IJCS INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE

ISSN: 2067-533X Volume 9, Issue 1, January-March 2018: 117-126 www.ijcs.uaic.ro

INVESTIGATION AND RESTORATION OF A 17th CENTURY AD MANUSCRIPT AT AL-AZHAR LIBRARY IN EGYPT

Taha Ayman SALAH*

Conservation Department, Faculty of Archaeology, Aswan University, Aswan 81528, Egypt

Abstract

This case study manuscript "Suluk alttariqat alssufia", which is kept at the Al-azhar Library in Cairo is documented and treated. The manuscript was made from cotton fibers that may have been used the induction of paper. It's exposure to various deteriorating factors, including neglect and inappropriate exhibition, caused a lot of damage. The unavailability of appropriate conditions at the library, including relative humidity, temperature, light and unsealed storage cases, lead to gathering of air dust particles and aerosols inside the storage rooms. All these factors led to severe damage which resulted in the manifestation of dust and fungi stains formed on the paper manuscript. This research offers a treatment and restoration plan and illustrates the actual scientific procedures that were followed during the restoration and treatment of the manuscript, starting from the archaeological documentation, the analysis and scientific inspection (SEM-EDX, FTIR-ATR) which were carried out to identify the components, and the actual stages of restoration and conservation.

Keywords*: Manuscript; Degradation and deterioration effects; Fungal attack; Preservation and restoration; Analysis methods by FTIR and SEM-EDXS, Identification of fungi*

Introduction

This part includes the conservation and restoration of a 17th century AD manuscript. It is considered to be monuments record for real estate property describing and location them. This manuscript belongs to Al-Azhar library so dates back to the 1688AD. The reason for choosing this manuscript object for restoration is because of the common problem that may be found in the most storage facilities or libraries where there is a bad storage condition as well as bad handling. Libraries and archives sometimes have suitable conditions for fungal growth, which is highly dependent of temperature and humidity. Where high humidity and temperature are frequent, have environmental conditions that facilitate the growth of these microorganisms. This situation can bring hazard to human health by mould infection of books and documents, besides causing the decay of these publications, which sometimes is old [1]. The most common types of damage sustained by bookbinding are caused by poor handling, poor storage methods, unsuitable display methods, and wear and tear from repeated use, chemical changes in the materials making up the bookbinding leathers exposed to polluting gases [2]. Bookbinding exposed to air and light exhibited a great content of sulphuric acid produce from the polluting atmosphere [3]. Fungal infection is considered a main concern for libraries or archives full of paper-based books and documents, it is critical not only to control active fungal growth, i.e., hyphae, mycelium, or mould, but also to remove or reduce the amount of fungal ascospores and

* Corresponding author: aymansalahtaha82@yahoo.com

conidia [4].The structural nature of ascospores as predecessors of future growth allows the fungi to survive severe conditions, and ascospores are consequently harder to inactivate than the vegetative hyphae. In unfavorable conditions remain spores have low water content and their metabolism is inactivated but changeful [5]. Fungi can hydrolyze a wide variety of polymers, including cellulose, as a result of their efficient degradative enzymes [6]. Cellulolytic fungi, which use cellulose as substratum, when growing in favorable environmental conditions, can break down paper material in a short time [7]. Fungi are important biodegrading and are considered as serious degrading agents where the presence of vegetative cells or spores on the surface of wood or other materials like paper may indicate a possible degradation in the future [8, 9]. If the paper is exposed to natural or artificial light, it is photo-degraded, assisted after deterioration by fragility. Particularly sun light has a serious damaging effect on written or printed paper materials. The ultraviolet radiation of light are mainly responsible for photochemical degradation of paper which takes place rapidly when paper is exposed to sun light in presence of air (oxygen). When some portion of cellulose is oxidized to oxy cellulose, the long cellulose chains are broken and the paper becomes weak and brittle. Fading of ink and dye of the coloured paper and yellowing of white paper also takes place due to the formation of ox cellulose [10]. Fine dry particles of any case present in the air are known as dust. This is highly critical for the library and archival collection, composed of soil, tar, metallic substances, fungus spores and moisture among other things. Since dust is air borne it settles down on any surface of the object. Dust is hygroscopic in nature and when it is mixed with high humidity, it is transformed into dirt and if this dirt sticks to the surface of the books. it becomes difficult to remove. Dust and dirt are sources of both physical and chemical degradation of the library collection. Powder acts nucleus around which moisture collects and this moisture provides the necessary humidity for the growth of fungus and for chemical reaction, which lead to the formation of acids. Since dust and dirt are solid particles of varying size and hardness they exert abrasion on the surface of the books [11]. Several techniques have been developed for book and document conservation reducing the threat of bio-degradation and bio-deterioration agents, such as fungi. Some of these techniques involve the use of very toxic chemicals, including ethylene oxide, which has carcinogenic properties and is banned in a number of countries, besides being expensive [1, 12]. Therefore, the present study was prepared to restoration this manuscript and searching for simple, cheap, non-toxic and eco-friendly control against causative microorganisms. This will participate effectively in the development of national and international strategy for the collection and storage of rare books and manuscripts in libraries.

