

# UTILIZATION OF *EUGENIA CARYOPHYLLATA* THUMB, *PIPER NIGRUM* LINN, AND *THYMUS VULGARIS* L EXTRACTS ON THE FUNGAL-INVADDED LIMESTONE OF SOME MONUMENTAL BUILDINGS IN CAIRO, EGYPT

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## ABSTRACT

The present work reports on the use of some medicinal plants as candidates against fungal contamination in historical buildings. Isolation of different fungal species was made from three different buildings in old Cairo (mosque of Tameem Al-Rassafy, madrasa of Azbak Al-Yusufi, and mosque of Yusuf Agha Al-Heen), which had undergone deterioration on their limestone surfaces. The plants were collected from the Egyptian herbalism and duly confirmed and identified as that belonging to *Eugenia caryophyllata* (Clove), *Piper nigrum*, and *Thymus vulgaris*. Extraction of the crude oil was carried out using steam distillation method and the antifungal activities of the crude oil extracts were examined on the isolated fungi. The potential sterilization of the crude oil extracts was further investigated on the limestone samples and the effectiveness of the treatment evaluated with laboratory tests. The results indicated that the formulated treatment was suitable for monumental stone conservation.

## KEYWORDS:

Antifungal activity, Biological deterioration, Clove, Piper, Thymus, Steam distillation.

## INTRODUCTION

Egypt has a long historical heritage, representing different eras, starting from ancient ages of the Pharaonic period, passing through Isa alaihissalam (Jesus Christ), the Greeks, Batolamics, and the Romans, through the Islamic period, into modern Egypt as seen today. This has placed Egypt in a unique and important position among the countries with monumental heritage. The old Cairo is considered as an open museum of different historical periods [1], containing all the preceding old capitals.

This great history produces a huge archeological treasure, immovable and movable. Immovable treasures include the temples, tombs, pyramids, mosques and buildings, and the movable treasures are the art pieces. These were made from different materials from organics such as woods, manuscripts, or textiles; or the inorganics such as stones and metals.

Many monumental buildings in old Cairo are constructed from limestone [1] which have undergone deterioration from man-made effects, the climate change or the weathering actions over the last centuries which have affected the physical, chemical, and mechanical properties of the construction materials. This decay can be seen with the characteristic color changes of the stone surfaces [2, 3]. This has been compounded further with biological deterioration from fungi, algae, and bacteria attacks on the buildings blocks. The persistence of chemical corrosion by sulfation on the exposed materials [4, 5], with the presence of fungal colonies on the stone surfaces of these buildings [6], suggest a combined action of particulate pollutants and microbial colonization in the stone deterioration.

Fungi have the most damaging effects, attacking and even penetrating the surfaces of the stone monuments [7, 8] where their activities are enhanced by climatic conditions (high irradiation, extreme wetting and drying by humidity, temperature, and underground water), and environmental factors (air pollution and air eutrophication). Although the inorganic composition of the stones should deter the growth of these heterotrophic microorganisms, it is likely that the organic residues from different sources on the stone surface have served as nutrients [9]. Light and sufficient warm temperature, in combination with rich nutrients of organic residues, catalyze reproduction of quiescent (dormant) fungal spores [10]. Those sensitive to humidity and heat, have hyphal growth that penetrates the substrate, with destructive effects [11].