DETERMINATION OF MICROBIAL CONTAMINATION AND BIODETERIORATION OF ARCHIVAL DOCUMENTS

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Small Grant co-funded by the International Visegrad Fund
MODERN APPROACH FOR BIODETERIORATION ASSESSMENT AND DISINFECTION OF HISTORICAL BOOK COLLECTIONS

Book collections

- Jozef Pilsudski Regional and Municipal Public Library in Lodz (Poland)
- Archdiocese Archives in Lodz (Poland)
- National Archive in Prague (Czech Republic)

11 books, 2 documents and one journal

Characterization of archival objects

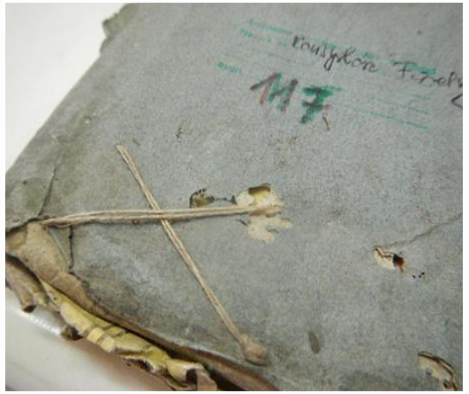
Category	Title	Year	Type of cover material
Book	Meyers Konversations Lexicon	N.A.	Cardboard and paper
	Konsuelo	1865	
	Abwasserreinigungsanlagen: ihre Leistungen und ihre Kontrolle vom chemisch-praktischen Standpunkt	1914	
	Do čtyř artikulů	1915	
	Handbuch der Kohlenwirtschaft	1926	
	Schmelzen des Glases	1928	
	Geschäftskunde für der Baugewerbe	N.A.	
	Die Heilige Schrift	N.A.	
	Dziennik Ustaw	1924	Cardboard and fabric
	Statisztikai és Közigazgatasi Évkonyve	1935	
	Dziennik Ustaw	1933	Cardboard, paper and fabric
Journal	Przekrój	1988	Paper
Document	Acta Casus, Konsystorz Foralny Piotrkowski	1822	
	Akta Kościoła Parafialnego w Moszczenicy Dekanatu Piotrkowskiego	1822	

N.A. – not available

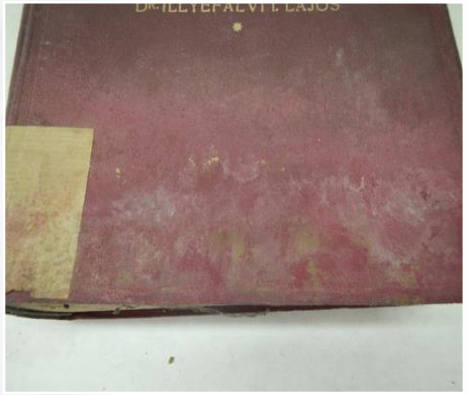
Visible signs of biodeterioration

Microbial growth

Foxing



Defects



Damp patches

Discoloration

Loss of structure

Methods

Sample collection

Microbial contamination

Bacteria total count

TSA + nystatin

(2 days, 28±2°C)

Fungi total count

MEA + chloramphenicol

(7 days, 28±2°C)