Materials and Methods

Description of the manuscript

The manuscript is a book on meanings interpretation for the revelations of the named "Suluk alttariqat alssufia" and has been dated to 1688AD. It was listed under Public No. 85314 and Special No. 2407 in the stores of Al-Azhar Library in Cairo, Egypt. Its length is 21cm and width 17cm. It was written in black, red ink, the manuscript has a stained spots and discoloration as a result of poor storage, and Ink smears due to washing away of the inks by water drops or storage in high relative humidity environment, as well as handling problems represented by the red lines where the reader has meant to highlight some important lines, and broken separated folds due to bad handling, as well as transparent tapes were also applied to reattach the disconnected folds. As a result of aging, they have lost adhesion and leave discolored spots underneath (Fig .1).

Fig .1. Degradation and deterioration of manuscript: missing parts of bookbinding, stains of dust, transparent tapes, destruction of paper edges

Investigations and scientific analysis by scanning electron microscopy with EDX

The paper manuscript is mainly made up of the following components, paper (fibers, mould pattern, sizing materials, pigments, fillers, inks, other secondary components e.g. pastes, binding mediums), identifying the fibers that were used for making the paper manuscript and conditions of the manuscripts, required the following procedures .

Fourier transform infrared spectroscopy (FTIR)

Infrared reflectance spectra was recorded using a Vertex 70V (Bruker Optics) spectrometer, The recording time varied according to the quality of spectra obtained and ranged between 600-4000cm^{-1} scans and spectral resolution was 4cm^{-1}.

Isolation and identification of fungi

Cotton swabs were inoculated directly on to agar plates. The media used was Sabouraud-glucose agar and Czapek's agar supplemented with choramphenicol for fungi. Petri dishes were incubated at at 28^{o}C for 7 days for fungi. Based on colony morphology, fungal colonies were picked up, sub-cultured on agar plates and purified using streaking method. The purified colonies were preserved at 4^{o}C for identification and further studies [13].

Preservation and restoration

The plan for the treatment, preservation and restoration of this manuscript includes the following procedures were applied.

Results and Discussion

SEM microscopy with EDXS Observation

Examination of the manuscript under the SEM electronic microscope with EDXS showed that it exhibits typical symptoms of bio-degradation. It was also possible to highlight in the structure of paper manuscripts the cotton fibers with their preservation status and the evaluation of the elemental composition in C, O, Ca and Fe and low content of Al and Cl. The presence of iron and aluminum had an important role in the formation of spots (Fig. 2).

