

P16. Toxicity of smoke particles from wildfires

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Worldwide, wildland fires destroy every year a vast area of forest and consequently huge amounts of smoke are released into the atmosphere, which poses a danger to public health. According to the Institute of Nature Conservation and Forests (ICNF), in the last decade, the mean area burnt by wildfires in Portugal was higher than 100 000 ha, per year. During a summer season, fine particulate matter (PM_{2.5}) samples were collected from the smoke plumes of representative wildfires. Samples were tested for ecotoxicity by the *Vibrio fischeri* bioluminescence inhibition bioassay, which relies on the light of luminescent microorganisms that is emitted as a normal consequence of respiration. In addition, the samples were also assessed by the WST-8 test, which evaluates the metabolic level of the cells. Therefore, the aim of this study was to compare the toxicity of the smoke particles emitted from the various wildfires and to generate dose-response data. All the samples showed statistically significant, dose-dependent decreases in the viability of epithelial cells as assessed by the WST-8 test, which indicates the presence of toxic substances absorbed on smoke particles. A noticeably decrease in cell viability for the majority of samples was obtained at the two highest concentrations (100 and 150 µg mL⁻¹). For the ecotoxicity, the 50%-effective concentration (EC₅₀) and the Toxic Unit (TU) were calculated with values ranging from 9.3 to 21 µg mL⁻¹ and from 4.7 to 11, respectively. Based on the TU values, 22% of the samples showed high acute toxicity, while the remaining samples presented a significant acute toxicity.



Mundialmente, os incêndios florestais destroem todos os anos uma vasta área florestal e consequentemente enormes quantidades de fumo são libertadas para a atmosfera, o que representa um perigo para a saúde pública. De acordo com o Instituto da Conservação da Natureza e das Florestas (ICNF), na última década, a área média queimada pelos incêndios em Portugal foi superior a 100 000 ha, por ano. Ao longo de um verão, foram amostradas partículas finas (PM_{2.5}) das plumas de fumo emitidas por incêndios florestais representativos. As amostras foram testadas quanto à ecotoxicidade pelo bioensaio de inibição de bioluminescência pela bactéria *Vibrio fischeri*, que se baseia em microrganismos luminescentes que emitem luz como uma consequência normal da respiração. As amostras também foram avaliadas pelo teste WST-8, que avalia o nível metabólico das células. Assim, neste estudo procurou-se comparar a toxicidade das partículas de fumo emitidas pelos vários incêndios florestais e gerar dados de dose-resposta. Todas as amostras mostraram reduções estatisticamente significativas e dependentes da dose na viabilidade das células epiteliais, na avaliação pelo teste WST-8, o que indica a presença de substâncias tóxicas absorvidas nas partículas de fumo. Foi obtida uma diminuição na viabilidade celular para a maioria das amostras nas duas concentrações mais elevadas (100 e 150 µg mL⁻¹). Para a ecotoxicidade, a concentração 50% eficaz (EC₅₀) e a Unidade Tóxica (TU) foram calculadas, apresentando valores entre 9.3 e 21 µg mL⁻¹ e entre 4.7 e 11, respetivamente. Com base nos valores obtidos de TU, 22% das amostras mostraram uma elevada toxicidade aguda, enquanto que as restantes amostras apresentaram uma toxicidade aguda significativa.

Toxicity of smoke particles from wildfires

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BACKGROUND:

Worldwide, wildland fires destroy every year a vast area of forest and consequently huge amounts of smoke are released into the atmosphere, which poses a danger to public health [1,2]. According to the Institute of Nature Conservation and Forests (ICNF), in the last decade, the mean area burnt by wildfires in Portugal was higher than 100 thousand ha, per year [3].

ACKNOWLEDGMENTS

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OBJECTIVES:

- Compare the toxicity of the smoke particles emitted from the various wildfires and to generate dose-response data.

