# Heritage ethnographic objects – antimicrobial effects of chitosan treatment

DOI: 10.35530/IT.072.03.1812

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**ABSTRACT – REZUMAT**

**Heritage ethnographic objects – antimicrobial effects of chitosan treatment**

*Chitosan is a natural polymer, which presents, according to studies made up to present, low toxicity and good biocompatibility. Recent studies are focused not only on its antimicrobial effects on textiles, because this polysaccharide leads to improvements such as: shrink resistance, dye uptake etc.*
*Two Romanian traditional shirts were non-invasively tested by applying Chitosan and by investigating the SEM images, before and after applying the chitosan. The paper underlines the surface modifications of tested textiles using chitosan. The odd agents on the fibres surfaces were removed and the limitation of the number of microorganisms was observed.*

***Keywords:*** *chitosan, ethnographic textiles, SEM images*

**Obiecte etnografice de patrimoniu – efecte antimicrobiene ale tratamentului cu chitosan**

*Chitosanul este un polimer natural care, conform studiilor realizate până în prezent, prezintă o toxicitate scăzută și o bună biocompatibilitate. Studii recente, care se concentrează nu doar pe efectele sale antimicrobiene asupra materialelor textile, au evidențiat că această polizaharidă conduce la îmbunătățiri din punctul de vedere al rezistenței la contracție, precum rezistența la contracție, absorbția coloranților etc.*
*Două cămăși tradiționale românești (ii) au fost testate neinvaziv prin aplicarea chitosanului și prin investigarea imaginilor SEM, înainte și după tratamentul cu chitosan. Lucrarea evidențiază modificările de pe suprafața țesăturilor testate folosind chitosan. După îndepărtarea agenților de pe suprafața fibrelor, s-a remarcat reducerea numărului de microorganisme.*

***Cuvinte cheie:*** *chitosan, textile etnografice, imagini SEM*

## INTRODUCTION

Heritage objects, especially textiles, depending on their composition and environmental conditions subjected to or stored in, can be contaminated with fungi, bacteria, etc., which may lead to their physical, chemical or biological deterioration, sometimes even to their destruction and negative impact upon the health of people manipulating them [1–8]. Biodeterioration generated by microorganisms requires proper remedy measures: mechanical, physical, respectively chemical; however, they should not endanger the workers' health and they should not affect or modify the features of the heritage object or those of the environment [9–17].

In this paper, two heritage ethnographic pieces were taken into analysis, out of cotton and flax fibres, both over 100 years old; one is in a private collection (figure 1), while the other one is in the care of the Tarii Crisurilor Museum from Oradea (figure 2).

It was proven once more [8; 13; 18–31] that Chitosan treatment is very useful for removing the odd agent on the fibres surface and as antibacterial effect against the microorganisms.

The paper explores the use of Chitosan for the treatment of aged cotton and linen fabrics to enhance its physical and antimicrobial characteristics. Scanning electron microscope (SEM) photographs showed that the surface of the chitosan coated cotton yarn was slightly changed after the series reaction.

## MATERIAL AND METHOD

The two traditional shirts (ii) belonging to the Romanian cultural heritage were non-invasively tested

Fig. 1. Traditional shirt "ie", Alba County, Romania

Fig. 2. Traditional shirt "ie", Hateg area, Hunedoara County, Romania

by applying Chitosan and investigating SEM images. SEM images for the Hateg area shirt (figure 2), enlarged 250 times (figures 3 and 4), allowed the determination of the tested fibres condition, which presented certain longitudinal fractures. 500 times magnification images (figures 5 and 6) show the mechanical deterioration of fibres. The successive size of images, × 1,000 (figures 7 and 8) emphasize the presence of fine dust and dirt particles and possibly of certain microorganisms [32–34]. The conducted tests, published in Ilies et al., 2020 [35], for the other traditional shirt, from Alba County (figure 1), confirmed the presence of *Aspergillus nigger*, *Penicillium spp.*, *Cladosporium spp.*, *Alternaria spp.* and *Candida spp.*

