THE IDENTIFICATION OF MICROBIOTA WITH DETERIORATIVE ACTION ON SOME HISTORICAL SILK MATERIALS

SIMONA DUNCA[1*], MARIUS ŞTEFAN[1], CĂTĂLIN TĂNASE[1], ANA COJOCARIU[1], GHIOCEL IOANID[2], DORINA RUSU[3]

Keywords: microbiota, biodeterioration, bacteria, silk
Abstract: The aim of this study was to provide information on the degradation process induced by microorganisms' action on some historical silk materials. It was analyzed historical silk samples and was isolated in pure culture 10 strains of microorganisms, belonging to bacteria and actinomycetes (*Bacillus*, *Clostridium*, *Sarcina* and *Streptomyces* genera).

INTRODUCTION

The cultural patrimony objects have in their composition organic and inorganic materials that become food resource for microorganism development in/on the surface of objects placed into inadequate conditions of environment or microclimate (Cappitelli F., 2006). Alterations and degradations of art objects are characteristic to the material, and are influenced by the external degradation agents. All these agents determine degradation that depend by nature, intensity and duration of action, but also by the type of their interaction and superposition (Cappitelli F., 2005). The biodegradation of materials involve different mechanisms: some processes have physico-mechanical nature (disintegrations), and others have chemical nature (decompositions). Generally, these types of processes are simultaneous and depend on biodegradation agent, substrate type and environmental conditions. Microorganisms' development creates new conditions for other species development and results an ecological succession (Ailiesei Octăvia *et all.,* 2001). When biodegradation is complete, the elements from original macromolecule are transferred into an inorganic form (Madigan M. *et all.,* 2000).

The aim of this study was to identify the microbiota with deteriorative action on some historical silk samples (XVI-XX century).

MATERIALS AND METHODS

In order to identify the deteriorative microbiota of the *collection of historical materials without patrimonial value*, it was taking into consideration very little samples from museum objects or archaeological material, respecting the limits of conservation standards. For the microbiological examination of the studied organic materials we have used a simple culture medium – **gelose**. After the repartition of the medium into the Petri plates and solidification, we have made the insemination by applying the sample of material on the center of medium surface. After 48 hours of incubation at 37ºC, we have studied the microbial development from the samples surrounding on the medium surface (Dunca Simona *et all.*, 2004).

The macro-morphological description consisted of microorganisms' colonies characterization, using he next criteria: colony type, sizes, form, edges aspect, colony profile, consistence, transparency/opacity and color (Wistreich, G. A., 1997).

For ***the micro-morphological characteristics*** of the isolated bacteria from historical materials, we have made smears from pure cultures, which were colored by the Gram method. The smears have been examined at microscope with immersion objective, observing the microscopic particularities of the microorganisms (Madigan M. *et all.*, 2000).

RESULTS AND DISCUSSIONS

The test samples were represented by 9 samples of historical silk, conventional noting MI (Table 1).

Table 1. Collection of the studied historical materials

Samples name	Sample indicative	DESCRIPTION. SOURCE. DATE
Silk (MI)	**MI 1**	- Cream-colored fabric. - From a pillow cover, collection of the Historical Museum of

Samples name	Sample indicative	DESCRIPTION. SOURCE. DATE
		Moldavia, Iasi. - XIXth Century.
	MI 3	- Cream-colored fabric. - From the umbrella lining, collection of the Historical Museum of Moldavia, Iasi. - XIXth Century.
	MI 4	- White-colored fabric. - From the umbrella lining, collection of the Historical Museum of Moldavia, Iasi. - XIXth Century.
	MI 5	- Silk fabric. - Discovered during archaeological researches, Capriana Monastery – Modavia Republic. - XVIth-XVIIth Century.
	MI 6a	- Silk fabric – canvas. - Discovered during archaeological researches, Capriana Monastery – Modavia Republic. - XVIth-XVIIth Century.
	MI 6b	- Silk fabric. - Discovered during archaeological researches, Capriana Monastery – Modavia Republic. - XVIth-XVIIth Century.
	MI 7a	- Red-colored silk fabric. - From the flag replica, collection of the Historical Museum of Moldavia, Iasi. - XVth Century.
	MI 7b	- Yellow-colored silk fabric. - From the flag replica, collection of the Historical Museum of Moldavia, Iasi. - XXth Century.
	MI 8	- Silk fabric – velvet. - Discovered during archaeological researches, Capriana Monastery – Modavia Republic. - XVIth-XVIIth Century.

