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*Toxicity of Biomass Combustion Generated Ultrafine Particles: Evidence from Stack-sampled and Airborne UFPs*

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**Introduction & Background**
Wood burning for domestic heating is a relevant source of fine and ultrafine particles in urban areas. Nevertheless, there is still a gap of knowledge on health impacts associated to UFPs (dp). The TOBICUP (TOxicity of Biomass COmbustion generated Ultrafine Particles) project was designed to gain deeper insight on the possible health effects of ultrafine particles (UFP, dp).

**Methodology**
UFP stack samples generated by wood (beech and fir) combustion in a 11 kW pellet stove (automatically stoked) and in a 8 kW wood stove (manually stoked) were collected during combustion tests intended to simulate real-world combustion cycles. Airborne UFP samples where collected during monitoring campaigns carried out at a small alpine town (Morbegno) in Northern Italy, where wood burning is largely diffused for domestic heating in winter. For comparison purpose, integrated UFP samples were collected both in wintertime (over three/four days) and summertime (seven days). Both stack and airborne UFP samples were collected by means of three parallel multistage impactors equipped with different collection substrates, depending on the subsequent analysis to be performed. Chemical analysis included elemental composition (ICP-AES), the main inorganic ions (IC), levoglucosan, mannosan and galactosan (HPAEC-PAD), total organic carbon by thermal-optical trasmittance (TOT), and PAH (GC-MS).

Biological effects were assessed by investigating the induction of the pro-inflammatory cytokine interleukin-8 (IL-8) in two human cells lines (THP-1 and A549), used as surrogates of alveolar macrophages and lung epithelial cells, and in human peripheral blood leukocytes. UFP-induced oxidative stress and genotoxicity were investigated in A549 cells by alkaline comet assay and γ-H2AX. Observed pro-inflammatory and genotoxic effects were compared to those in cells treated with NIES certified diesel exhaust particles (DEP).

**Results & Conclusions**
Stack-sampled UFPs induced IL-8 production in both A549 and THP-1 cell lines, with logwoods UFPs more active compared to pellet UFPs. With the exception of the higher effect of beech logwood UFPs only in THP-1 cells, the induced release of IL-8 was not influenced by the kind of wood; in addition, on a weight base, IL-8 release was similar or even lower compared to DEP, arguing against a higher biological activity of UFP compared with larger particles. Genotoxic effects, with statistically significant increase of all DNA damage markers, were more evident for UFPs generated by logwood combustion than by pellet, but without differences between the two types of wood.

Our tests confirmed that pellet stoves generate UFPs with reduced in vitro activity compared to wood stoves but showed that cells treated with DEP suffered more damage than those treated with UPFs from both logwood and pellet combustion. Airborne UFPs were able to stimulate an inflammatory response, with the release of IL-8 in several cellular models, including THP-1 cells and peripheral blood leukocytes. Summertime UFPs were more active in inducing IL-8.
release compared to winter UFPs in both cells lines, but the release was overall similar to the one observed with DEP. Opposite to the inflammatory effects, genotoxic effects induced by wintertime UFPs were higher than those induced by summertime UFPs, indicating that seasonal differences in UFPs composition differently affected biological responses. Results also indicated that cell types and toxicological parameters were differently triggered depending on the seasonal composition of airborne UFPs, but did not show a higher reactivity of airborne UFPs compared to DEP.

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