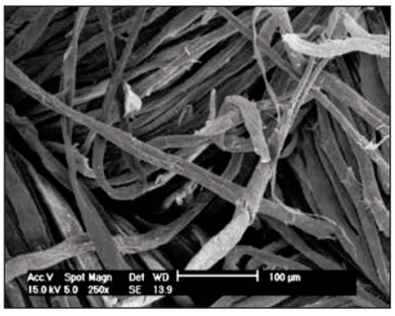


Fig. 3. SEM image of the fibres form traditional shirt "ie" from Hateg County, at 250× magnification

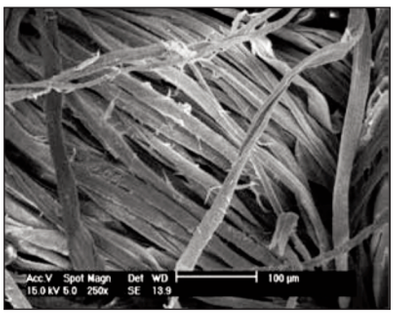


Fig. 4. SEM image of the fibres form traditional shirt "ie", from Hateg County at 250× magnification

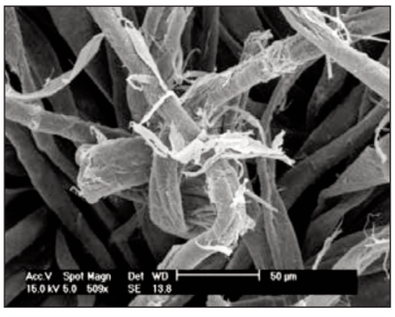


Fig. 5. SEM image of the fibres form traditional shirt "ie", from Hateg County, at 500× magnification


Fig. 6. SEM image of the fibres form traditional shirt "ie", from Hateg County, at 500× magnification

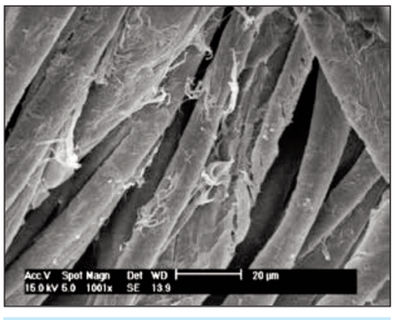


Fig. 7. SEM image of the fibres form traditional shirt "ie", from Hateg County at 1000× magnification

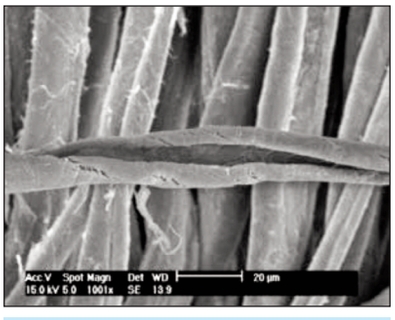


Fig. 8. SEM image of the fibres form traditional shirt "ie", from Hateg County, at 1000× magnification

**Method**

Chitosan Medium Molecular Weight was purchased from Sigma Aldrich. Acetic Acid was supplied by Panreac. Chitosan was prepared with the concentration 10 g/l. Because of the solubility of Chitosan in water at acid pH, 5 ml/l acetic acid was added. The solution was magnetically stirred for 24 hours [29]. The samples were dipped into the chitosan solution and dried flattened at room temperature.

The samples were observed with a Field Emission Microscope FESEM (ULTRA 55, ZEISS). Each sample is placed on a surface and covered with a layer of gold and palladium in order to make them into conductive by using a Sputter Coater and covering them with gold. The samples were analysed with the appropriate magnification and with an acceleration voltage of 10 kV.

## RESULTS AND DISCUSSION

Every sample studied has been observed by FSEM and comparisons were established, in order to determine the effect of Chitosan treatment. From the comparison, it can be stated that some foreign substances are placed on the fibres. Those strange particles on some occasions can be appreciated as a coating that covers the fibres and keeps them stacked together.