Strains identification

Bacterial strains

16S rRNA sequencing

Fungal strains

ITS region sequencing

Cellulolytic activity

R2A agar + 0.2% hydroxyethylcellulose and 13.5% Kongo Red

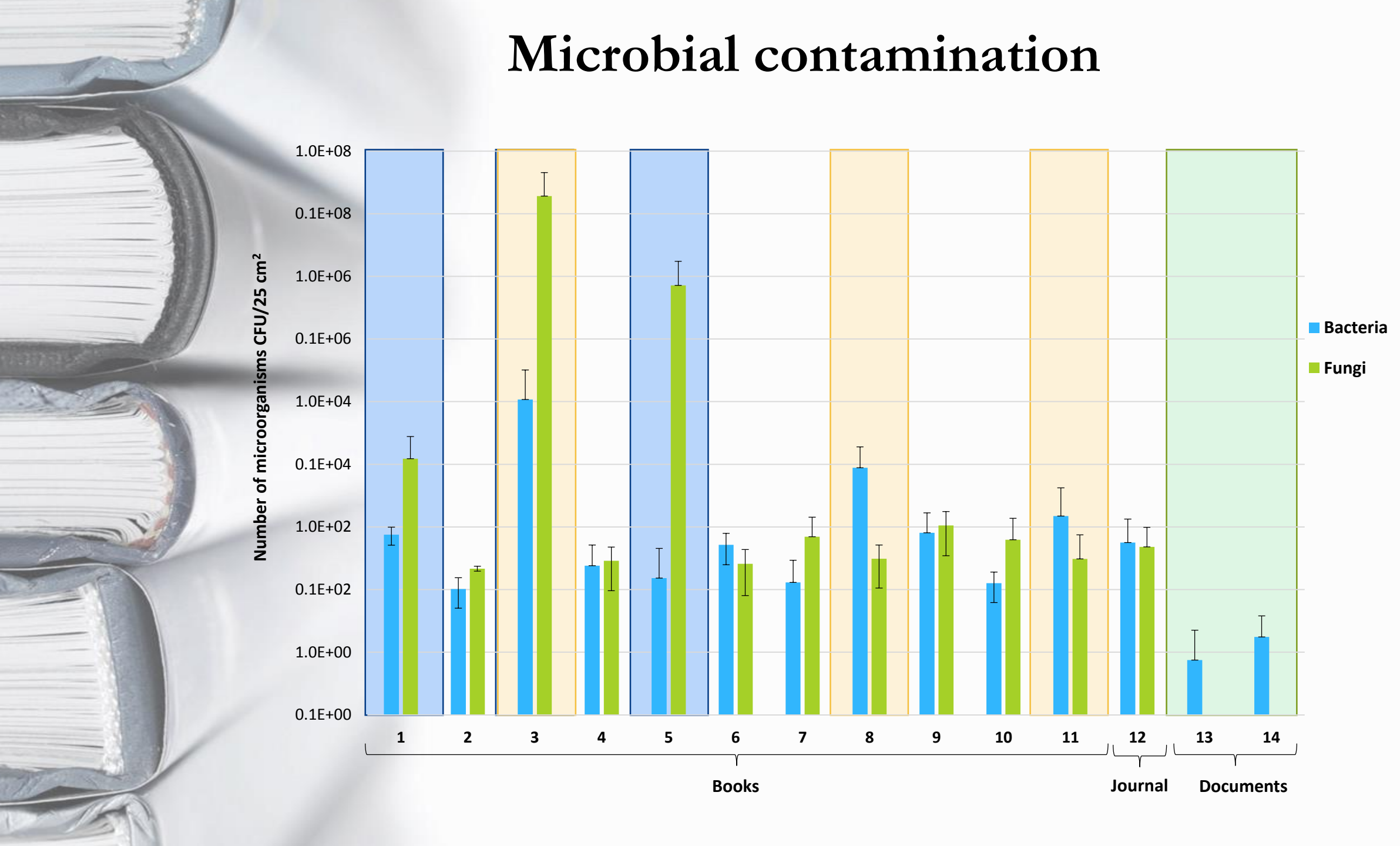
(7 days, 28±2°C)