Macro-morphological characteristics study

After the macro-morphological characteristics examination of the *isolated microorganisms from historical silk collection*, we have determined the presence of the both

rough colonies (R type), white and grey-colored, with irregular edges, flat profile, dry or mucilaginous consistence, mostly opaque, and smooth colonies (S type), yellow or white colored, smooth edge, hemispheric and umbonated profile, cartilaginous or mucilaginous consistence, opaque (Table 2).

Micro-morphological characteristics study

The results of micro-morphological analyses to the bacterial strains isolated from historical silk samples (Table 3) show the presence both coccoide morphological type, Gram positive, grouped in shape of cubical pack (sarcina) – Figure 1 f – or diplo – Figure 1 a - , and also bacillary morphological type, Gram positive, different in grouping and spores types (Figures 1b, 1c and 1e). We have also isolated the actinomycetes, determining the micelial hyphae Gram positive in the MI3 and MI6a2 samples (Figure 1 d).

Identification of the main bacteria types

As a result of the macro- and micro-morphological studies, the isolated strains from the collection of historical silk were systematized by kingdom, division, section, family and genera, using *Bergey's Manual of Systematic Bacteriology*, IXth Edition – 1984, 1984, 1989 (Krieg, N.R., Holt, J.G., 1984; Sneath, P.H.A., Holt, J.G., 1986; Williams, S.T., Holt, J.G., 1989).

We have highlighted a great taxonomical diversity of the isolated strains. The most representative genera and frequent found on the studied materials are *Bacillus* and *Clostridium*. Our results confirm the data from specialty literature regarding the presence of these bacteria on the organic materials (Allsop *et all.*, 2004). A low percentage was determined for the *Streptomyces* genus (MI3, MI6a2) – Table 4.

CONCLUSIONS

From the analyzed samples of historical silk, 10 strains of microorganisms were isolated in pure cultures belonging to bacteria and actinomycetes.

The study of the macro- and micro-morphological characteristics allowed us to classify the isolated bacterial strains into the following genera: *Bacillus, Clostridium, Sarcina* and *Streptomyces.*

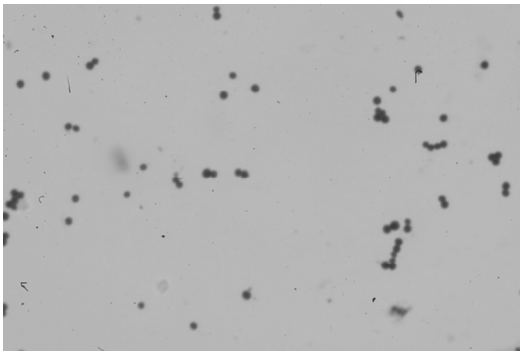
Table 2. Macro-morphological description of the isolated bacterial strains from the historical silk samples (MI)

Sample	Isolated strains	Colony type	Shape	Edges aspect	Colony profile	Consistence	Transparency/ Opacity	Color
MI 1	MI 1	R	irregular	lobate	flat	dry	opaque	white
MI 3	MI 3	S	round	whole	hemispheric	cartilaginous	opaque	white
MI 4	MI 4	S	irregular	whole	umbonated	mucilaginous	opaque	yellow
MI 5	MI 5	R	irregular	serrated	flat	mucilaginous	opaque	white
MI 6	MI 6a1	R	irregular	lobate	flat	mucilaginous	transparent	grey
	MI 6a2	S	round	whole	umbonated	cartilaginous	opaque	white
	MI 6b	R	irregular	irregular	flat	dry	opaque	white-grey
MI 7	MI 7aG	S	round	whole	hemispheric	mucilaginous	opaque	yellow
	MI 7bR	S	round	whole	hemispheric	mucilaginous	opaque	yellow
MI 8	MI 8	R	irregular	irregular	flat	mucilaginous	opaque	grey

