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# Biodegradation of atmospheric pollutants in the corrosion of carbonate building stone: an experimental study

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In urban environments atmospheric pollution by motor traffic is regarded as a main factor of decay of building materials. In these contexts the introduction of fuels with different environmental impact led to a progressive modification of the composition of the atmosphere consisting in a sharp decrease of the amounts of some pollutants such as sulphur dioxide, lead and benzene and in a clear increase of the amounts of other pollutants such as PM10. The result is the persistence of high levels of chemical corrosion of the stone surfaces. This fact along with the constant development of black crusts and the remarkable presence of fungal colonies on the surface of monuments points to a combined action of particulate pollutants and microbial colonization in the deterioration of stone. The aim of this work was to enlighten some aspects of the microbe-stone interaction in the presence of particulate matter pollutants. To this purpose, in vitro microbiological tests were carried out by exposing fungal cells to different inorganic and organic media.

Experiments involved powdered stone specimens, PM10 samples and selected components of PM10 employed as sole cultural media. In the first set of experiments powdered stone (40 mg/ml) and PM10 (0.04 mg/ml) samples were incubated in aqueous suspensions with *Aspergillus fumigatus* at different concentration ($10^4$and $5*10^4$ CFU/ml) in order to evidence the role of substrata and the influence of fungal concentration on microbial growth. Blank samples of powdered stone and PM10 in the absence of fungal cells were also prepared for comparison. In the second set of experiments aqueous suspensions of graphite (0.02 mg/ml), benzene (0.02 mg/ml), iron

sulphate (0.02 mg/ml) and *Stafilococcus aureus* ($10^3$ CFU/ml) were incubated with *Aspergillus fumigatus* ($10^4$ CFU/ml) in order to establish the influence of the specific components of particulate matter on fungal growth. All the mixtures were incubated at 25˚C and the tests were performed in triplicate. At different times of exposure (7, 15 and 30 days) samples were collected and analyzed for microbial monitoring and pH.

Results of in vitro tests show that fungi can actively colonize both lithic and PM10 substrata through acidic attack of the mineral surfaces and mobilization of sulphur and metals species. The presence within PM10 of significant amounts of ammonium and metal sulphates, these latter being derived from diesel exhaust emissions, leads us to consider PM10 a potential reservoir of sulphate ion which is made available due to the weathering action exerted by fungi. The persistence of sulfation processes on carbonate rocks despite the present-day low amounts of sulphur dioxide may, thus, be related to a significant fungal growth in the presence of sulphate particulate matter deposited on the surface of stone. In the light of these points an effective control of the mechanisms of deterioration of building stones will be actually achieved not only by reducing the reactivity of stone through the development of protective chemical products, but also by inhibiting the mechanical accumulation of particulate pollutants on the exposed surfaces.