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Fungal Contaminations in Historical Manuscripts at *Astan Quds* Museum Library, Mashhad, Iran

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ABSTRACT

Bio-deterioration of library materials is a worldwide problem, which is the great damage to unique manuscripts and books. This paper presents the state of fungal contamination in *Astan Quds* museum library. *Astan Quds* library is a major cultural collection, which contains many historical manuscripts that are centuries old. In this investigation 495 randomly selected manuscripts were examined. Books were visually inspected for fungal growth or damage. The pages were scraped and examined microscopically and cultured. Seventy-nine manuscripts were invaded and damaged by molds and four books by yeasts. The most common isolated fungi were: *Aspergillus spp.* (41%) and *Penicillium* (22.9%). Fungal contaminations were observed in 50 books; while direct microscopic examination and culture showed 79 contaminated manuscripts. Considering heavy fungal contamination of invaluable hand-written books in this library, environmental condition should be improved in a way that fungal growth reaches to minimum. Potential sources of fungal contamination should be eliminated wherever possible.

Key Words: Fungal contamination; Library; Books; *Aspergillus; Penicillium*

INTRODUCTION

The activity of different environmental factors may cause some changes in physical and chemical properties of library collections. In addition to internal causes of the deterioration of paper in books, due to its acidity, external agents are a major threat to manuscripts (Wessel, 1970; Zyska, 1993). Bio-deterioration of library materials is a worldwide problem and it is a great damage especially to unique manuscripts and books stored in the libraries (Zyska, 1993). In this study we intend to discuss one of the biological factors as a main external group of factors that influence library materials. Of interest here is the biological deterioration of library materials due to the activity of fungi and their control, which is part of the art of being able to preserve library collections (Strzelczyk & Leznicka, 1981; Zyska, 1994).

Astan Quds Archives, which contains many historical books that are centuries old, is a major cultural collection. This library is one of the largest repositories, and also is the main research source for historians, writers and students. *Astan Quds* Library documents the history of culture and presents many religious, political and social events in Iran, from the time of the prophet to the present day.

This paper presents the status of fungal colonization of *Astan Quds* library materials and describes fungi that have been isolated from *Astan Quds* library materials, which help their control for the preservation of library collections.

MATERIALS AND METHODS

This descriptive, cross – sectional, prospective study was performed in the Department of Mycology, Emam Reza Medical School, Mashhad. In this study, 495 randomly selected manuscripts including un-identified books, consolidated books, papers and papyrus, were collected from different parts of the library. Some of the selected manuscripts were more than 1000 years old. At first, books were visually inspected for mould growth or any damage. The pages were scraped by sterile scalpels or swabs and wet mount prepared by 10% potassium hydroxide and directly examined by low power, for detection of hyphae or conidia. Culture of swabs or scrapings was performed on Sabourod Dextrose Agar containing Chloramphenicole media in order to isolate fungal contaminants. Complementary tests (slide culture, etc.) were performed for distinguishing the genera of the fungi (Tilak & Pillai, 1988; Gupta *et al*., 1993).

RESULTS

Among 495 selected documents, 113 manuscripts (22.8%) macroscopically showed fungal growth or damage. By direct microscopic examination among all of the 495 manuscripts, 50 manuscripts (10.1%) were positive for presence of fungi but by culture, fungal contaminations were revealed in 79 manuscripts (15.7%). Most books were infected with one kind of fungi and only four manuscripts were contaminated by 2 fungi simultaneously. Manuscripts, which were detected as contaminated by culture, were reexamined for macroscopic signs of fungal growth. Among these books, 56 documents (70.8%) had visible signs of fungal growth and in 23 of them, (29.2%); no visible damage or contamination was observed. According to these

findings, sensivity and specificity of macroscopic inspection for detection of contamination were 70.1% and 86.3%, respectively and sensivity and specificity of direct microscopic examination in comparison to culture were 63.3% and 100%. Table I shows frequency and percentages of manuscripts revealed fungal contamination by macroscopic, microscopic examination and culture in *Astan Quds* library during this study.

Among contaminated books, seventy-nine manuscripts (95.2%) were contaminated by Filamentous fungi, and yeast fungi were detected on four cases (4.8%). Table II is a listing of fungi isolated from library materials during this study.

The results in Table I indicated that *Aspergillus spp.* (41%) and *Penicillium spp.* (22.9%) were the main contaminating molds of all tested manuscripts and account for two third of contaminations.