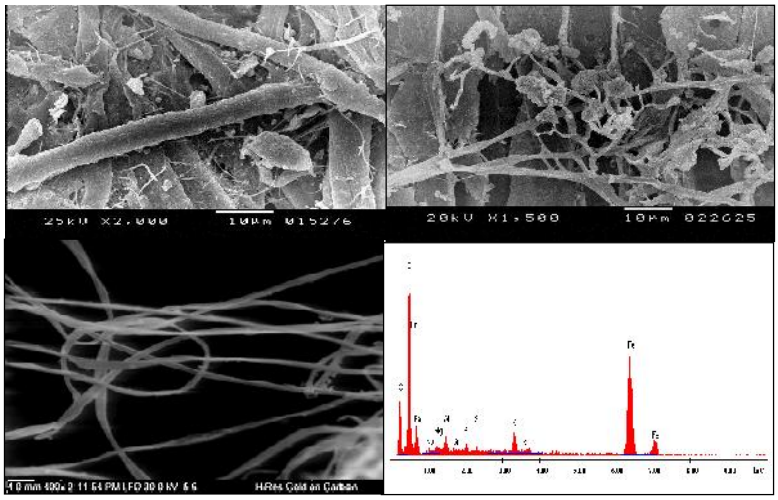

Fig. 2. Microorganisms on fiber paper and EDX analysis to old paper,
Shows the structure of the paper manuscripts

FT-IR analysis

The main aim of using the analysis in this study is to know the animal glue, which is used to cohere manuscript, and the cellulose decomposition of the manuscript paper (Figs. 3 and 4).

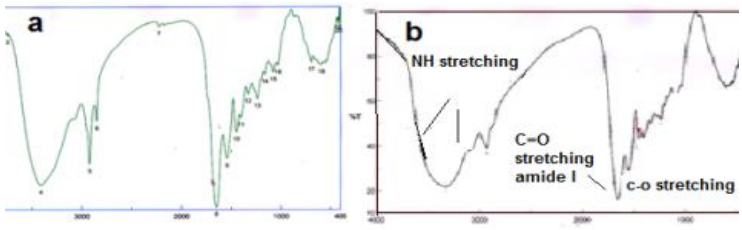

Fig. 3. FT-IR Spectres: a - Shows IR analysis of Standard animal glue;
b - The sample animal glue, which is used to adhere manuscript.

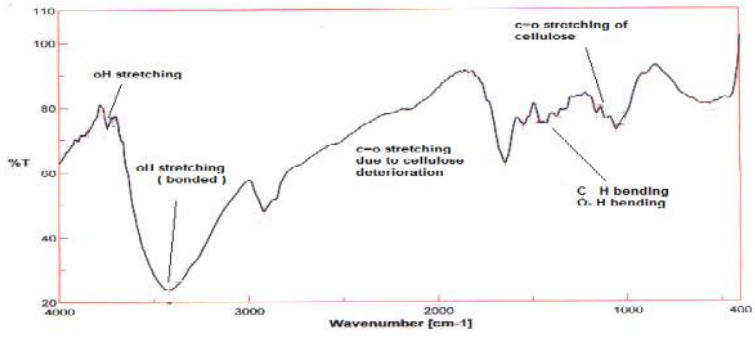

Fig.4. Shows FT-IR analysis of a sample paper from the manuscript, where the presence of the absorption pulse of the carbonyl group C = O at wave number 1639.2cm^{-1}

Identification of Isolated Fungi

Based on colony morphology different isolates were selected and then sub-cultured onto a fresh nutrient agar medium for 24h at 37°C by the streaking method. Isolate 1 is *Penicillium citrinum* in manuscript surface, and in the surface of secondary support cover, we identified *Aspergillus niger*. While the conservation and restoration of this object by a mixture of ethyl-alcohol and deionized water 1:1 was sprayed on the backside of the taped area to help removing the tape without affecting the paper surface. Interestingly, the crude extract of Acacia nilotica fruit was used as non-toxic, cheap and eco-friendly control against the causative microbial fungi (Figs. 5 and 6).

Fig. 5. Mold damage of the cover and the folios of the manuscript

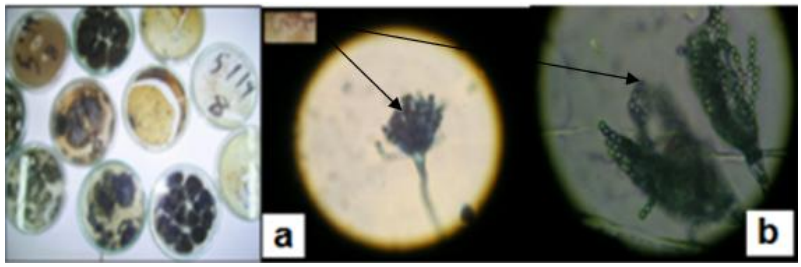

Fig. 6. The fungi isolated from old paper: a - *Aspergillus niger; b - Penicillium citrinum* .

