Microbiological characterization and inactivation of ceramic tiles

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Introduction

- Conservation of cultural heritage
  - Prevention
  - Control

- Biological contamination

- Possible causes of deterioration
  - Environmental conditions
  - Physical and chemical properties

- Mechanisms of deterioration by microorganisms
  - Chemical reactions (acid excretion)
  - Physical rupture (excretion polymeric substance – cause mechanical stress)
  - Esthetic alterations (production of pigments)
Objectives

- Microorganisms:
  - Quantification
  - Characterization
  - Inactivation © Estimate $D_{\text{min}}$ (Cobalt-60)

Evaluate and compare methodologies
Objects of study

- “Grande Panorama de Lisboa”
  - **Date**: XVIII century
  - **Location**: “National Tile Museum”
  - **Classification**: National Treasure
  - **Origin**: unknown
  - **Length**: 23 m

- “Quinta de Santo António”
  - **Date**: XVIII century
  - **Location**: “National Tile Museum”
  - **Classification**: n.a.
  - **Origin**: Water well
  - **Length**: unknown
Sampling

- Sterile swab
  - one tile per swab

- Sampled areas
  - with visible signs of deterioration
  - without visible signs of deterioration
  - representativity

- “Grande Panorama de Lisboa”
  - N=11 exposed
  - N=8 reserve

- “Quinta de Santo António”
  - N=5

- Morphological characterization of the isolates
  - macroscopic
  - microscopic
  - gram staining
  - biochemical tests (catalase and oxidase)

Temperature
23.4 °C

Relative humidity
58.6 %
Microbial inactivation

- "Quinta de Santo António"
  - Experimental source of Cobalt-60 ("Precisa 22"); 8233 kCi in November 2009
  - Individually in sterile plastic bags
  - Blank – 0 kGy (N=2; 1 and 4 kGy)
  - Doses – 1, 2 and 4 kGy (1 tile/dose)
  - Dose rate – 1.7 kGy/h
  - Uniformity of dose ($D_{\text{max}}/D_{\text{min}}$) – 1.2
  - Routine dosimetry – Amber Perspex Dosimeters, Harwell
## Results – microbial characterization

<table>
<thead>
<tr>
<th>Ceramic Tile Panel</th>
<th>CFU ± standard error (CFU/100 cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Quinta de Santo António”</td>
<td>$4.4 \times 10^2 \pm 0.8 \times 10^2$</td>
</tr>
<tr>
<td>“Grande panorama de Lisboa” – reserve</td>
<td>$13.0 \times 10^2 \pm 7.5 \times 10^2$</td>
</tr>
<tr>
<td>“Grande panorama de Lisboa” – exposed</td>
<td>$2.4 \times 10^2 \pm 1.3 \times 10^2$</td>
</tr>
</tbody>
</table>

### Morphologic types

- **Quinta de Santo António**
  - gram + non spore forming rods: 46%

- **Grande Panorama de Lisboa - reserve**
  - gram positive cocci: 80%

- **Grande Panorama de Lisboa - exposed**
  - gram positive spore forming rods: 61%

(“Grande panorama de Lisboa” – exposed: N=60/ reserve: N=106; “Quinta de Santo António”: N=33)
Results point out to a non linear inactivation kinetics

Inactivation efficiency of 25% for doses about 2 kGy
Results - microbial inactivation

Morphologic types – “Quinta de Santo António”

Predomination of other morphological types with the increase of the absorbed dose

Prevalence of fungi (86%) for 4 kGy

(0 kGy - N=33; survivors - N=173)
Conclusions

- Panels sampled
  - Average bioburden of 100 – 1000 CFU/100 cm² of tile
  - Bacteria was the major constituent of panels microbial population.
  - Panels microbial constitution didn’t show a pattern of contamination

- "Grande panorama de Lisboa" - expose and reserve
  - Distinct microbiological profile
    - Suggests no effect of ceramic tile composition
  - Heterogeneity of the microbial population
    - Environment – potential critical parameter in the biodeterioration

- Efficiency of microbial inactivation – 25 % from about 2 kGy

- Most frequent survival microorganisms after irradiation – fungi
Thank you!

Mulțumiri!