

## Microbiological Deterioration Survey of Historical Parchment in Different Institutions

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### Abstract

*The knowledge of our generations is based on the information and the historical documents that conserve all cultural value for humankind and race, this knowledge was transmitted from ancestral by writing material like parchment, which was made from animal skin. Furthermore, the essential components of parchment were the collagen, water, and inorganic materials. As others nutritive source these writing materials can be the target of many microorganisms especially the fungus.*

*A total of forty historical parchments were collected from different institution, twelve of them were suspected to be infected by microorganisms due to visible color change on the surface of the parchment. The sample collected by sterilized swabs on the different spot of suspected infected parchment, then the specimen cultured on sabouraud dextrose agar (Actidione®) for 7 days at 25 °C. The identification is based on the morphology of the colony on the agar and the microscopic observation.*

*As results, after the incubation time at favourable temperature, eight of these twelve historical parchments have an active fungus infection with at least one genus. The detected fungi were respectively six *Aspergillus niger*, five *Aspergillus flavus*, three *Fycomycetes*, one *Penicillium funiculosum*, and one *Trichoderma viride*.*

*Finally, the microbial analysis of the infected manuscript which had kept in different national library identified four fungi genus. Further studies are required to identify the species of some fungi using a molecular method, and to study the mechanical effect of this infection on the components of parchment and their elasticity and use approximately all the method of cleaning for eliminate the effect of fungus reaction on parchment.*

### Keywords

*The knowledge of our generations is based on the information and the historical documents that conserve all cultural value for humankind and race, this knowledge was transmitted from ancestral by writing material like parchment, which was made from animal skin. Furthermore, the essential components of parchment were the collagen, water, and inorganic materials. As others nutritive source these writing materials can be the target of many microorganisms especially the fungus.*

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## 1. Introduction

The knowledge of our generations is based on the information and the historical documents that conserve all cultural value for humankind and race, this knowledge was transmitted from ancestral, and can be found on parchment or other writing material depending on the century of this features. Furthermore, the parchment was used by Assyrian peoples as a writing material because the Aramaic script wasn't able to write in the clay tablets(1,2).

In Europe and the Mediterranean the most used kind of writing material was the parchment because it has several advantages over the papyrus (the most ancient writing material), the parchment is able to resist the environmental conditions more than other type of writing material (good mechanical properties), can be used from the two sides, and also it can be reusable due to the ability of removing of the ink and re-writing on it again(3).

The parchment is made from animal skin, usually from calf, goat, camel or sheep, after a long treatment procedure(3). It is composed from water, inorganic materials and organic components like collagen type I or type III depending on the body parts or the type and the age of the animals(4,5). The collagen is a fibrous protein formed by a chain

of amino acids with abundance of glycine, proline, and hydroxyproline(3).

Like any nutritive sources the collagen can be denatured due to various agents as the biodegradation caused by microorganism vital activity which can hydrolyse the parchment components into disordered gelatine, and produce pigments and organic acids responsible of color change and indirect damage(6).

The main microorganisms which can attack the writing material, especially the parchment or vellum, are the fungi and the bacteria, but the principal ones are the microfungi(7), which are widespread organisms and can be found anywhere because of their resistant forms (spores) that present in 20 thousand to 2 million fungus spores in 1m<sup>3</sup> of air(8). These spores grow and spread when the environmental condition, like the temperature, pH and humidity, are favourable(9).

The results of microbial damage depending on the species that attack the parchment. The microorganism identification is usually based on phenotypic method like culture method and the microscopic observation.

The aim of this study was to determine the type of the microorganisms that cause infections and damage of 12 historical

parchments of a total 40 manuscripts stored in different institutions that contain important and historical manuscripts.

## Materials and methods

### [Samples resources](#)

All the historical parchments in this study were collected from different institution, which contain a parchment manuscripts such as

1- Manuscripts store of the Egyptian Book House.

2- Manuscripts and Papyrus store in

Egyptian Book House.3- Papyrus and

parchment store in Egyptian Book House.

4- Museum and manuscripts store in the library of the Egyptian Book House.

Stores of the National Archives and the institution of restoration of the National Archives.

4- Museum of manuscripts in Alexandria library.


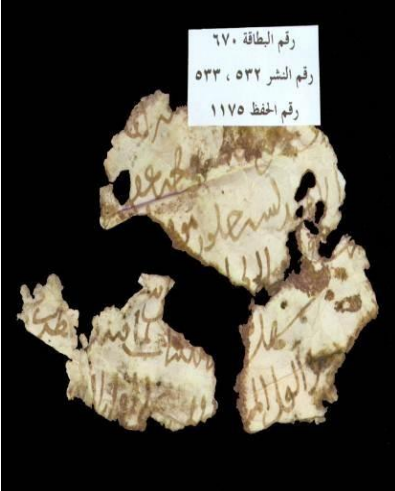
5- Laboratory of manuscripts restoration in Central Institute for the Study of Book Diseases in Rome, Italy.