Positive results

clear zone around the colonies

MEA – Malt Extract Agar; TSA – Tryptic Soy Agar

Microbial contamination

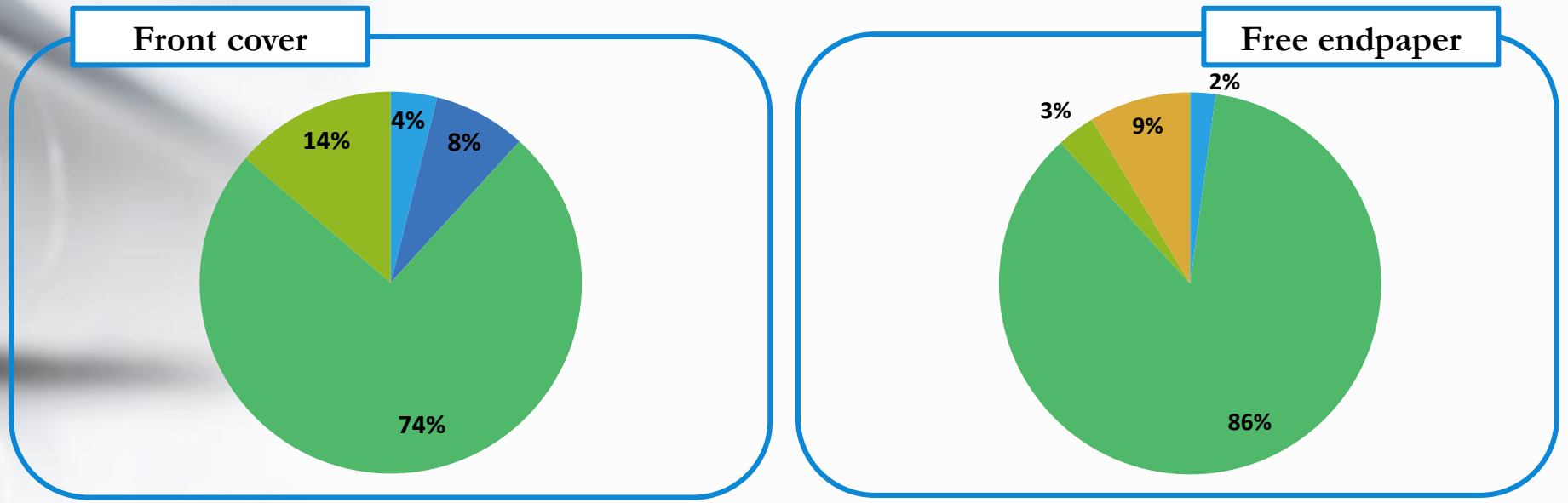


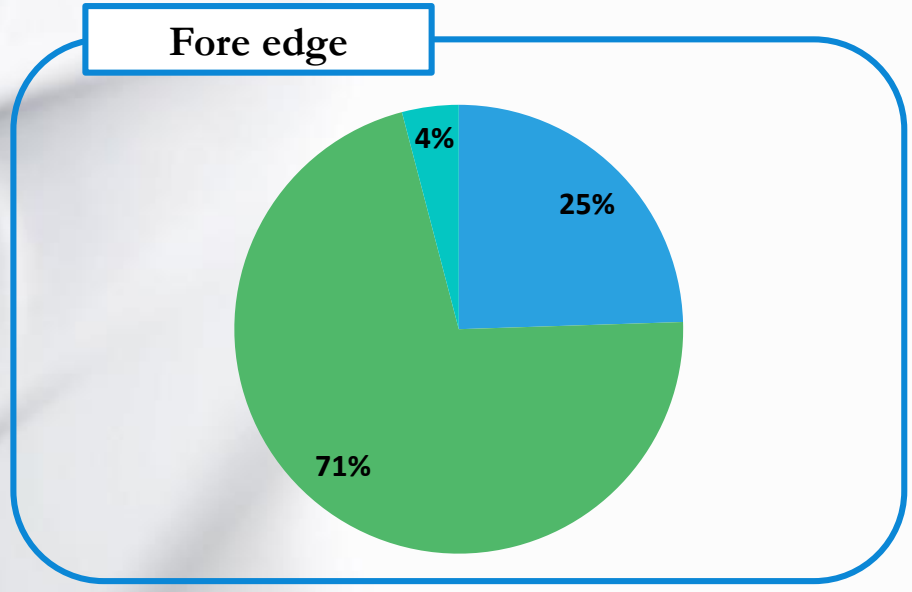
Identification of bacterial and fungal strains

