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Pink! Why not? On the unusual colour of *Évora* Cathedral

Tânia Rosado [a, b], Andreia Reis [a, b], José Mirão [a, c], António Candeias [a, b], Peter Vandenabeele [d], Ana Teresa Caldeira [a, b, *]

[a] HERCULES Laboratory, Évora University, Largo Marquês de Marialva 8, 7000-809 Évora, Portugal
[b] Évora Chemistry Centre and Chemistry Department, Évora University, Rua Romão Ramalho 59, 7000-671 Évora, Portugal
[c] Évora Geophysics Centre and Geosciences Department, Évora University, Rua Romão Ramalho 59, 7000-671 Évora, Portugal
[d] Ghent University, Department of Archaeology, Sint-Pietersnieuwstraat 35, S-12, B-9000 Ghent, Belgium

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ABSTRACT

The inner walls of the *Évora* Cathedral have a pink/orange hue of unknown origin that covers the majority of the surface. In this work, an integrated approach was envisaged to explore whether the walls pink colour is due to anthropic intention or to natural sources, by combining material characterisation of the surface layers with its microbiological study.

Mortars material characterisation showed no presence of inorganic chromophores and therefore the use of inorganic pigments. The microbiological characterisation revealed that *Rhodotorula* yeast is the major microorganism isolated from the stained sites. Carotenoids were identified in the mortars from pink walls and in the isolated yeast culture by Raman and FTIR analysis. In this context, carotenoids detection could be tied mainly to the development and metabolic activity of *Rhodotorula* sp. in the surface of the walls. The extension of *Rhodotorula* sp. colonisation and the results obtained by the spectroscopic analysis are a strong indication that this microorganism is one of the main agents responsible for the colour alteration on the inner walls of *Évora* Cathedral.

Therefore, the perceived pink colour of the Cathedral is due to natural processes rather than to Human intention.

1. Introduction

Évora Cathedral or *Santa Maria* Church is one of the most emblematic monuments in *Évora*, a Southern Portugal, monumental town classified by UNESCO as World Heritage. This monument is the biggest Portuguese Cathedral and has a Romanic-Gothic style or Gothic with Cistercian and Medicant influences. Its construction dates back to the 13th century and was inspired by the model of Lisbon's Cathedral and other foreign cathedrals.

This monument has suffered several conservation/restoration interventions through the ages, without, however, any type of previous knowledge about the type of mortars and materials used. Recent works (Adriano et al., 2009; Silva et al., 2010) focused on the material characterisation of the renders, have shown that the inner walls of the Cathedral are composed of dolomitic aerial lime mortars with siliceous aggregates similar in composition to the granodiorites of *Évora*'s region with crushed ceramics as additives which can be dated back to a 16th century documented rehabilitation intervention. These works, however, were unable to detect any pigment and hence to explain the pink colour that covers the majority of the inner walls surface.

Thus, in order to identify the phenomena that promote these stains appearance in the walls, a biological approach was adopted.

The role of microorganisms in mortars alteration is related to climatic conditions and to the physical and chemical properties of the materials which act in co-association, ranging from synergistic to antagonistic effects (Jain et al., 2009; Wiktor et al., 2009).

Among the microbial organisms that colonise artworks, fungi are the most harmful agents associated to biodeterioration of organic and inorganic materials. Their occurrence on the mortars can cause aesthetic and/or structural damages due to physical and chemical alterations of the constituents, stains and biofilms formation on the surfaces, cracking and detachment of some fragments (Capodicasa et al., 2010; Pepe et al., 2011). However, phototrophic microorganisms such as cyanobacteria and algae may also colonise mortars, owning an important role in the mortars decay (Altenburger et al., 1996; Ariño and Saiz-Jimenez, 1996;

* Corresponding author. Évora Chemistry Centre and Chemistry Department, Colégio Luís António Verney, Rua Romão Ramalho n° 59, 7000-671 Évora, Portugal. Tel.: +351 266745311; fax: +351 266745303.
E-mail address: atc@uevora.pt (A.T. Caldeira).

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