Conservation and Treatment

Removing the degraded transparent tapes

To remove the old transparent pressure-sensitive tapes, some routine experiments were tried in order to determine the best method without damaging the paper surface. Starting with ethyl alcohol, the adhesive of the tape did not completely dissolve. Then a mixture of three solvents, ethyl alcohol and toluene and benzyl alcohol achieved the best results of removing the tap by dissolving the adhesive [14]. Tweezers, cotton swabs and a scalpel were the tools used for mechanical manipulations of the tapes. Figure 7 shows the three steps (a, b, c) of removing damaged bands from the paper surface. A mixture of ethyl alcohol and deionized water 1: 1 was sprayed on the back side of the taped area to help removing the tape without affecting the paper surface. Blotting paper was also used locally to avoid spreading the dissolved adhesive. The taped

areas were fortunately on the separated folds that have no writing inks. They were successfully removed as shown.

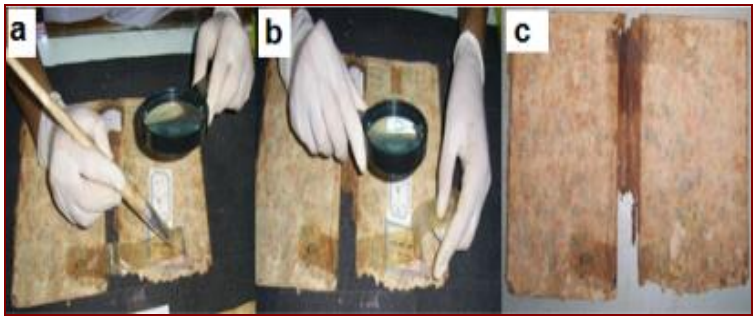

Fig.7. Showings remove the old transparent tapes

Mechanical cleaning

Paper was cleaned mechanically by soft brushes in the direction of the fibers from the middle toward the edges, beside using tweezers, a spatula, and air pump sometimes [15] (Fig. 8).

Fig. 8. Dust removal by soft hairbrush

Consolidation of the paper

The ink was found stable to the neutral water treatment up to 3 minutes, then starts bleeding, moving in to the water solution. The longer the immersion time, the more displacement of the inks particles occurred. Therefore, for fixing the ink from bleeding during the aqueous treatments, a 2% of hydroxyl propyl cellulose in pure ethyl alcohol was applied by small brush (Fig. 9).

Treating of manuscripts by Antimicrobial activities of the crude extract of Acacia nilotica fruits

The fruits of Acacia nilotica were collected from Aswan city, Egypt. Fruits were identified at the Department of Botany, Faculty of Science, Aswan University, Egypt. The fruits were washed under running tap water and air dried for 24h. Methanolic extract was prepared from the fruits [16, 17]. Each papers were washed with the crude extract of Acacia nilotica fruits using soft brush, a solution of each prepared concentration of extracts from 500mL to 62.5mg/mL, for 3min. This method of cleaning was repeated several times and then the papers were air-dried for 24h. Finally papers were washed with distilled water using soft brush. Then

they were immersed in 5% hydroxyl propyl cellulose solution to improve mechanical properties without affecting the optical properties (Fig.10).

Fig. 9. Showings fixing the ink and consolidation old paper

Fig.10. Treating of the manuscripts by Antimicrobial activities

Rebinding

Due to the degradation and deterioration of the original cardboard, cover is almost decomposed. It was decided that it could not be used and to carry out the process of rebinding the manuscript with a new cover. These bindings had chain stitch sewing those laces through the cardboard.