### [Samples isolation](#)

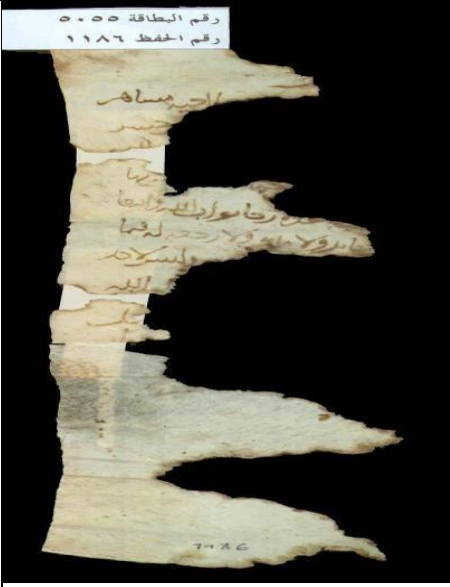

Forty historical parchments documents were analysed and studied but only twelve parchments are selected in this study based

on the macroscopic observation like color change, water spots and parchment degradation (table 1) (morphological characteristics). Six out of 12 dated back from 2 to 4 Hijri, while three dated back to 697 to 760 Hijri and three were unknown date. A new parchment was found infected due to bad conservations condition; therefore it was added to the historical parchmentsspecimen. The samples collection was done using sterile probact transport swabs (Technical service consultant Ltd), swabs collected across spots showing visible color change such as dark purple stains on several areas of the document and then used to inoculate Petri plates containing Sabouraud dextrose agar (Actidione®) to obtaincultures suitable for fungal identification. Then, the petri-dish incubated at 25 °C for 7 days, after that each petri-dish were purified on sabouraud agar tube (percentage of contamination was decreased on decreasing the surface of contact) to conserve all these specimen for others studies. The identification method was based on the morphological observation of the colony on the agar media and microscopic observation.

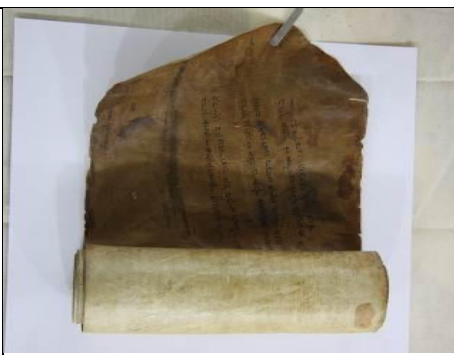
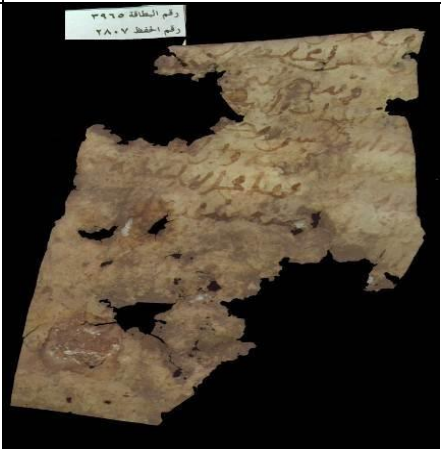
Table1: table showed the manuscripts included in this study and their description.

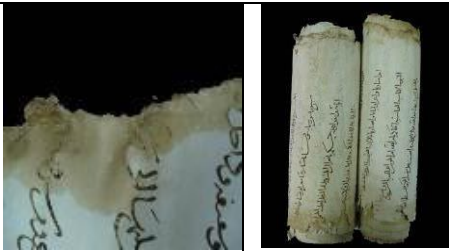

Number of restoration	Manuscripts	Manuscripts information	Description
668		<p>Marriage contract dating back to the 4th Hijri century and was found in the city of Ashmounin.</p>	<ul style="list-style-type: none"> <li>▪ Calcification dirty</li> <li>▪ Water stains</li> <li>▪ Dust on the surface</li> <li>▪ Adhesive Scotch</li> </ul>
670		<p>A marriage contract between a couple dating back to the 4th Hijri century found in the city of Fayoum.</p>	<ul style="list-style-type: none"> <li>▪ Corrosion stains caused by the active iron ink</li> <li>▪ Dehydration.</li> </ul>

<p>5052</p>		<p>Proofs of the purchase of a house dating from the 2<sup>nd</sup> Hijri century</p> <p>an unknown where it was found.</p>	<ul style="list-style-type: none"> <li>▪ Purple stains maybe due to biological activity.</li> </ul>
<p>5053</p>		<p>Marriage contract dating back to 2-3 Hijri century and from unknown resource.</p>	<ul style="list-style-type: none"> <li>▪ Water stains</li> <li>▪ Deformation on the edges of the manuscript.</li> </ul>

