METABOLIC ACTIVATION AND CYTOTOXICITY OF AIRBORNE PARTICULATE MATTER

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INTRODUCTION

Mutagenic activity of airborne particulate matter is mainly located on
the smallest particles.
The primary target cells for respirable particles are the macrophages
bordering the lung alveoles. The regular clearance mechanism of the
alveolar region, represented by the phagocytic activity of the macro­
phages may be impaired by the toxic action of respirable particles.
In this study the cytotoxicity of indoor and outdoor air samples on
rat alveolar macrophages was determined.
Man is exposed to indirect acting mutagens for a far larger extend as
to direct acting mutagens. Since lung, in particular the bronchial
epithelium is the target tissue for carcinogenic substances it is not
clear whether tests for mutagenicity with liver extracts might be re­
liable predictors of mutagenic activity in lung.
In this study also liver and lung homogenates of different species we­
re compared towards their capacity of activating extracts of indoor
and outdoor particulate matter.

MATERIALS AND METHODS

Preparation of aerosol extracts

Sampling of particulate matter was performed at indoor and outdoor lo­
cations, following a sampling and extraction technique, which is des­
cribed previously (van Houdt et. al., 1987). Two samples were collec­
ted in livingrooms, one polluted by smoking and one polluted by wood
combustion. Three samples were obtained outdoors: one in winter when
wind direction was easterly and two in summer when wind direction was
northerly. In summer a clean extract was obtained by sampling the same
air mass two times.

Cytotoxicity testing

Alveolar macrophages were isolated from the lungs of female Wistar
rats (±200 g) as described by Mason et. al.(1977). Alveolar macropha­
ges were cultured following the methods described by Rietjens et. al.
(1985). Cells were exposed by a two hour incubation to different
amounts of aerosol extract. Phagocytosis was determined after incuba­
tion of the cells for 1,5 hour at 37°C in the presence of approximately
10⁷ dead yeast cells, coloured by bioiling them for 30 minutes in
congo red PBS solution. All experiments were carried out on at least 5
occasions in duplicate.

Mutagenicity testing

The experiments were performed using the standard plate assay, accor­
ding to Ames et. al.(1975), with minor modifications described pre­
viously (van Houdt, 1984).

Enzymic systems were prepared from livers and lungs of three month old male Wistar rats and six week old male Swiss mice. Half of the animals were pretreated with Aroclor 1254 (500mg/kg; Ames et al., 1975). Two independent tests were carried out in duplicate. In the results presented, the spontaneous revertants are subtracted. Tester strain TA 98 was used in all experiments.

The level of metabolic activation of each enzyme preparate is expressed as metabolic factor, calculated from the slope of the dose(homogenate)-effect curve.

RESULTS

The results of the mutagenicity testing of 5 extracts, expressed as revertants per m³, calculated from the slope of the linear part of the dose effect curve are presented in table 1. In the indoor samples only a slight direct activity is detectable, while enzyme mediated mutagenic activity was strong. To a lesser extend this was also found in the outdoor sample, collected in winter. Both with and without liver S9 the samples, collected in summer hardly showed any mutagenicity.

The data presented in table 2 clearly show that extracts of airborne particulate matter may cause a dose dependent decrease in phagocytosis of rat alveolar macrophages.

Reduction of phagocytosis by extracts, obtained from different locations gave the following sequence of declining phagocytosis: indoor air polluted by wood combustion, indoor air polluted by smoking, outdoor air collected in winter and outdoor air collected in summer. Clean air, just like DMSO did not reduce phagocytic activity.

Metabolic activation capacity of liver and lung homogenates towards extracts of airborne particulate matter is presented in table 3. Activating capacity was only determined in extracts, which show mutagenic activity in table 1.

Although activating capacity of the lung homogenates is less than the Aroclor induced liver homogenates, in all dose effect curves a high correlation (p<0.05) was found between the amount of added tissue and the number of revertants. Aroclor 1254 induction gives a strong increase of the metabolic activation capacity of mouse liver and rat liver. Activation by lung homogenates are comparable with uninduced liver homogenates. In contrast to indoor samples a relatively strong activation of outdoor samples was found by the rat tissue homogenates.

Extracts of indoor and outdoor particulate matter are activated at a comparative level by mouse tissue homogenates.

<table>
<thead>
<tr>
<th>extract</th>
<th>-S9</th>
<th>+S9 (A1254) liver</th>
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</thead>
<tbody>
<tr>
<td>outdoor clean</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>outdoor summer</td>
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</tr>
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<td>indoor smoking</td>
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<td>98</td>
</tr>
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