

COMPOSITION FOR RESTORING PAPER FROM DOCUMENTS AFFECTED BY MICROORGANISMS

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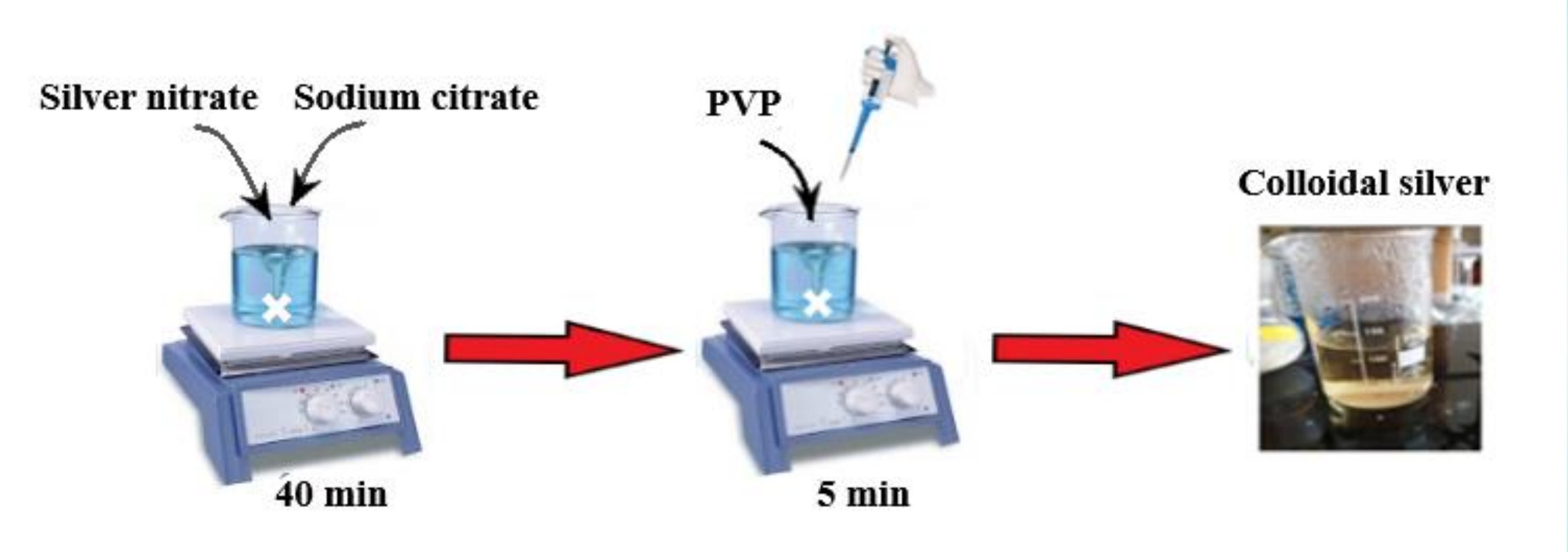
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Introduction

