PERFORMANCE IMPROVEMENT OF HYGIENIC AND OLFACTORY PROPERTIES IN MILITARY BASE LAYER TEXTILES

Emilia VISILEANU[1,*], Elena PERDUM[1], Roxana CONSTANTINESCU[1], Alina VLADU[1], Felicia DONDEA[1,2], Florin MICULESCU[2], Aura Cătălina MOCANU[2], Daniela MANOLE[2] ,Maria HAIDUCU[1]

[1]*The National Research and Development Institute for Textiles and Leather, Lucretiu Patrascanu, 030508 Bucharest, Romania*
[2]*Department of Metallic Materials Science, Physical Metallurgy, National University of Science and Technology Politehnica Bucharest, 313 Splaiul Independentei, J Building, District 6, 060042 Bucharest, Romania*

1. OBJECTIVES

Military base layer garments, worn directly against the skin, play a crucial role in ensuring hygiene, comfort, and sustained operational performance under prolonged and physically demanding missions. In such conditions, bacterial proliferation and the accumulation of odour-causing compounds can negatively impact skin health, comfort, and mission effectiveness. Optimising these functional properties is therefore critical for military textile equipment.

By integrating performance evaluation with durability testing, this study demonstrates the potential of advanced textile solutions to maintain hygiene, reduce microbial contamination, and enhance olfactory comfort, even under challenging operational conditions.

2. METHODOLOGY

Mint essential oil-loaded particles were prepared by complex coacervation.

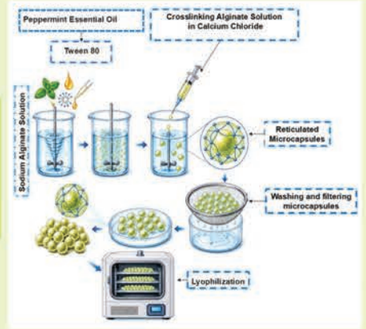
A 0.3% (w/v) sodium alginate solution (500 mL) was prepared and mixed with 3 mL mint essential oil and 0.2% Tween 80 under stirring for 15 min. Separately, a 0.3% (w/v) chitosan solution (600 mL) was dissolved in 1% acetic acid.

The alginate mixture was added dropwise into the chitosan solution at pH 3.6, maintaining an alginate:chitosan volume ratio of 5:6, resulting in coacervate formation. The suspension was heated to 45 °C and stirred for 1 h, cooled to 20 °C for the addition of 3 mL glutaraldehyde, then reheated to 45 °C and stirred for an additional 1.5 h.

The obtained crosslinked particles were filtered, washed, and lyophilized.

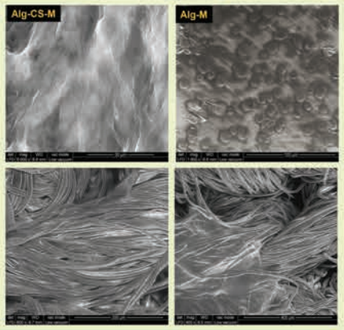
Mint essential oil-loaded microcapsules were prepared using the sol-gel method. Solution I consisted of 0.3% (w/v) sodium alginate dissolved in 200 mL distilled water, followed by the addition of 1.2 mL mint essential oil and 0.2% Tween 80 under constant stirring and homogenization.

Solution II was prepared by dissolving 1.6 g calcium chloride in 200 mL distilled water under continuous stirring. Solution I was added dropwise into Solution II using a fine-needle syringe under homogenization, allowing ionic crosslinking of the capsules. The resulting microcapsules were filtered, washed, and lyophilized.



3. RESULTS AND DISCUSSION

3.1 SEM Analysis



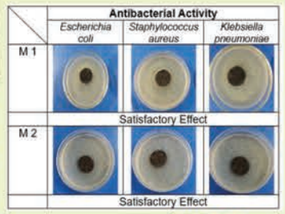
Scanning electron microscopy (SEM) imaging was used to determine the average sizes of the microcapsules in the investigated suspensions. The images, including scale bars for size measurement. The dried suspension shows spherical formations consistent with the morphology of the microcapsules. At the same time, the amorphous structures observed in the images are attributed to the drying of the components used in the embedding matrix of the microcapsules. SEM analysis indicates an average particle diameter of approximately 10 µm.

The discrepancy between the DLS and SEM results can be explained by particle aggregation that occurs during the drying process required for SEM sample preparation.

A textile material made of COTTON/ELASTAN was treated with 2 solutions:

The treatment solutions I and II were applied by padding using a ROACHES machine. The textile structure was passed 5 times through the treatment solution and air-dried at room temperature.