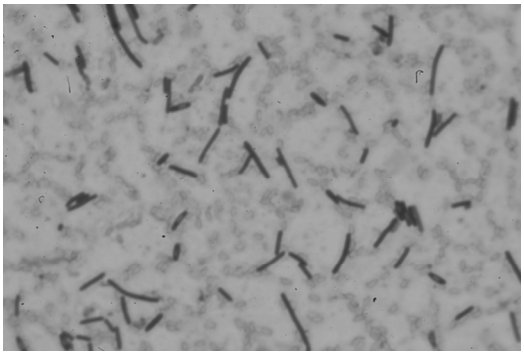
Table 3. Micro-morphological examination of the isolated bacterial strains from the historical silk samples (MI)

Analyzed sample	Isolated strains	Morphological type	Tinctorial affinity	Grouping mode	Sporulation capacity	Taxonomical group characteristics
MI 1	MI 1	bacillus	Gram +	isolated	central spores, undeforming	bacteria
MI 3	MI 3	micelial hyphae	Gram +	-	-	actinomycet
MI 4	MI 4	coccus	Gram +	cubical pack (sarcina)	unsporulated	bacteria
MI 5	MI 5	bacillus	Gram +	letters shape	central and sub-terminal spores, undeforming	bacteria
MI 6	MI 6a1	bacillus	Gram +	isolated and diplo	terminal spores, deforming	bacteria
	MI 6a2	micelial hyphae	Gram +	-	-	actinomycet
	MI 6b	bacillus	Gram +	long chains	unsporulated	bacteria
MI 7	MI 7a	coccus	Gram +	cubical pack (sarcina)	unsporulated	bacteria
	MI 7b	coccus	Gram +	cubical pack (sarcina)	unsporulated	bacteria
MI 8	MI 8	coccus	Gram +	diplo	unsporulated	bacteria

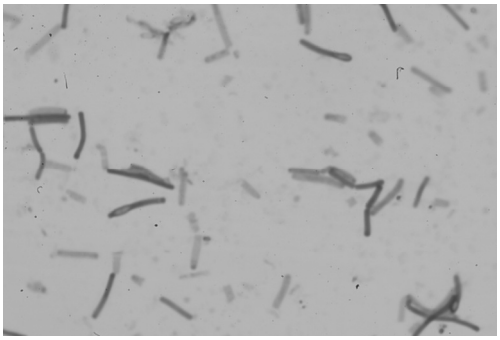
Figure 1. Microscopic view of the isolated strains (x 1000)