Chitosan treatment has shown efficiency in removing the odd agent from the fibres surfaces. Therefore, it can be concluded that it fits with the presence of some microorganisms on the fibres. Due to the antibacterial effect attributed to chitosan, the microorganisms have disappeared. The effect of chitosan treatment for this case study can be observed on figure 9.

For Sample 1, the SEM images show that some of the fibres are stacked together because of the presence of some strange agent (figure 9, *a*). Once the fibres have been padded with chitosan solution and dried, it can be noticed that the odd agent is not present any more on the fibres' surface (figure 9, *c*). The particles which agglomerate the fibres (figure 9, *b*) are present on the original fabric of the sample 2, but they have been removed by the Chitosan treatment (figure 9, *d*).

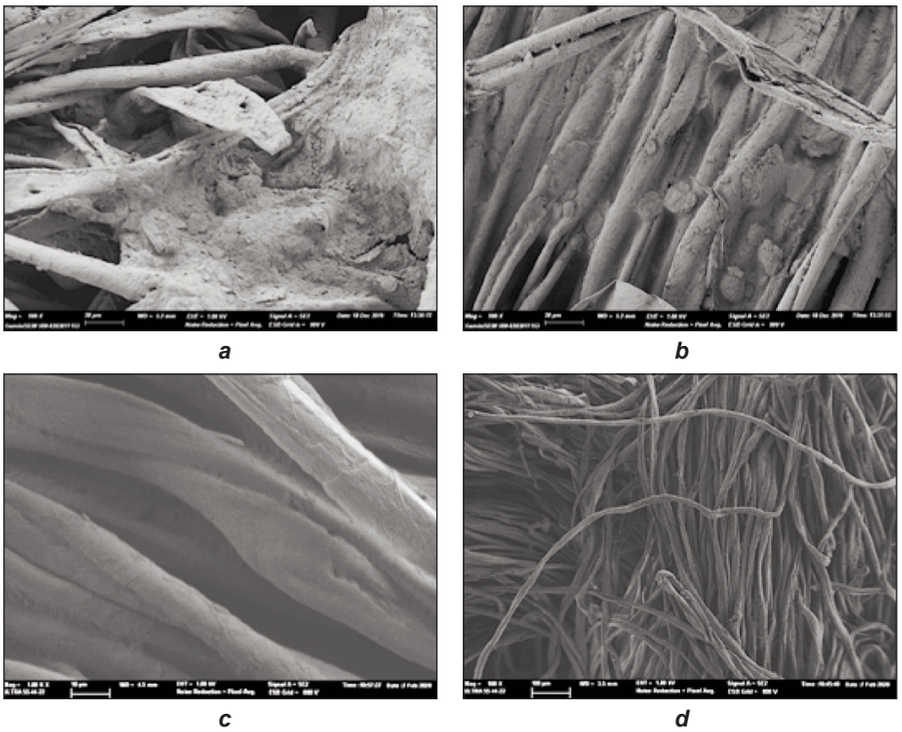

Fig. 9. SEM images of: *a* – untreated fabric, sample 1 at 500×; *b* – untreated fabric, sample 2 at 500×; *c* – treated fabric, sample 1; *d* – treated fabric, sample 2 at different magnifications ×1000, ×500 and ×100

## CONCLUSIONS

The use of chitosan, which is very economical [29] and biodegradable, with characteristics which make it non-toxic for fabrics and for the people who handle them, provides favourable perspectives regarding using it on a large scale in the sustainable industry of fibre production and fabric treatments, with antimicrobial and antifungal effects on aged textiles from museums and other collections.


## ACKNOWLEDGEMENTS

The research was possible by equal scientific involvement of all authors and acknowledges the support of the Grant PN-III-P1-1.2-PCCDI-2017-0686.


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