<p>5055</p>		<p>Sale contra ctdating back to 2- 3 Hijri century and from unknown resource.</p>	<ul style="list-style-type: none"> <li>▪ Adhesive in the back of the manuscript</li> <li>▪ Deformation in the edges cause a whitecolor.</li> </ul>
<p>32131/ن</p>		<p>NA</p>	<ul style="list-style-type: none"> <li>▪ Dirty and dehydration in the edges of the roll.</li> </ul>



<p>32136/ن</p>		<p>NA</p>	<ul style="list-style-type: none"> <li>▪ Water stains</li> <li>▪ Soil dusty.</li> </ul>
<p>3965</p>		<p>Unknown the resources of this manuscript, and dating back to 2-3 Hijri century.</p>	<ul style="list-style-type: none"> <li>▪ Mud dirty</li> <li>▪ Birds residues</li> <li>▪ Water stains</li> <li>▪ Paper support in the back of the parchment.</li> </ul>

4740	NA	NA	NA
20	 <div data-bbox="618 1203 883 1314" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p>بكوند 0000-000000 محنةظة رقم 00</p> </div>	Sultan Hossam Al Dine Abo Al Fatah argument's dating back to 697 Hijri.	<ul style="list-style-type: none"> <li>▪ Water spots</li> <li>▪ Degradation and deformation of the edges.</li> </ul>
42	 <div data-bbox="630 1707 824 1757" style="border: 1px solid black; padding: 5px; margin: 10px auto; width: fit-content;"> <p>محنةظة رقم 42</p> </div>	Sultan Abi Al Mahassan Hassan Bin Mohamad Bin Kalawoon argument's dating back to 759 Hijri.	<ul style="list-style-type: none"> <li>▪ Deformation of the edges</li> <li>▪ Color change in some area of the manuscript.</li> </ul>

45		Masrour Bin Abdalla Al Shabbily argument's dating back to 760 Hijri.	<ul style="list-style-type: none"> <li>▪ Color change maybe due to biological activity</li> <li>▪ Dehydration.</li> </ul>
New parchment (non-historical)		A new parchment found infected else that due to bad conservations condition.	<ul style="list-style-type: none"> <li>▪ Color change.</li> </ul>

NA: not available

### Results and discussion

Based on macroscopic (table 2) and microscopic observation (figure1), 4 genus of fungus are detected on parchments specimens, *Aspergillus*, *Penicillium*, *Trichoderma* and *Phycomycetes*. The first genus included 2 species of *Aspergillus*: *niger* and *flavus*, the others each genus included only one species *Penicillium funiculosum*, *Trichoderma viride*, and *Phycomycetes*. Eight of the twelve historical parchments have at least one active fungal infection.

Furthmore the new parchment infected else by 3 type. The nine (with the new one) parchments are showed in the table 2 with

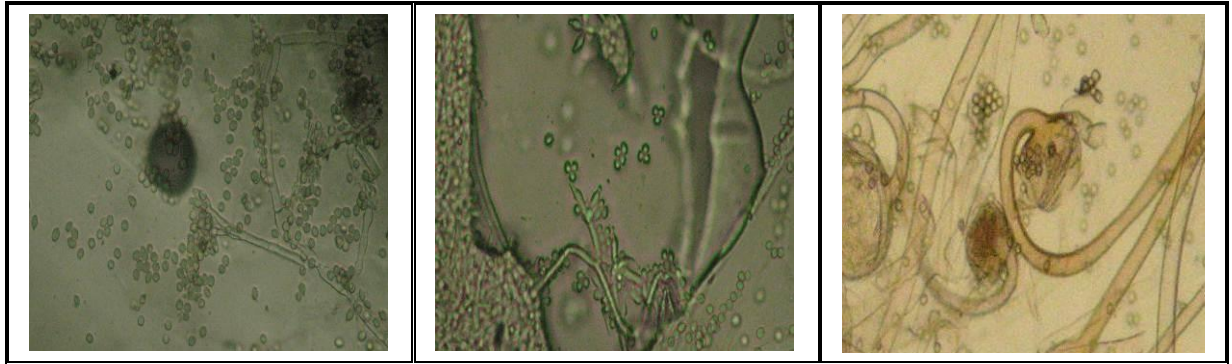
the identification of the fungus species. The most common species of fungus that were identified in our manuscripts are presented in figure 2. Overall, 16 isolates were identified in these manuscripts, which *Aspergillus niger* (6 isolates, 37.5%) was the dominant species, followed by *Aspergillus flavus* (5 isolates, 31.25%), *Phycomycetes* (3 isolates, 18.75%), *Trichoderma viride* (1 isolates, 6.25%), and *Penicillium funiculosum* (1 isolates, 6.25%). These results are congruent with previous studies such as the study conducted by Megan Hempel et al(7) and PG Kalaskar et al(8), which both shown that the most common species identified in infected manuscripts were *Aspergillus* and *Penicillium*. In general, many studies showed that these two previous species were also more common in different manuscripts type like papers (8) and textiles (10).



