SUMMARY OF FINDINGS

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Studies of the Chemical Composition and Toxicity of Airborne Fine Particles in Cork's Mid-Harbour

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Particulate matter (PM) was collected over a period of one year (April 2007 to April 2008) in Cork Harbour, Ireland. A high-volume cascade impactor and polyurethane foam collection substrates were used in the collection process. The inorganic constituents found in the fine fraction of PM obtained at the mid-harbour site (Haulbowline Naval Base) were characterised by inductively coupled plasma- optical emission spectroscopy (ICP-OES) and ion chromatography. The ability of the fine PM collected to induce toxic effects on biological systems was experimentally investigated. Oxidative stress, cytotoxicity and inflammatory responses were measured in an *in vitro* system using A549 human lung epithelial cells.

Key Words: Particulate matter, air pollution, chemical/toxicological correlations, oxidative stress, toxicity profile.

Background

The chemical composition of PM has been linked previously to its ability to induce toxic effects on biological systems and also reflects associated emission-source contributions. The collection of reliable information about pollutant sources to levels of key chemical species that are known to adversely impact on human health is crucial for devising effective air quality, legislative strategies. From a public health perspective, it is also very valuable to possess detailed datasets regarding the nature of air pollution sources particularly when relevant to urban, industrialised regions.

Key points

- Chemical characterisation of fine PM samples collected at the mid-harbour Haulbowline Naval Base showed that the major water soluble inorganic ion and metal species accounted for an estimated 57% of the total mass of the fine PM fraction, meaning that just under half of the collected fine PM mass (43%) was comprised of non-water soluble elements and carbonaceous species.

- PM concentrations in the ambient air at the mid-harbour site were consistently lower compared to similar studies previously carried out in the Cork urban/city region. It could be inferred that the more central city sites are receptors of a higher local background source of fine PM whilst the mid-harbour collections are more dependent on weather conditions for local and regional depositions.
- Principle Component Analysis identified four main aerosol types: (i) marine; (ii) secondary inorganic aerosol; (iii) re-suspended materials; (iv) from combustion of commercial and heavy fuel oil. It was estimated that these four principle components, together, explained 85% of the variance in the data set.
- Toxicological tests, using an *in vitro* model system for human epithelial lung cells, showed biological responses to the fine PM samples collected during different seasons. PM sample had the ability to cause oxidative stress to cells irrespective of season. The samples also induced an inflammatory response, indicated by the production of the Interleukin 6 (IL-6) cytokine, irrespective of season. This finding is in contrast with a previous Cork city/urban study in which only summer samples resulted in IL-6 responses.
- Chemical/toxicological correlations based on analysis of mid-harbour samples identified zinc, copper and potassium as being linked with oxidative stress responses. In contrast a previous similar study had identified lead, cadmium, nickel, iron, antimony and cobalt with oxidative stress responses.

Findings/Recommendations

- Further refinement of the Principle Component Analysis apportionment approach (including Principle Least Squares regression analysis) and the inclusion of toxicological data into an appropriate model are required in order to link PM source to toxicological endpoints. Such a model could be then used to assess the toxicity profile of ambient PM based on chemical composition. This methodology could possibly provide a means of quickly assessing ambient PM, with respect to public health concerns because it avoids use of resource-demanding bioassays and large sample banks. The ultimate objective of such an approach would be to develop an early warning measure (Air Quality Forecast) for population health risk associated with ambient PM exposures.

For Further Information

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Publications connected to this work

Hellebust, S., Allanic, A., O'Connor, I.P., Jourdan, C., Healy, D. and Sodeau J.R. Sources of ambient concentrations and chemical composition of $PM_{2.5-0.1}$ in Cork Harbour, Ireland. *Atmospheric Research* 2010; 95: 136-149.