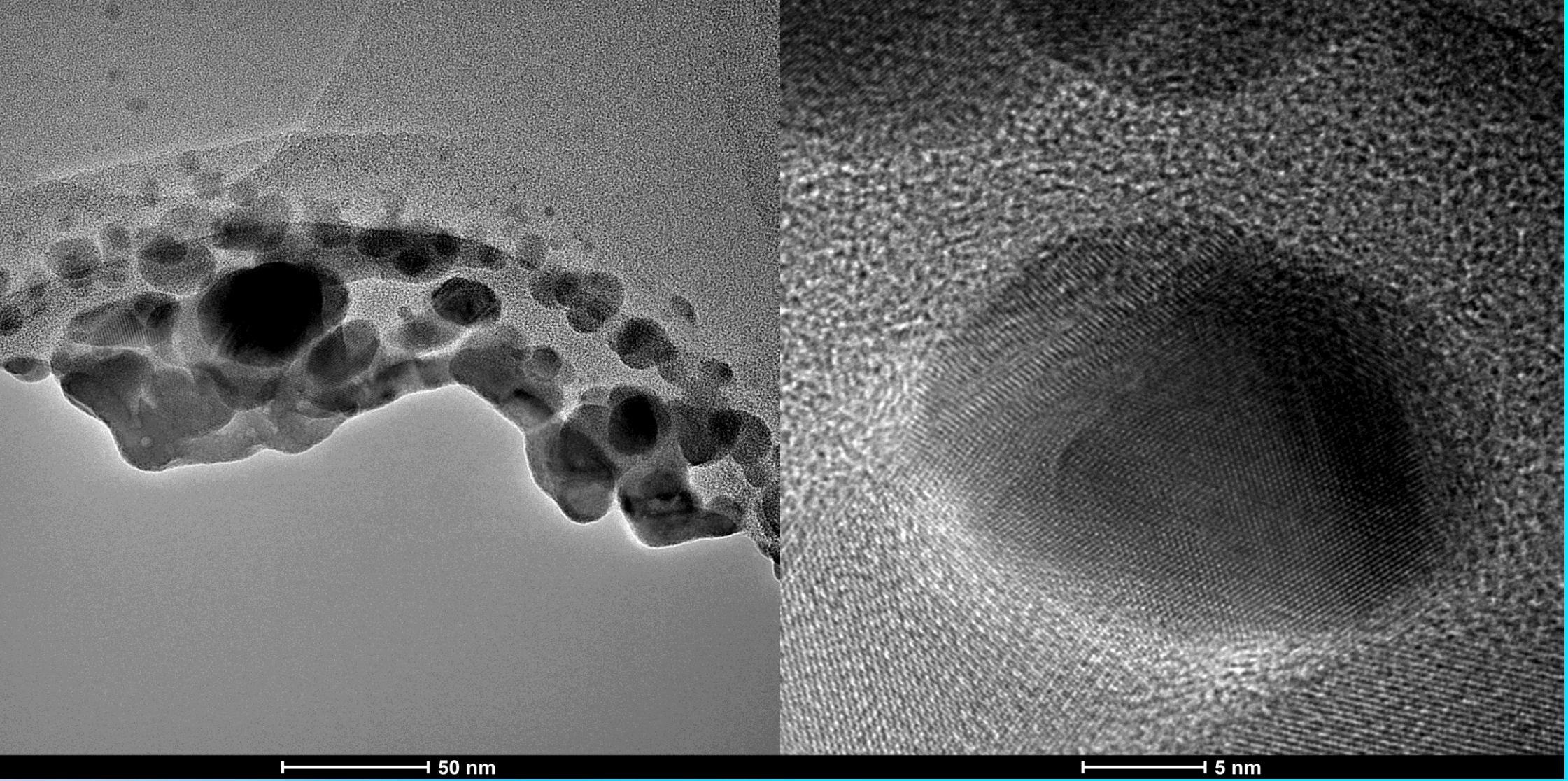
The present invention relates to the production of innovative compositions consisting of cellulose gel with Ag nanoparticles, for the treatment of degraded paper support of documents affected by pathogens (fungi, molds or bacteria). One of the current problems faced by libraries, archives, but also private collectors or occasional customers of antique shops, is the degradation of books or documents, especially those stored in less stringent conditions. Normally the temperature should not fall below 21°C, the humidity should not exceed 50% and the storage place should benefit from good air ventilation. Most of the time, private collectors, but also smaller libraries or institutions, do not have the necessary financial strength to hire a professional restorer and / or to purchase the necessary equipment, which is extremely expensive. Also, this problem of mold and specific odor can be faced by anyone when buying a book from an antique shop or borrowing it. Moreover, in the case of schools that reuse books in several successive years, an advanced sterilization of books can be ensured, either in a regime organized by the educational units or by the direct beneficiaries (parents of the students). If the removal of visible inflorescences is relatively easy, there is always the problem of the subsequent appearance of molds as the spores remain trapped in the cellulosic, fibrillar texture, which acts as a net. The cellulosic gel loaded with silver nanoparticles can be used to repair the degraded support, the missing bits, it can be placed under the printed letters, or it can be used as a surface treatment of whole sheet. The nanoparticles will remain trapped into the cellulosic net and will confer a long-lasting antimicrobial activity. This will ensure an increased resistance of the support to subsequent attacks.

