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# Biological colonization on majolica glazed tiles: biodeterioration, bioreceptivity and mitigation strategies

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The impact of microbial activity on the deterioration of cultural heritage is a well-recognized global problem. Glazed wall tiles constitute an important part of the worldwide cultural heritage. When exposed outdoors, biological colonization and consequently biodeterioration may occur. Few studies have dealt with this issue, as shown in the literature review on biodiversity, biodeterioration and bioreceptivity of architectural ceramic materials. Due to the lack of knowledge on the biodeteriogens affecting these assets, the characterization of microbial communities growing on Portuguese majolica glazed tiles, from Pena National Palace (Sintra, Portugal) and another from Casa da Pesca (Oeiras, Portugal) was carried out by culture and molecular biology techniques. Microbial communities were composed of microalgae, cyanobacteria, bacteria and fungi, including a new fungal species (Devriesia imbrexigena) described for the first time. Laboratory-based colonization experiments were performed to assess the biodeterioration patterns and bioreceptivity of glazed wall tiles produced in laboratory. Microorganisms previously identified on glazed tiles were inoculated on pristine and artificially aged tile models and incubated under laboratory conditions for 12 months. Phototrophic microorganisms were able to grow into glaze fissures and the tested fungus was able to form oxalates over the glaze. The bioreceptivity of artificially aged tiles was higher for phototrophic microorganisms than pristine tile models. A preliminary approach on mitigation strategies based on in situ application of commercial biocides and titanium dioxide ($TiO_2$) nanoparticles on glazed tiles demonstrated that commercial biocides did not provide long term protection. In contrast, $TiO_2$ treatment caused biofilm detachment. In addition, the use of $TiO_2$ thin films on glazed wall tiles as a protective coating to prevent biological colonization was analysed under laboratorial conditions. Finally, conservation notes on tiles exposed to biological colonization were presented.