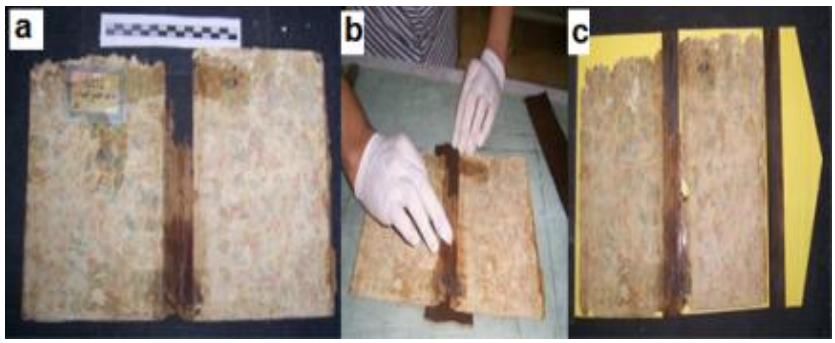

Fig.11. Stages in restoration of covers: a - Cardboard cover preprocessing;
b - During processing; c - After perfecting of treatment

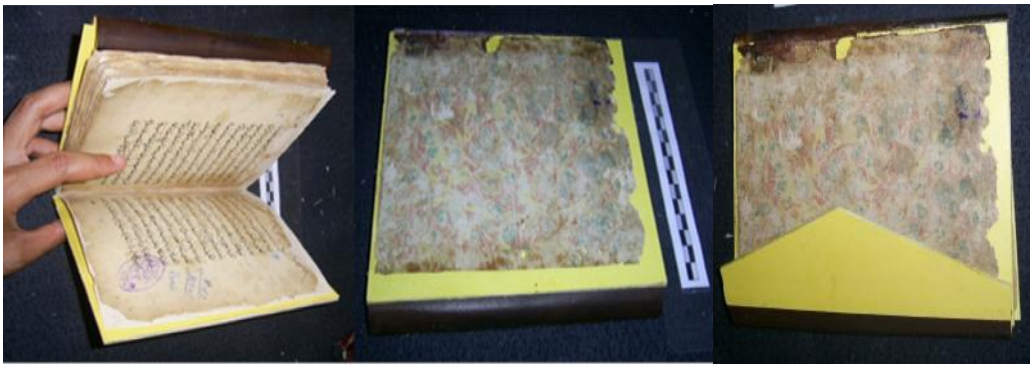

Fig.12. the manuscript after restoration

The sewing was done through geminate of sewing stations with a needle on each end of the thread. Reddish brown skin was used to make the new part leather binding typically to the original cover. The cover has many deterioration and degradation problems, is shown in the missing parts as holes, the insects damage is seen obviously not only on the surface missing parts, but also on the paperboard that used to strengthen the cover. Rag paperboard was used for replacement of the old paper pasteboard that removed earlier. To get the typical thickness of the old paperboard, which should be suitable for remounting the treated cover, sheets were cut exactly the same size of the old one [18-20] (Figs. 11 and 12).

Conclusions

This research transact with the conservation process of manuscript no. 85314 - 2407 in Al-Azhar Library and as a result we can conclude that SEM-EDX-FTIR is a good elemental technique to characterize paper manuscript, like previous studies this study found out the animal glue was widely used as an adhesive to stick the cover manuscript, Many aspects of degradation and deterioration were noted on the surface of the paper or bookbinding, such as holes caused by insects, wrapping, erosion of tanning material and missing parts. The most dominant fungi were *Aspergillus niger* and *Penicillium citrinum,* the pH values of the paper and bookbinding were higher than their normal values because this manuscript was damaged by alkaline environmental conditions. The method of applying a temporary facing technique has greatly facilitated the safe removal of transparent tapes, and control against causative microorganisms by the crude extract of Acacia nilotica.

Acknowledgements

Author is introducing them sincere thanks and gratitude to the staff members of Al-Azhar Library in Cairo for their kind assistance and cooperation for restoration of the manuscript. Grateful thanks to Conservation department, Faculty of Archaeology, Aswan University for their supporting, Also, we thank at Botany Department, Faculty of Science, Aswan University for her kind helping in the identification of fungal isolates.

References

[1] M.E. Gonzalez, A.M. Calvo, E. Kairiyama, *Gamma radiation for preservation of biologically damaged paper,* **Radiation Physics and Chemistry, 63**, 2002, pp. 263–265.

[2] P. Agrawal, M. Barkeshli, **Conservation of Books, Manuscripts and Paper Documents**, Indian Council of Conservation, Institutes Luck Now, 1997, p. 111.