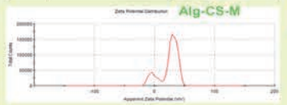
3.2 Antibacterial Activity

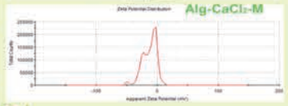


The antibacterial evaluation of the treatments was performed in accordance with SR EN ISO 20645:2005 and ISO 20743:2013, using *Staphylococcus aureus* ATCC 6538 (Gram-positive), *Escherichia coli* ATCC 10536 (Gram-negative), and *Klebsiella pneumoniae ATCC 4352 (gram negativ)* .

For the R I and R II variants, the results are consistent with the zeta potential measurements. These samples show lower colloidal stability, which leads to reduced diffusion of the active compounds. As a result, the inhibition zones are smaller. However, according to the evaluation standard, the antibacterial effect of both samples is still considered satisfactory.

3.3 Zeta Potential





Zeta potential describes the electric charge on the surface of particles or a formulation and indicates how stable the dispersion is.
For the initial solutions, a zeta potential of PZ-RI 22.8 mV was obtained, while for RIV it was −8.41 mV.
For formulations containing essential oil, the best zeta potential value was obtained for RII with a concentration of 0.30% (−23.1 mV)

4. CONCLUSION

Textile treatments based on mint essential oil microcapsules improved the hygienic and olfactory properties of materials used for military equipment. The treated materials demonstrated effective antibacterial activity against both Gram-positive and Gram-negative bacteria, contributing to the reduction of microbial contamination. The study confirms the potential of functionalized textiles to maintain hygiene, comfort, and performance of military equipment under demanding conditions.

5. ACKNOWLEDGMENT

This work was carried out through the Core Programme within the National Research Development and Innovation Plan 2022-2027, carried out with the support of MEC-ANC, project no. **6N/2023/PN23260201/23001.7** project title *"Intelligent equipment to ensure combatant survival in operational conditions" IRHEM.*

Contact person: Dr.Eng. Emilia Visileanu
E-mail address: e.visileanu@incdtp.ro

Ministry of Education and Research

ROMANIA

THE TECHNOLOGIC AND BUSINESS INCUBATOR ITA TEXCONF

ITA TEXCONF is an entity in the infrastructure of innovation and technological transfer without legal personality, established within INCDTP based on HG 406/2003, accredited for the Bioeconomy, Advanced functional materials and Environment and eco-technologies fields, Certificate no. 169/2026, issued by the Ministry of Education and Research.


ROMÂNIA
MINISTERUL EDUCAȚIEI ȘI CERCETĂRII
CERTIFICAT DE ACREDITARE
„Centrul Incubator Tehnologii și de Afaceri ITA-TEXCONF" este acreditat ca centru incubator tehnologii și de afaceri pentru domeniile: Bioeconomie, Materiale funcționale avansate; Medii și eco-tehnologii și deține titlul de entitate a infrastructurii ReNITT.
Entitatea este constituită ca departament în cadrul Institutului Național de Cercetare-Dezvoltare pentru Textile și Pielărie – INCDTP, cu sediul social în str. Lucrețiu Pătrășcanu nr.16, sectorul 3, București, având codul unic de înregistrare fiscală 9311329.
Prezentul CERTIFICAT DE ACREDITARE se acordă pentru o perioadă de 5 ani, începând cu data emiterii ordinului ministrului educației și cercetării privind acreditarea.
Certificare

ITA TEXCONF is part of the National Network for Innovation and Technology Transfer ReNITT and acts for the sustainable economic and social development of the textile sector, by ensuring access to technological performance, developing the innovative environment, introducing quality systems and developing human resources.

The incubator is involved in specific actions of collaboration with all 5 existing clusters in the textile field, of which it is part as an active member: Romanian Textile Concept Cluster – RTxC, ASTRICO NE, Traditions Manufacture Future, Transilvania Textile & Fashion Cluster and Fashion Future Cluster.

Services:

- Services of sustaining textile-clothing SME competitiveness within the competitional background of the market economy;
- Services aiming at creating partnerships and financing drawing in within the projects;
- Services aiming at the product, equipment, innovation technology promoting in the field of textile-clothing, as part of scientific events (fairs, symposiums, conferences, etc.);
- Mediating contracts of technology transfer/manufacturing of products, experimental models, prototypes and specific applications for technical textile, personal protective equipment, invasive and non-invasive medical devices, special-purpose items, etc .;
- Mediating contracts in the field of investigating the textile material and product properties, within the RENAR accredited INCDTP laboratories.

16, Lucretiu Patrascanu street, postal code 030508, Bucharest, ROMANIA
Phone: (0040)-21-340.49.28; 340.42.00; Fax: (0040)-21-340.55.15
E-mail: office@incdtp.ro
General manager: Dr. eng. Alexandra Gabriela Ene