METHODS AND RESULTS:

During a summer season, fine particulate matter (PM_{2.5}) samples were collected from the smoke plumes of representative wildfires. Samples were tested for ecotoxicity by the *Vibrio fischeri* bioluminescence inhibition bioassay [4] and for cytotoxicity by the WST-8 test.



Table 1. Wildfire episodes over Portugal where smoke samples were collected.

Sample	Sampling locations	Major types of biomass
S1	Sever do Vougo	<i>Pinus sp.</i> and <i>Quercus</i> / Mixed forest (<i>Pinus pinaster</i> and <i>Eucalyptus globulus</i>)
S2	Albergaria-a-Velha	<i>Eucalyptus globulus</i> / <i>Arceuthobium obscurum</i>
S3	Forninhos	<i>Pinus pinaster</i>
S4	Chão do Caro (Oliveira de Frades)	<i>Eucalyptus globulus</i> and bark
S5	Sobrosa (São Pedro do Sul)	<i>Pinus pinaster</i> / <i>Pinus murrayana</i> / <i>Pinus resinosa</i> / <i>Cistus</i>
S6	Junqueira (Vila de Combão)	<i>Pinus pinaster</i> / <i>Eucalyptus globulus</i> / <i>Cistus</i> / <i>Arceuthobium</i>
S8	Vila Nova de Teófilo	<i>Pinus pinaster</i> and <i>Quercus</i> / <i>Cistus</i> / <i>Arceuthobium</i> / <i>Quercus alba</i> / <i>Rhus</i> / <i>Arctostaphylos</i> / <i>Arbutus unedo</i> / <i>Quercus europaea</i> L.
S9		

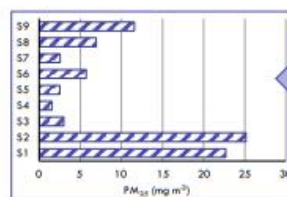


Figure 1. PM_{2.5} concentrations of the smoke samples collected from the wildfires.

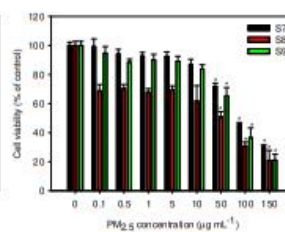
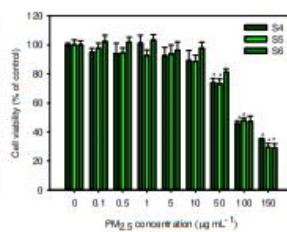
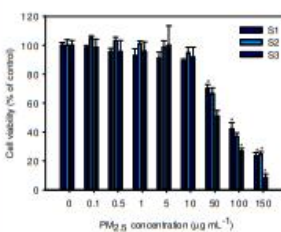


Figure 2. Cell viability for different PM_{2.5} concentrations for the smoke particles emitted by the wildfires ($p < 0.05$).

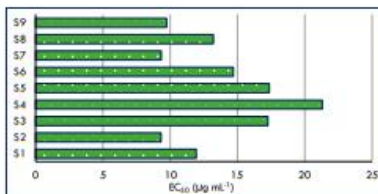


Figure 3. Ecotoxicity of smoke particles emitted by the wildfires.

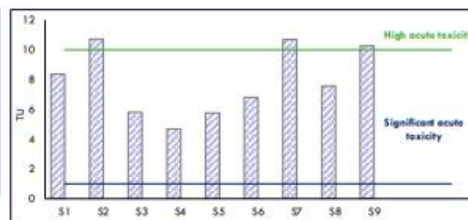


Figure 4. Acute toxicity results expressed in toxic unit (TU) for all samples collected from the wildfires.

CONCLUSIONS:

- All the samples showed statistically significant, dose-dependent decreases in the viability of epithelial cells as assessed by the WST-8 test, which indicates the presence of toxic substances adsorbed on smoke particles;
- A noticeably decrease in cell viability for the majority of samples was obtained at the two highest concentrations (100 and 150 $\mu\text{g mL}^{-1}$);
- Based on the TU values, 22% of the samples showed high acute toxicity, while the remaining samples presented a significant acute toxicity.