
3rd International Conference on
**AERoGELS FOR BIOMEDICAL AND
ENVIRONMENTAL APPLICATIONS**



BOOK OF ABSTRACTS

Zoran
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Supercritical Solvent Impregnation Technique for the Development of Antimicrobial Starch-based Aerogels

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Natural compounds found in different plant extracts can show numerous biological activities and be used as health promoters. For instance, thymol, carvacrol, citronellol, and eugenol (found in extracts of thyme, oregano, lemongrass, and clove, respectively) can be used as anti-inflammatory, antiviral, and antimicrobial agents [1-4]. The high volatility of the mentioned natural bioactive compounds (NBCs), which restricts their broader application, can be managed by the incorporation of NBCs into polymer matrices. Therefore, intending to develop devices that release antimicrobial substances in a controlled manner, this study tested the applicability of the supercritical solvent impregnation (SSI) technique for the incorporation of NBCs into starch aerogels. First, the hydrogels were prepared from corn starch. The water in the hydrogels was replaced by ethanol, and the obtained alcogels were dried using the supercritical drying (SCD) technique. The parameters of the aerogels' preparation were optimized previously [5]. Later, SSI was performed at 150 bar and 35 °C for 2 h. The obtained materials were analyzed using FTIR, to determine the potential interactions between the NBCs and polymer that could determine the rate of controlled release and antimicrobial activity. Controlled release of NBCs from the aerogels was tested in phosphate-buffered saline solution at 37 °C. The antimicrobial

activity of the impregnated aerogels was tested against the Gram-negative bacteria *E. coli* ATCC 25922, Gram-positive bacteria *S. aureus* ATCC 25923, and the fungi *C. albicans* ATCC 24433, using an agar disk diffusion standard method. Freshly grown microbial cultures were diluted in a sterile physiological saline solution to obtain the inoculum with an initial number of cells of *ca.* 10^6 CFU/mL for *E. coli* and *S. aureus* and 10^5 CFU/mL for *C. albicans*. The diameter of the inhibition zones (DIZs) was determined after 24 h of incubation at 37 °C.

The SCD technique allowed the preparation of aerogels with diameters of 10 mm, density of 291 kg/m³, and porosity of 81%. The loading of aerogels was in the range from 9.4 to 11.1%, being the lowest for thymol and the highest for eugenol. The disk diffusion test revealed that DIZs for samples impregnated with thymol and carvacrol were larger compared to samples impregnated with citronellol and eugenol (Figure 1). It was interesting to note that DIZs for *C. albicans* could be determined only for the eugenol and citronellol samples, while the zones were overlapped in the cases of thymol and carvacrol. This could be due to the smaller number of cells in the inoculum, or better susceptibility of yeast towards impregnated extracts. Additionally, it was observed that the antibacterial activity of aerogels with carvacrol, eugenol, and citronellol was the same against Gram-positive and Gram-negative bacteria, achieving a DIZ of 27, 19, and 12 mm, respectively. On the other hand, the aerogels with thymol showed stronger antibacterial activity against Gram-positive bacteria, achieving a DIZ of 55 mm.



Figure 1: Antimicrobial activity of starch aerogels: neat (O) and impregnated with thymol (T), carvacrol (K), citronellol (C), and eugenol (E)

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References

- [1] M. I. S. Santos, C. Marques, J. Mota, L. Pedroso, A. Lima, *Microorganisms*, 10, 760, 2022.
- [2] A. Escobar, M. Perez, G. Romanelli, G. Blustein, *Arabian Journal of Chemistry* 13, 9243–9269, 2020.
- [3] M. Ulanowska and B. Olas, *International Journal of Molecular Sciences* 22, 3671, 2021.
- [4] P. L. Santos, J. P. S. C. F. Matos, L. Picot, J. R. G. S. Almeida, J. S.S. Quintans, L. J. Quintans-Júniora, *Food and Chemical Toxicology* 123, 459–469, 2019.
- [5] I. Lukic, J. Pajnik, V. Tadic, S. Milovanovic, *Journal of CO₂ Utilization* 61, 102036, 2022.