CARBON-POLYMER DRESSINGS FOR THE TREATMENT OF CHRONIC ULCERS

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INTRODUCTION.

Cryogels are sponge-like, highly porous, interconnected hydrogels formed using a freezing process. They have a large surface area for wound contact and, in this case, with a selective barrier (agarose) that allows the passage of volatile malodorous molecules but not serum proteins. This way agarose scaffold absorbs wound exudate and incorporated activated carbon prevents odorous molecules from escaping. In this study, agarose cryogels, hydrogels and films and their composites with activated carbon (AC) were studied as potential wound dressing materials.

MATERIALS AND METHODS.

Methods for preparation of the following polymer materials from agarose and agarose-activated carbon were optimised: cryogels, hydrogels, thin films, double-layered cryogels, and three-layered films. Agarose (AGR) cryogels, hydrogels and films with or without activated carbon were characterized according to their physical, mechanical properties, release of povidone-iodine and sorption of inflammatory cytokines responsible for delay of wound healing process (Fig. 1).

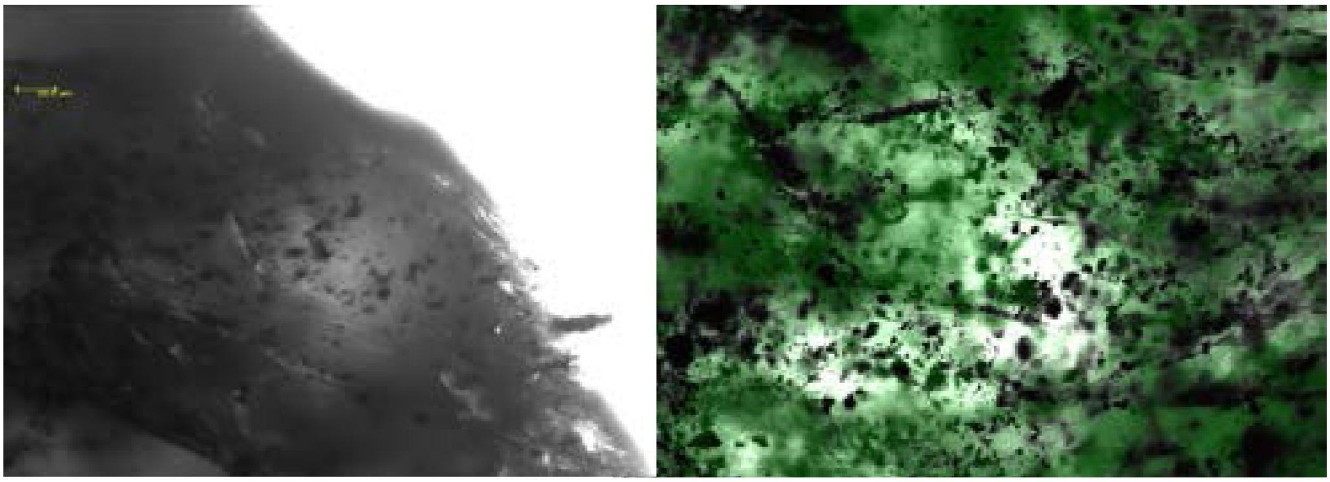

Figure 1. *AGR-AC cryogels stained with FITC show an even distribution of activated carbon particles. The pores are not visible because agarose and water were stained. These cryogels contain >90% water (by weight).*

RESULTS.

Cryogels are highly porous, elastic with an excellent shape memory, which are produced by polymerisation in frozen water. The ice crystals play the role of a pore forming agent and the resulting cryopolymers have large interconnected (macro)pores [1]. For better tissue regeneration, porous materials with high flow rate and permeability are required for transport of biomolecules and cells through the scaffold along the wound bed. Among the materials prepared, AGR cryogels and their composites with AC demonstrated the best physical and mechanical properties. Further incorporation of activated carbon enhanced their flow rate, permeability, and absorption properties. On the other hand, agarose hydrogels produced by a conventional method at room temperature exhibited very flow rate and permeability, and tighter (micro)porous structure. Agarose cryogel films had high absorptive and swelling capacity. Diffusion of povidone-iodine from films demonstrated pronounced antimicrobial effect (5mm) on *E.coli, S.aureus, and P.aeruginosa* (Fig. 2).

Figure 2. *Release of antimicrobial agent povidone-iodine from agarose films. Left – P.aeruginosa, right – E.coli.*

CONCLUSION.

Cryogels, hydrogels, thin films, double-layered cryogels and three-layered films from agarose and agarose with incorporated activated carbon particulates were successfully prepared for the first time. Comparison tests demonstrated cryogels as highly porous materials with desirable physical and mechanical properties, and films capable of effective antimicrobial release.

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REFERENCES.

Mikhalovsky S.V., Savina I.N., Dainiak M., Ivanov A., Galaev I. (2010). In: *Comprehensive Biotechnology*, 2nd ed., Editor-in-Chief, Moo-Young Murray, Vol 5: Medical Biotechnology and Healthcare, Volume Editor Cui Zhanfeng | Section 5: Regenerative Medical Technology | Ch. 432. Biomaterials | Cryogel (on-line edition), 2010; hard copy: 2011, pp. 11-22.