Penicillium funiculosum

Aspergillus flavus

Aspergillus niger



*Penicillium funiculosum*

*Trichoderma viride*

*Phycomycetes*

Figure1: figure showed the microscopic observation of each species detected in the infected historical parchments.

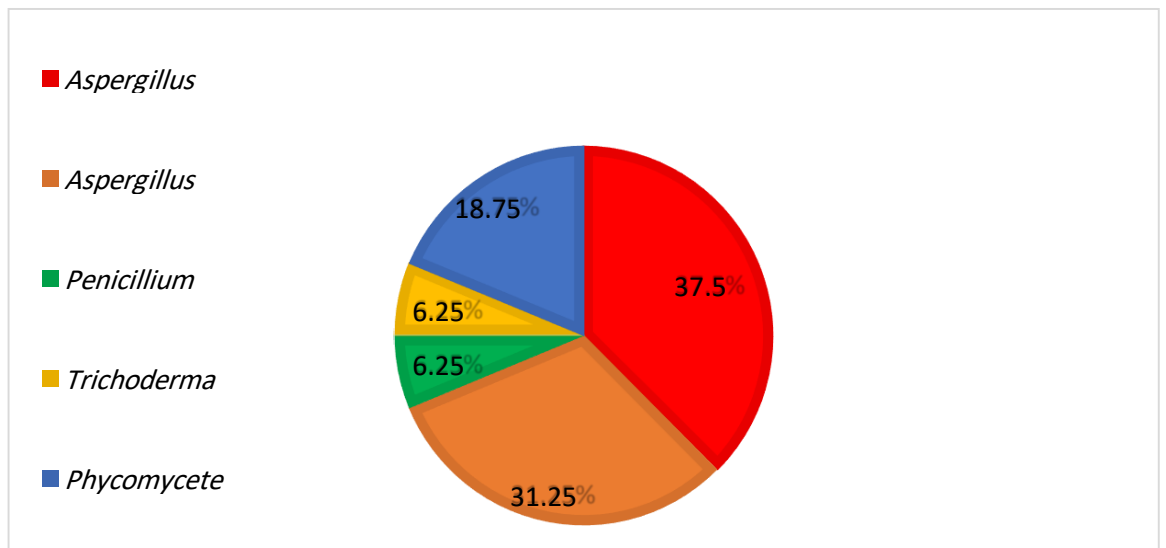


Figure 2: Percentage of identified species detected in the infected

manuscripts. Table 2: the table showed the results of

parchments cultures.

Number of restoration	Presence/absence of fungal infections	Identification of fungus
668	+	<i>Aspergillus niger</i> <i>Aspergillus flavus</i>
670	-	
5052	-	
5053	-	
5055	+	<i>Aspergillus niger</i> <i>Aspergillus flavus</i>
/٥32131	-	
/٥32136	+	<i>Penicillium funiculosum</i>
3965	+	<i>Trichoderma viride</i>
4740	+	<i>Aspergillus niger</i> <i>Aspergillus flavus</i> <i>Phycomycetes</i>

20	+	<i>Aspergillus niger</i> <i>Aspergillus flavus</i>
42	+	<i>Aspergillus niger</i>
45	+	<i>Phycomycetes</i>
The ne wparchment	+	<i>Aspergillus niger</i> <i>Phycomycetes</i> <i>Aspergillus flavus</i>

Presence: +, Absence: -

### Conclusion:

In these days, there are many unique and valuable manuscripts that are exposed to a high risk of damage because of the inappropriate storage, inadequate climate conditions, and improper handling. All these previous conditions could be an essential cause for creation a good media for microorganisms' developments, therefore preventive action should be taken to protect this heritage for the next generations. This study identified the type of fungus that caused infection and damage for eight historical parchments in different institution that contains rare and historical manuscripts, which *Aspergillus niger* was the dominant species, followed by *Aspergillus flavus*, *Phycomycetes*, *Trichoderma viride*, and *Penicillium funiculosum*.

New perspectives will be addressed in the future:

- The use of a molecular identification method for these fungi such as PCR and sequencing.
- Studying the mechanical characteristic of these fungal infections on the components of the parchment and their influence on its elasticity.
- The use of different cleaning method to eliminate the effect of fungus on parchment manuscripts.

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