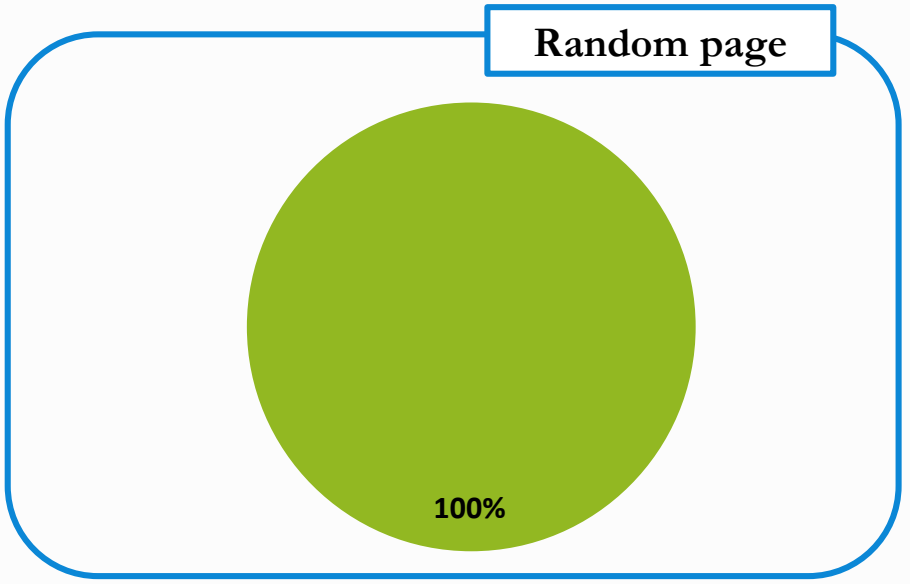
Bacterial strains
• *Bacillus atrophaeus*
• *Bacillus cereus*
• *Bacillus licheniformis*
• *Bacillus subtilis*
• *Lysinibacillus fusiformis*
• *Microbacterium aerolatum*
• *Psychrobacillus psychrodurans*
• *Staphylococcus epidermidis*
• *Staphylococcus pasteuri*
• *Staphylococcus saprophyticus*
• *Staphylococcus succinus*
• *Streptomyces ambofaciens*

Fungal strains
• *Aspergillus creber*
• *Aspergillus niger*
• *Aspergillus ochraceus*
• *Aspergillus versicolor*
• *Chaetomium elatum*
• *Chaetomium globosum*
• *Chaetomium murorum*
• *Cladosporium globisporum*
• *Myxotrichum deflexum*
• *Oidiodendron cerealis*
• *Penicillium chrysogenum*
• *Penicillium spinulosum*
• *Rhodotorula mucilaginosa*

