Cairo University
Faculty of Archaeology
Department of Conservation

Experimental comparative study for the evaluation of the efficiency of using some traditional methods and nano materials for the treatment of biodeteriorated paper manuscripts - With application on a selected object

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Submitted by
Mohamad AbdEl-Haleem Mahmoud El-Sadany
Director of Restoration and Conservation of Islamic Antiquities in Dakahlya and Damietta.
M.Sc.,(conservation of manuscripts and verifying the authenticity of it), Cairo University, Faculty of Archaeology, Department of Conservation. (1434 A.H-2013 A.D)

Supervision committee
Prof. Dr. Hossam-Eldin Abdel-Hamid Mahmoud
Professor of conservation of Antiquities EX-Head of Restoration Department & EX-Vice Dean of Faculty of Archaeology,Cairo University.

Prof. Dr. Gomaa Mohamed Mahmoud Abdel-Maksoud
Professor of Restoration & Conservation Dep. Dean of Faculty of Archaeology, Cairo University

Dr. Amr Fouda Mahmoud Hamza
Assistant Professor of Microbial Biotechnology, Botany and Microbiology Department, Faculty of Science, Al-Azhar University, Cairo.

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١- أ.د/ جمعه محمد محمود عبد المقصود.		
٢- أ.د/عمرو فوده محمود حمزه.		
٣- أ.د/ مصطفى عطيه محى عبد الجواد.		
٤ -أ.د/ محمد السيد عبد العزيز		

ABSTRACT

Potential high bio-deterioration of certain microorganisms due to their metabolic activities on organic materials causes serious problems in the conservation of cultural heritage. This study aims to isolation and identification of causative biodeterioration microbes and create a new approach for the treatment of biodeteriorated paper manuscripts. Macroscopic observations of collected manuscripts, isolation of microbes from the historical samples, microscopic identification for fungal isolates, identification of bacterial isolates using morphological, physiological and Vitek 2 methods were carried out in this study. Molecular identification showed that eleven bacterial species and fifteen fungal species were identified using 16S rRNA and ITS sequences, respectively. Paper models conservation effect of Ag-NPs, ZnO-NPs, $AgNO_3$ and $Zn(CH_3CO_2)_2.2H_2O$ against strains *Bacillus subtilis*, *Aspergillus niger* and *Penicillium chrysogenum* was evaluated. Color change (CIE L*a*b*), tensile strength and elongation, FT-IR and SEM were assessed to know the effects of microorganisms and materials used on paper properties. The manuscript under the title "*Al-Mosamara Sharh Al-Mosayara*" , dated back to 1124 A.H, and deposit in Al-Azhar Library, Cairo, was used for the applied study. Analytical techniques and investigations used for the evaluation of the manuscript state were optical microscope, investigation of black ink, acidity ratio measurement, FTIR, SEM, EDX, XRD, and microbiological investigation. The required conservation steps of the manuscript studied were carried out and included sterilization by using 2.0mM Ag-NPs, cleaning, deacidification by $Ca(OH)_2$-NP_S, paper restoration and consolidation by Klucel G. Screening of cellulolytic activity exhibited that *Bacillus subtilis*, *Aspergillus niger* and *Penicillium chrysogenum* achieved the highest cellulolytic activity amongst obtained bacterial and fungal strains. The results revealed that application of 1.0 or 2.0mM silver NPs exhibited the best preservation effect on the paper models achieving 100% microbial inhibition (bacteria and fungi, respectively). The manuscript investigation showed that cellulosic fibers is cotton and the black ink is iron-gall.

Key words

Paper manuscripts

Bio-deterioration

Whatman filter-paper

Silver nano-particles

Zinc oxide nano-particles

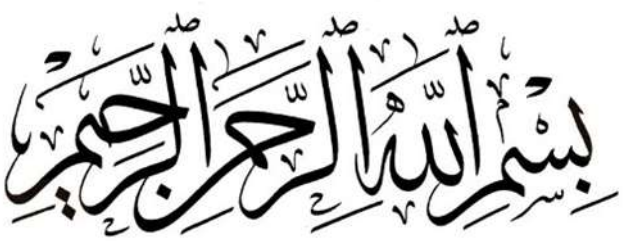
Silver nitrate

Zinc acetate

Aspergillus niger

Penicillium chrysogenum

Bacillus subtilis



(... يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنْكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ)

(المجادلة: آية ١١)

DEDICATION

I dedicate this thesis with affection to all who seek knowledge of the Islamic religious sciences and other useful sciences;

With the intention of obeying Allah the Almighty and to have the veil of ignorance removed.

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