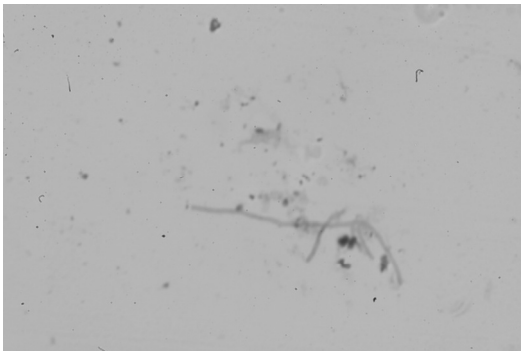
MI 4b Figure 1 a



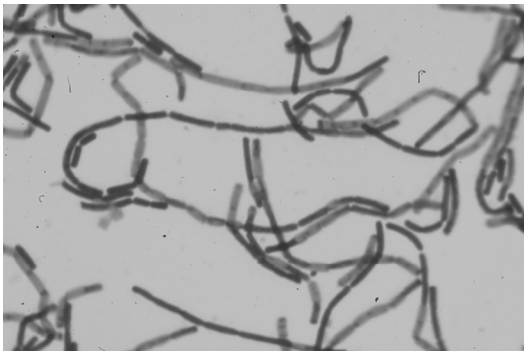
MI 5 Figure 1 b



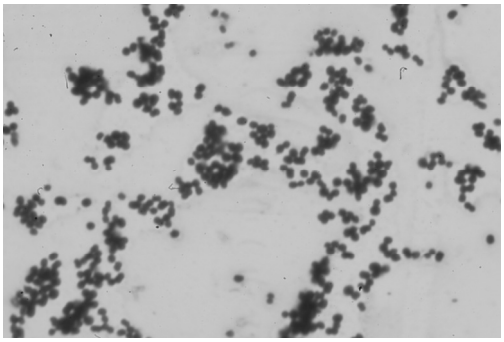
MI 6a1 Figure 1 c



MI 6a2 Figure 1 d



MI 6b Figure 1 e



MI 8 Figure 1 f

Table 4. Systematic affiliation of the isolated bacterial strains from the historical silk samples (MI)

Sample	Strain	Kingdom	Division	Section	Family	Genus
MI1	MI1	Prokaryotae	Firmicutes	13 – Endospore – forming Gram positive rods and cocci	-	*I. Bacillus*
MI5	MI5					
	MI6b					
MI6	MI6a1					*III. Clostridium*
MI4	MI4a			12 – Gram positive cocci	II. Deinococcaceae	*Sarcina*
MI7	MI7a					
	MI7b					
MI8	MI8					
MA	MA					
MI3	MI3			29 – *Streptomyces* and related genera	-	*Streptomyces*
MI6a	MI6a2					

REFERENCES

Ailiesei Octăvița, Nimițan Erica, Dunca Simona, 2001. *Analele Ştiințifice ale Universității "Alexandru Ioan Cuza" Iaşi* (serie nouă), Secțiunea II, a. Genetică şi Biologie Moleculară, ISSN: 1223-6578, Tomul II, 74-80.
Allsop, D., Seal, K.J., Gaylarde, Christine C., 2004. *Introduction to Biodeterioration* (Second Edition), Cambridge University Press, UK, 1-15.
Cappitelli, F., Principi, P., Sorlini, C. 2006. *Trends Biotechnol.,* 24(8), 350-354.
Cappitelli, F., Sorlini, C., 2005. *Crit. Rev. Microbiol*., 31(1), 1-10.
Dunca Simona, Ailiesei Octăvița, Nimițan Erica, Ştefan Marius, 2004. *Microbiologie aplicată* - Ed.Tehnopress, Iaşi.
Krieg, N.R., Holt, J.G., 1984. *Bergey's Manual of Systematic Bacteriology*, vol. 1, Williams & Wilkins Company, Baltimore.
Madigan, M., Martinko, J., Parker, J., 2000. *Brock Biology of microorganisms* - 8th edition, Prentice Hall., Inc.Simon & Schuster, Viacom Company, New Jersey.
Sneath, P.H.A., Holt, J.G., 1986. *Bergey's Manual of Systematic Bacteriology*, vol. 2, Williams & Wilkins Company, Baltimore.
Williams, S.T., Holt, J.G., 1989. *Bergey's Manual of Systematic Bacteriology*, vol. 4, Williams & Wilkins Company, Baltimore.
Wistreich, G. A., 1997. *Microbiology Laboratory* - Prentice Hall, Upper Saddle River, New Jersey

ACKNOWLEDGEMENTS

The research presented in this paper was carried out under Program CEEX -no.54/6948/2006 „*Integrated multifunctional technology for the conservation of the national patrimony*" (MITECH). The authors would like to express their gratitude to MATNANTECH PROGRAME for the financial support and for their valuable contribution to this research.

1) "Alexandru Ioan Cuza" University of Iaşi
2) "Petru Poni" Institute of Macromolecular Chemistry Iaşi
3) "Moldova" Museum Complex of Iaşi
*) sdunca@uaic.ro