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Understanding the Health Impacts of Aerosols Produced in Peat Fires

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Background

Drier and warmer climate conditions are expected to increase the frequency, size and intensity of wildfires across the globe (Abatzoglou and Williams 2016). In addition to damage caused by the flames, the smoke is a major contributor to ambient air pollution (Chen et al 2021). As such, understanding the health impacts of these events is of growing importance. Peat smokes is composed of over one hundred gaseous species and particulate matter (PM), which includes both organic material and heavy metals (Hu et al 2019).

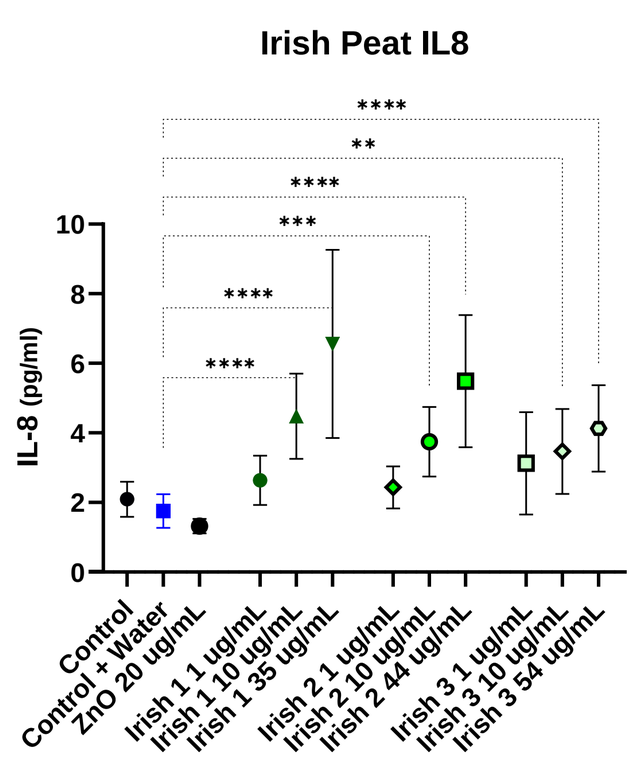
While the inhalation of peat fire smoke has been correlated with respiratory diseases. Here, we describe one of the first in vitro toxicology studies of the effect of peat particles on human lung cells. *We hypothesised that PM from smouldering peat fires would exhibit cytotoxicity against human lung alveolar epithelial cells, a major target of inhaled airborne particles.*

Methodology

Five peat samples (Figure 3, three Irish, one Canadian (H), and one Indonesian peat) were burned in an open reactor under conditions previously outlined by CITE. PM was collected when 40 to 60% of the wet peat mass had been lost using four separate methods:

- BioSampler for Biological Analysis
- MOUDI for Gravimetric Analysis
- Dekati PM10 Impactor for Elemental Analysis
- Collection for TEM

The BioSampler was used instead of filter collection to avoiding potential losses of volatile compounds or an incomplete extraction of metal compounds that occur during traditional filter extraction processes.



Figures 1 and 2: Inflammatory response (IL8 and IL6, ELISA assay) of TT1 cells exposed to increasing concentrations of peat PM. The negative control mimicking collection conditions (Blue) and positive ZnO control (Black) are also shown. Data shown is the mean and standard deviation from three biological experiments performed in sextuplicate .

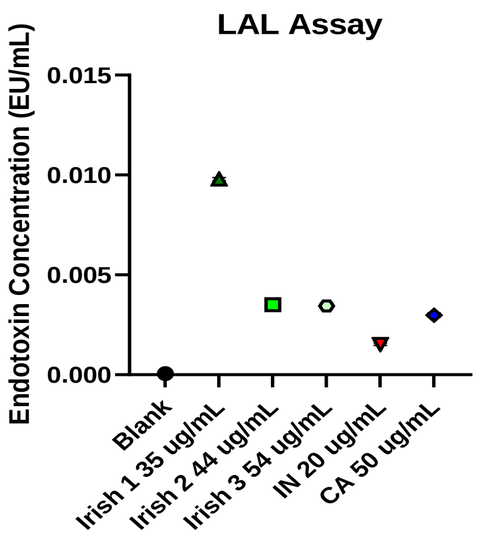


Figure 2: Endotoxin Concentration (LAL assay) of samples after they have been diluted to match maximum dosages

Cell Response

The Peat PM collected was then applied to transformed type-1 cell-like human alveolar epithelial cells (TT1) to assess putative cell toxicity using the following assays :

- MTT
- LDH
- ROS
- ELISA: IL6 and IL8

While MTT, LDH and ROS (N=3, with 6 technical replicates) experiments failed to produce results that were biologically significant. Production of IL6 and IL8 was seen with increasing dosages of PM, which varied depending on the sample. Results showed that while the mass of the PM drove the response in the individual sample, across the total data set it wasn't the defining feature. This is made clearer by the three Irish samples from the same source (Figure 1).

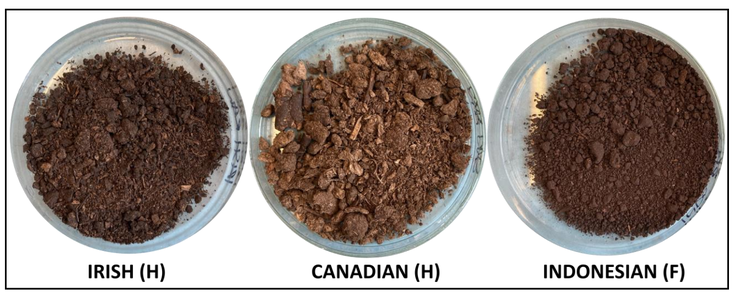


Figure 3: Examples of Irish, Canadian and Indonesian Peat Samples prior to ignition

Discussion

While Peat samples were generated in a uniform manner and in some samples were from the same source, there was a large degree of variation in biological response. This we believe is driven by variations in:

- Particle Number Concentration
- Particle Size
- pH of the Samples
- Endotoxin Concentrations
- Chemical Compositions

So far trends suggest that number concentration is more important the mass concentration and that endotoxin concentration is playing a significant role.

References

- Abatzoglou, J. T. & Williams, A. P. Impact of anthropogenic climate change on wildfire across western US forests. Proc. Natl. Acad. Sci. U. S. A. 113, 11770–11775 (2016).
- Chen, H., Samet, J. M., Bromberg, P. A. & Tong, H. Cardiovascular health impacts of wildfire smoke exposure. Part. Fibre Toxicol. 2021 181 18, 1–22 (2021).
- Hu, Y., Christensen, E., Restuccia, F., Rein, G., Transient gas and particle emissions from smouldering combustion of peat,Proceedings of the Combustion Institute, 37, 3, 4035-4042, (2019)

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