP from Betula pendula birch pollen and to clarify the corresponding mechanism of heterogeneous ice nucleation. For these investigations birch pollen washing water was used. To reduce sample complexity fractions from solid phase extraction (SPE) and centrifugal filtration were collected. Results from SPE are indicating that INP from birch pollen have amphiphilic properties. To gain information about the size of INP, centrifugal filtration and chip-based gel electrophoresis with laser-induced fluorescence were utilised. Furthermore, capillary zone electrophoresis (CZE) with UV detection, liquid chromatography – electrospray ionisation – mass spectrometry (LC-ESI-MS) and multistage– mass spectrometry (ESI-MSn n = 2-3) were applied for further, more detailed characterization.

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