[3] V. Ganiti, E. Pavlidou, F. Zorba, K.M. Paraskevopoulos, D. Bikiaris, *A post-Byzantine icon of St Nicholas painted on a leather support. Microanalysis and characterisation of technique*, **Journal of Cultural Heritage, 5**, 2004, pp. 349-360.

[4] A. Michaelsen, F. Pinzari, N. Barbabietola, G. Piñar, *Monitoring the effects of different conservation treatments on paper-infecting fungi,* **International Biodeterioration and Biodegradation, 84**, 2013, pp. 333 – 341.

[5] D. Bridžiuvienė, V. Raudonienė, *Fungi Surviving on Treated Wood and Some of Their Physiological Properties*, **Materials Science** (Medžiagotyra) **19**(1), 2013, pp. 43-50.

[6] J.W. Bennett, B.D. Faison, *Use of Fungi in Biodegradation*, **Manual of Environmental Microbiology** (Editors: C.J. Hurst, G.R. Knudsen, M.J. McInerney and L.D. Stetzenbach), ASM Press, Washington, 1997, pp. 758–765.

[7] M. Adamo, G. Magaudda, P.T. Nisini, G. Tronelli, *Susceptibility of cellulose to attack by cellulolytic microfungi after gamma irradiation and ageing*, **Restaurator, 24**, 2003, pp.145–151.

[8] A.A. Fabbri, A. Ricelli, S. Brasini, C. Fanelli, *Effect of different antifungals on the control of paper biodeterioration caused by fungi*, **International Biodeterioration and Biodegradation, 57**, 1997, pp. 61–65.

[9] N. Mesquita, A. Portugal, S. Videira, S. Rodríguez-Echeverría, A.M.L. Bandeira, M.J.A. Santos, H. Freitas, *Fungal diversity in ancient documents. A case study on the Archive of the University of Coimbra*, **International Biodeterioration and Biodegradation, 63,** 2009, pp. 626 – 629.

[10] L.K. Prasad, **Protection of Documents from Photo Chemical Effects of Light- CCPI**, Vol. 28, New Delhi, 1995, pp. 45- 49.

[11] B. Narendra, **Conservation of Manuscripts: Prevention is Better than Cure - Conservation of Cultural Property in India**, Vol. 30. New Delhi, 1997, pp. 52-63.

[12] M. Adamo, M. Brizzi, G. Magaudda, G. Martinelli, M. Plossi-Zappala, F. Rocchetti, F. Savagnone, *Gamma radiation treatment of paper in different environmental conditions*., **Restaurator, 22**, 2001, pp. 107–131.

[13] E. Merck, **Hand Book of Microbiology**, Federal Republic of Germany, 1990, p. 45.

[14] A.F. Clapp, **Curatorial Care of Works of Art on Paper**, Intermuseum Conservation Association, Oberlin, Ohio, 1973, p. 45.

[15] J. Frozen, **Conservation of Ancient Papyrus Materials, the Oxford Hand Book of Papyrology**, Oxford University Press, 2009, pp. 79-100.

[16] A.D. Alanis, F. Glazada, J.A. Cervantes, J.Tarres, G.M. Ceballas, *Antibacterial properties of some plants used in mexican traditional medicine for treatment of gastrointestinal disorders*, **Journal of Ethnopharmacology 100**(1-2), 2005, pp. 153-157.

[17] N.A. Hagaggi, A.S. Taha, Microbial deterioration of a 13 AH – century manuscript housed in Al-Azhar library in Egypt : Acase study, **Journal of Basic and Environmental Sciences, 3,** 2016, pp. 65– 74.

[18] H. Bansa, *Computerized Leafcasting*, **Restaurator**, **11**, 1990, pp. 69-94.

[19] A.M. Rushdy, W.N. Wahba, M.S. Abd-Aziz, M. El Samahy, S. Kamel, *A comparative study of consolidation materials for paper conservation,* **International Journal of Conservation Science, 8**(3), 2017, pp. 441-452.
[20] S.M. Jacob, J. Raseetha, V. Kelkar-Mane, *Physico-chemical assessment of biodeteriorated and biodegraded archival paper,* **International Journal of Conservation Science, 8**(4), 2017, pp. 607-618.

Received: May 28, 2017
Accepted: February 28, 2018