DISCUSSION

Astan Quds Library is a treasure house of reference materials especially on Islam in Iran. More than 100,000 books, manuscripts, documents and letters about the people and events that have shaped our Islamic and Iranian heritage have been collected in this library. *Astan Quds* museum library contains archives, which range in date from before Islam until today. This archive documents the social, religious and even political history of Iran, with an emphasis on Islamic aspects. This library museum also contains more than 26400 unique historic manuscripts.

The awareness of microbial deterioration of library materials came only after nineteen century (Orlita, 1977; Gallo, 1993). The first scientific study, which discusses microbial deterioration of papers, comes from France, 1917 (See, 1919). The history of insect-cause deterioration of library materials exceeds 1000 years, while knowledge of microbial deterioration of library materials is only about 90 years old (Zyska, 1993). In this study we intended to survey the extent of fungal contamination of library materials as one of the main external factors that influences library materials.

Among three methods used for fungal isolation, culture was more sensitive than direct microscopic examination and also was more reliable than macroscopic inspection. So it could be recommended that culture should be used for routine inspections especially in libraries containing old and valuable archival materials. *Aspergillus* and *Penicillium* are the most frequently isolated fungi (Singh *et al*., 1990; Singh *et al*., 1995). These genera can cause the decay of stored products in many fields therefore, they are economically and ecologically important. They also are important in view of health hazards (Singh *et al*., 1990; Singh *et al*., 1995). Since *Aspergillus* and *Penicillium* are found every-where, their presence as contamination agents on studied manuscripts, are not un-expected (Singh *et al*., 1990; Singh *et al*., 1995).

Table I. Frequency and percentages of manuscripts revealed fungal contamination by macroscopic, microscopic examination and culture in *Astan Quds* library

Total Number of Manuscripts	Fungal Contamination detected in manuscripts by Macroscopic Examination	Direct Microscopic Examination	Culture
495	113 (22.8%)	50 (10.1%)	79 (15.7%).

Table II. Frequency and percentages of different fungi isolated from documents of *Astan Quds* Library

Fungal Genus	Frequency	Percent
Aspergilus	34	41%
Penicillium	19	22.9%
Mucor	8	9.7%
Cladosporium	6	7.2%
Trichoderma	4	4.8%
Rhizopus	3	3.6%
Alternaria	2	2.4%
Helmentosporium	2	2.4%
Cephalosporium	1	1.2%
Cryptococcus	2	2.4%
Other yeast	2	2.4%
Total	83	100%

Bearing in mind that fungi have isolated from a great number of books, activity of fungi and deterioration of manuscripts are a real hazard to library materials. For prevention of damage and preserving library collections, environmental conditions should be adjusted in a way that fungi growth diminishes (Florian, 1994). The optimum temperature for this purpose should be between 18 to 22ºC and humidity should be adjusted below 55% (Florian, 1994). Therefore, sanitary measures should be considered during the construction of library buildings in order to prevent exposure to fungi and to minimize fungal growth (Florian, 1994). Along with these activities, various methods of disinfection such as chemical methods and radiation should be considered for elimination of contaminating fungi (Ballard & Baer, 1986; Haines & Kohler, 1986; Adamo *et al*., 2001).

One of the main objects of this study was to identify possible sources and routes of contamination and so guidelines could be suggested for controlling fungal contaminations. In *Astan Quds* library the most suspected items are those, which are used for, repairing books like animal and vegetable glues, inks and wax seals. Such items used for repairing old books are often natural and complex objects. They are usually constructed from a combination of different materials, each of which could be a source of fungal contamination (Florian, 1994). Further investigation should be performed on repairing items and suitable methods for disinfection or substitution of them should be considered. Recognition and management of other routes of contamination like people, infected books recently added to the collection and other potential sources of contamination should not be forgotten. Potential sources of fungal

contamination should be eliminated wherever possible with focus on molds fungi as *Aspergillus* and *Penicillium.*

Among the isolated fungi, colonies of *Cryptococcus neoformans* had contaminated 2 books. This finding indicates the role of pigeons as a source of contamination. Many pigeons are living in the holy shrine and especially around the library building.

In conclusion, molds, especially *Aspergillus* and *Penicillium* are the most common fungi, which destroy the books if they are kept in bad conditions. Culture is a reliable method for detecting the opportunistic fungus.

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