Obtaining method

Silver nanoparticles are a well-known antimicrobial agent with multiple uses in day-by-day life. Its intrinsic bacteriostatic property promote the silver nanoparticles as a topical wound dressing in combinations with other drugs. There are antimicrobial paints or house-holds appliances with silver nanoparticles or even cloths. The round shaped silver nanoparticles were obtained by Turkevich method. Briefly, 0.6 g AgNO₃ were solved in 100ml H₂O and 0.6 g sodium citrate was added to the boiling solution. The yellow colloidal silver solution was used further in the obtaining process of cellulose gel. Cellulose hydrogel was obtained by mixing with certain amounts of chitosan and colloidal silver solution. The

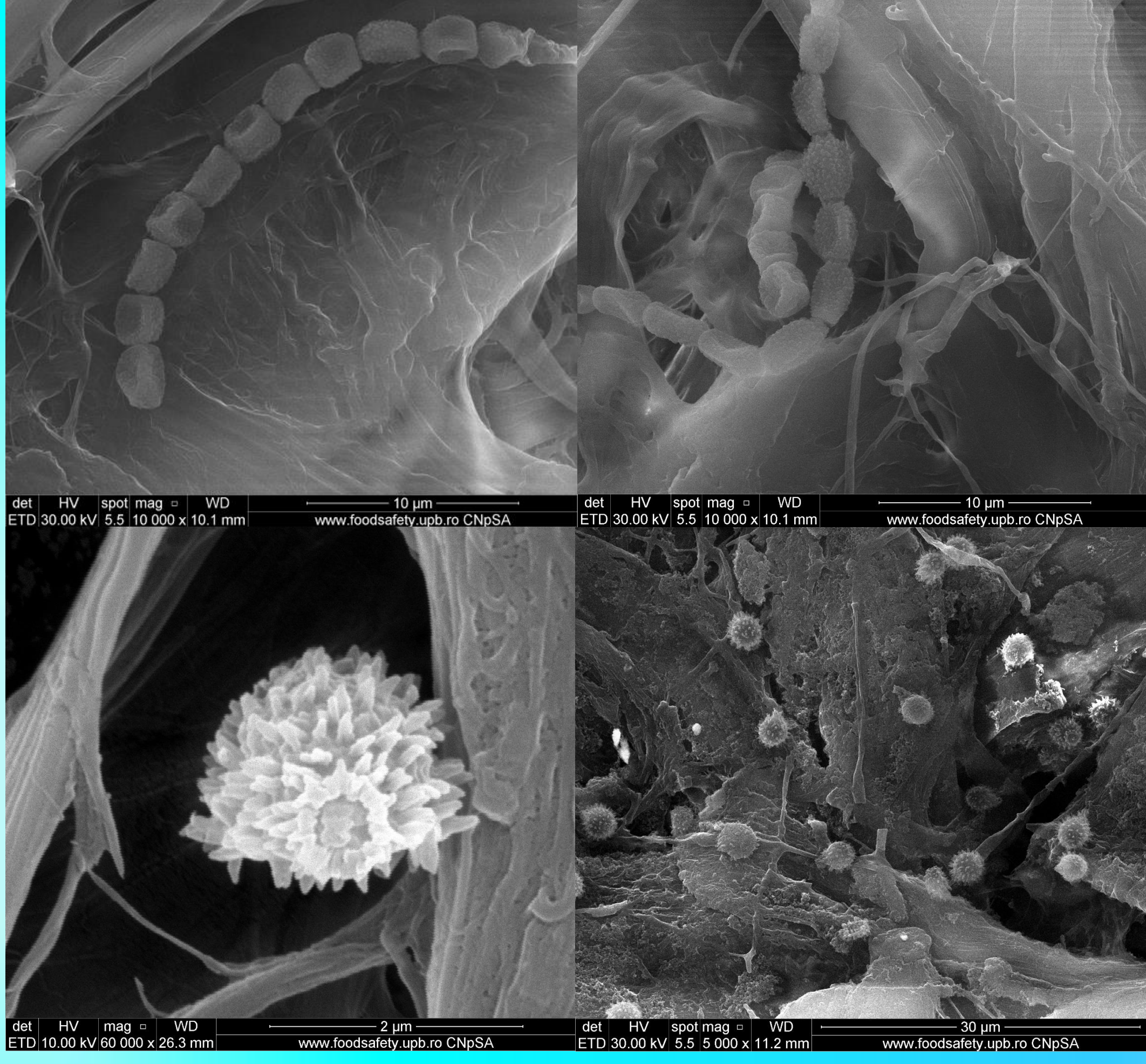


The gel with cellulose derivatives, with silver nanoparticles, by rapid drying, forms a cellulose film that will repair the damaged areas (ruptures, holes with missing material, etc.). The gel can also be inserted under the letters that came off the initial support following the degradation of the cellulosic material. By rapid drying it will act as a real glue, but having the same composition, based on cellulose. Because the composition contains silver nanoparticles, the cellulose film remaining after drying has antimicrobial activity and no longer allows the development of microorganisms on the treated area.