Frequency of bacteria occurrance on the book no. 1

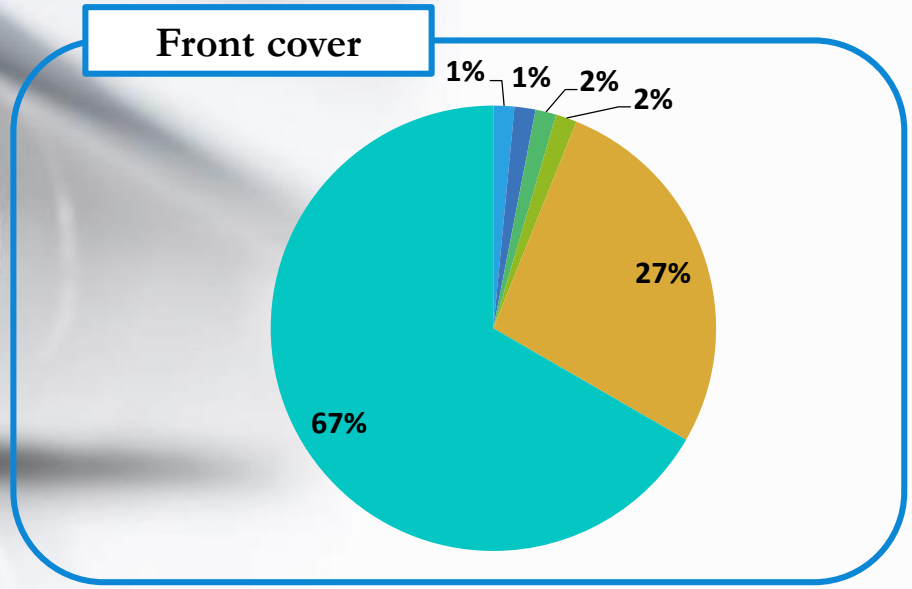


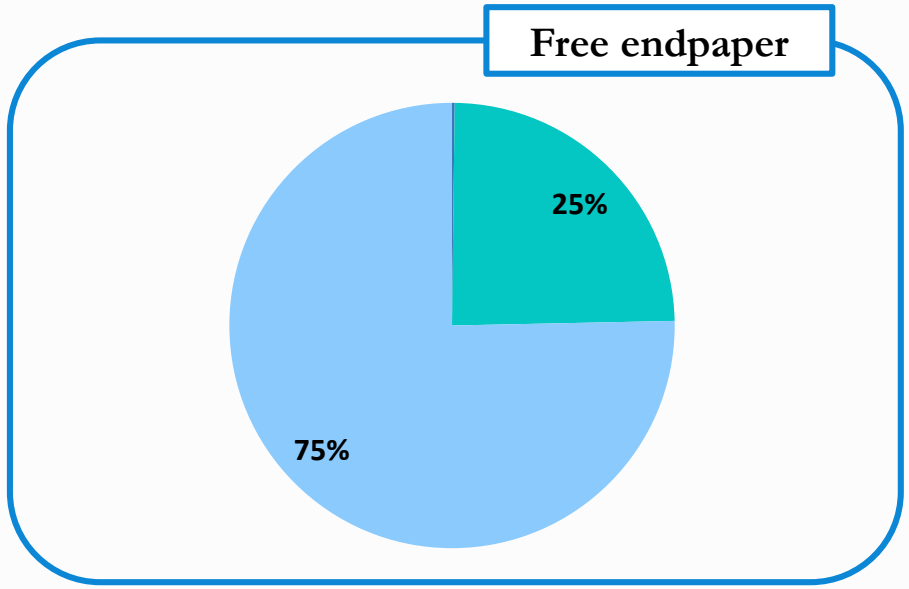


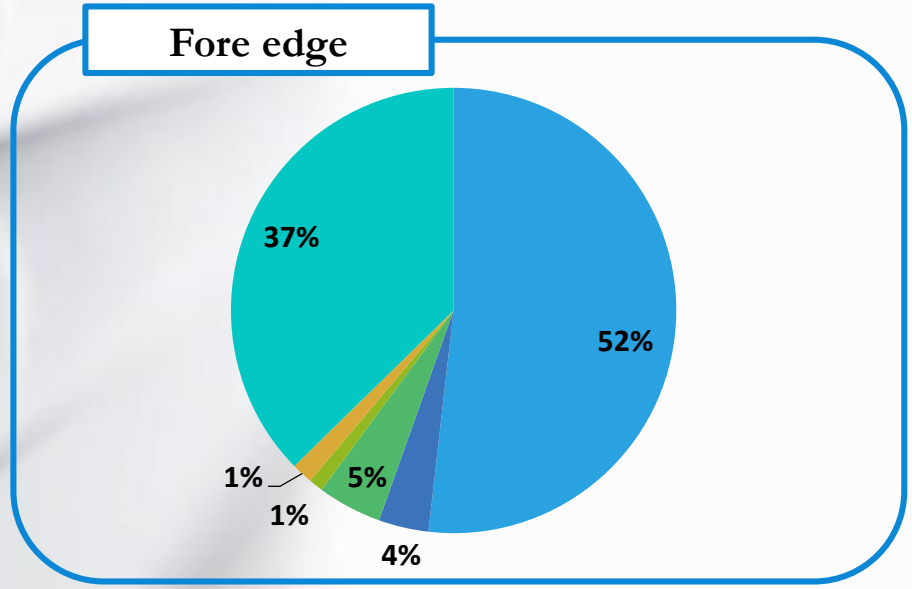


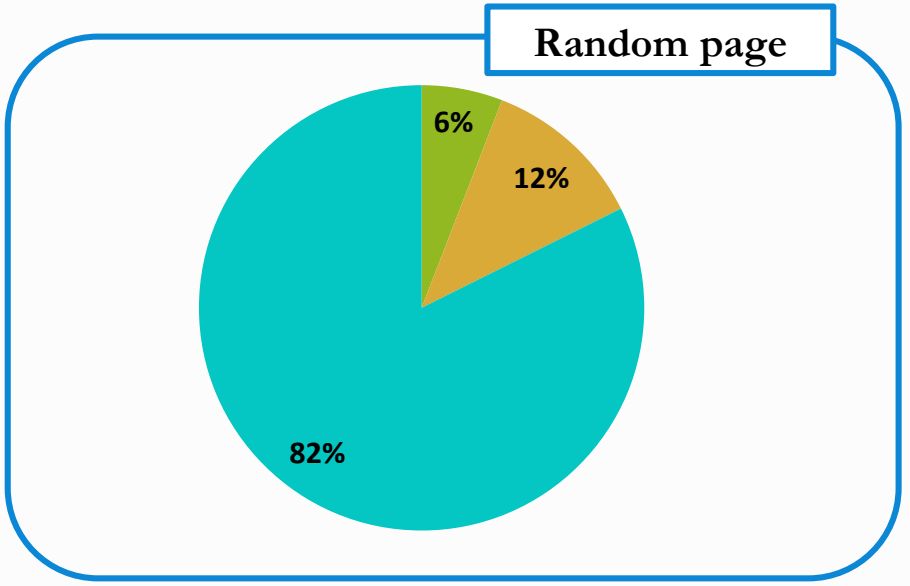
- *Bacillus cereus*
- *Bacillus licheniformis*
- *Microbacterium aerolatum*
- *Psychrobacillus psychrodurans*
- *Staphylococcus succinus*
- *Streptomyces ambofaciens*

Frequency of fungi occurrance on the book no. 1









Chaetomium elatum

Chaetomium globosum

Chaetomium murorum

Myxotrichum deflexum

Penicillium chrysogenum

Penicillium spinulosum

Cellulolytic activity of the isolated strains

	Isolated strain	Cellulolytic activity
Fungi	*Aspergillus creber*	-
	Aspergillus niger	-
	Aspergillus ochraceus	+
	Aspergillus versicolor	+
	Chaetomium elatum	-
	Chaetomium globosum	+
	Chaetomium murorum	-
	Cladosporium globisporum	+
	Myxotrichum deflexum	++
	Oidiodendron cerealis	-
	Penicillium spinulosum	-
	Penicillium chrysogenum	-
	Rhodotorula mucilaginosa	-
Bacteria	*Bacillus atrophaeus*	++
	Bacillus cereus	+++
	Bacillus licheniformis	++
	Bacillus subtilis	+++
	Lysinibacillus fusiformis	-
	Microbacterium aerolatum	-
	Psychrobacillus psychrodurans	-
	Staphylococcus pasteuri	-
	Staphylococcus saprophyticus	-
	Staphylococcus epidermidis	-
	Staphylococcus succinus	-
	Streptomyces ambofaciens	++

- no cellulolytic activity

+ low cellulolytic activity (zone around colony 1 – 3 mm)

++ medium cellulolytic activity (zone around colony 4 – 6 mm)

+++ high cellulolytic activity (zone around colony 7 – 10 mm)

Conclusions

- The visual evaluation of archival objects revealed fungal growth, discoloration, permanent staining, foxing, loss of structure, damp patches and paper defects.
- The bacterial contamination of archivals was in the range of 8 - 1×10^5 CFU/25cm^2 and fungal in the range of 2×10^2 - 2×10^8 CFU/25cm^2.
- The most contaminated part of books was the cover and the first free endpaper.
- The culture-dependent identification of microorganisms showed that 12 bacterial and 13 fungal species inhabited the analysed archival objects.
- *Bacillus* sp. and *Staphylococcus* sp. were the most often isolated bacterial strains, while the most dominant fungi belonging to *Aspergillus, Chaetomium*, and *Penicillium* species.

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