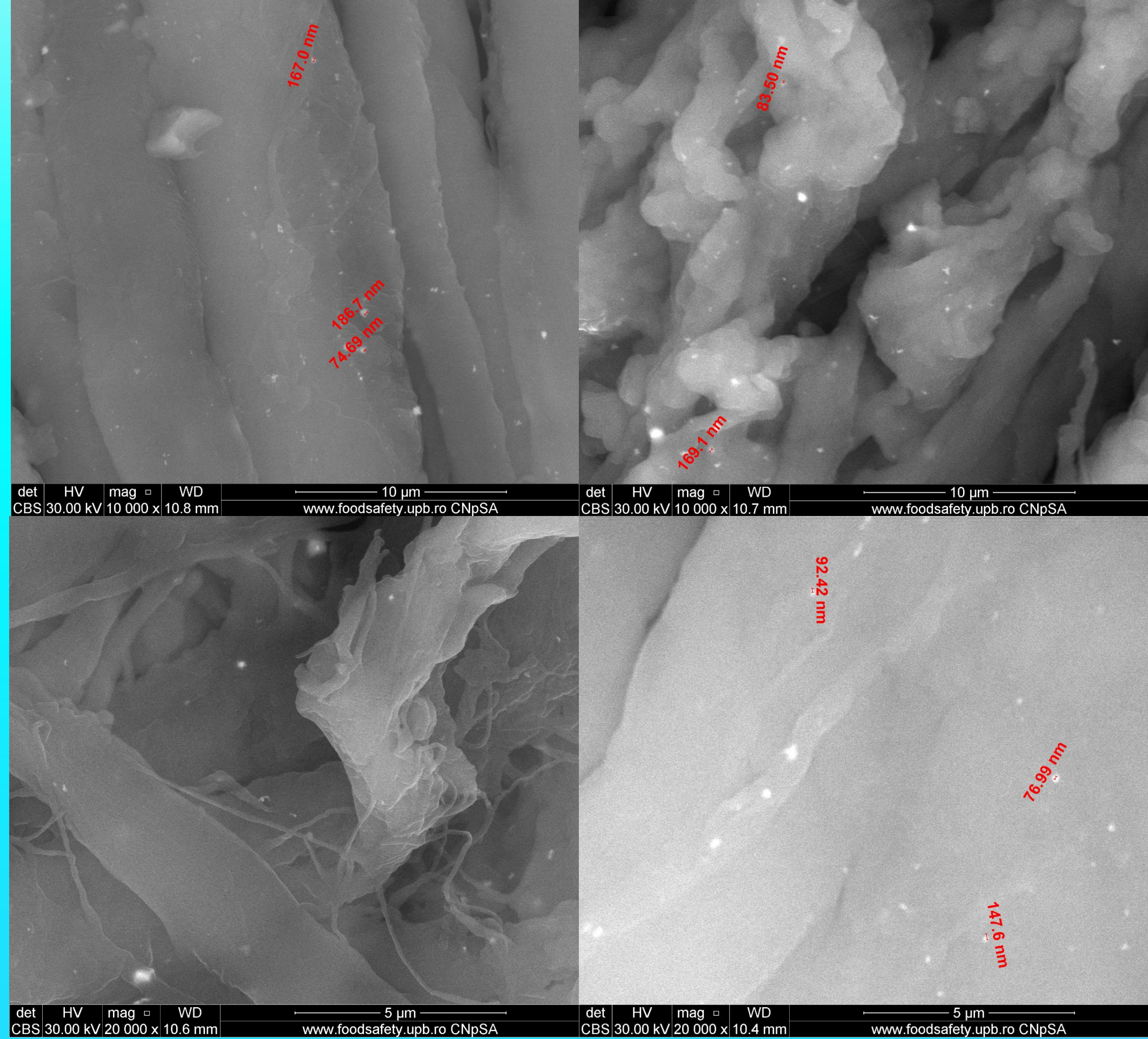
TEM and HRTEM for Ag NPs

Paper samples before treatment



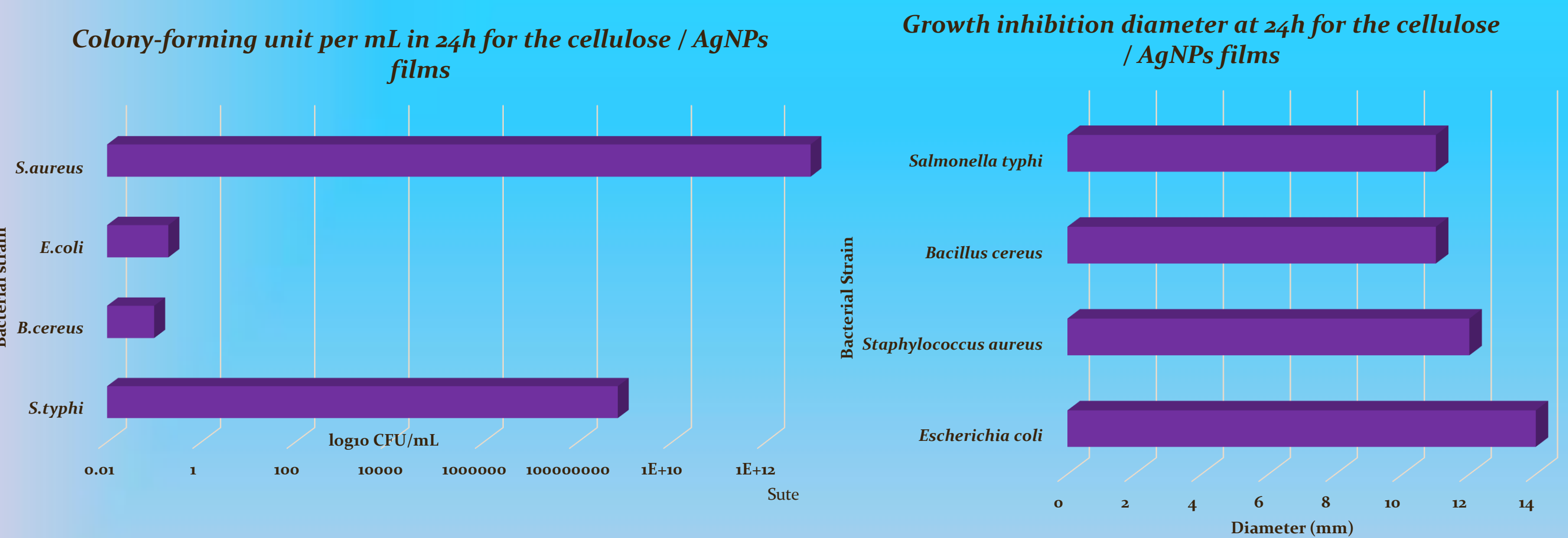
Infested paper from XVI-XVIII

Paper samples after cellulose/Ag gel treatment



Treated paper with cellulose and Ag NPs trapped among fibers

Quantitative assay of the Ag antimicrobial activity



Advantages of the novel solution types

The present invention relates to the production of gel-type compositions based on cellulose derivatives, with silver nanoparticles protected with biocompatible polymers, such as PVP, PEG for the restoration of paper documents, which will provide long-lasting antimicrobial protection. The advantages of the proposed treatment solutions consist in the synergistic, complex activity of the antimicrobial agents, as well as in the fact that a lasting antibacterial and antifungal activity can be ensured after application. Moreover, it is important to mention that the nanoparticles exhibit a good adhesion to the cellulosic surface of the paper. The antibacterial and antifungal activity of silver nanoparticles manifests itself at a slow rate but is sufficient to prevent the reappearance of molds. The gel with cellulose derivatives, with silver nanoparticles, by rapid drying, forms a cellulose film that will repair the damaged areas (ruptures, holes with missing material, etc.). Because the composition contains silver nanoparticles, the cellulose film remaining after drying has antimicrobial activity and no longer allows the development of microorganisms on the treated area.