Novel alginate/activated-charcoal platform for local treatment of resistant pathogens in wounds

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INTRODUCTION: Antibiotic resistance is one of the biggest threats to global health, food security, and development today [1] and new strategies to address this clinical problem are urgently needed. The aim of this work was to produce novel composites based on either Ca- or Zn-alginate *hydrogels* and activated charcoal (AC) particles that would, upon contact with physiological fluids, continuously release at least one bioactive agent directly into the wound area. In addition, AC particles served as carriers of other active substances such as povidone iodine (PVP-I), a very powerful antiseptic, which was used as a model substance.

EXPERIMENTAL: The composite Ca- and Zn alginate beads with incorporated AC particles impregnated with PVP-I were prepared as described previously [2,3]. The obtained beads were comprehensively investigated *in vitro* regarding its antimicrobial activity against wide range of wild resistant pathogens (MRSA, ESBL-*E. coli*, *P. aeruginosa*, *A. baumannii*, *P. mirabilis*, *E. faecalis*, *C. albicans*), all isolated from patients' wounds. Also, the beads were characterized regarding its textural parameters (ASAP 2020, Micromeritics, USA), morphology and iodine presence (MIRA 3 XMU Field Emission Scanning Electron Microscope, Tescan USA Inc., Cranberry Twp, PA). AC release profiles as well as the level of iodine adsorption and desorption from AC particles were determined by UV–visible spectrophotometer (UV-3100, Mapada Instruments, Shanghai, China) while flame atomic absorption spectrometer (Perkin Elmer, AAnalyst 300, USA) was used to determine Zn^{2+} release profiles. All experiments were carried out in triplicates.

RESULTS AND DISCUSSION: The obtained composites have exhibited excellent antimicrobial activity. Precisely, synergistic activity of AC particles and adsorbed iodine was shown to be crucial for excellent antibacterial activity while synergy of AC particles and Zn^{2+} ions showed equally strong antifungal effect. However, Zn^{2+} ions proved to be selectors of resistant strains of bacteria which could be of relevance in everyday life, since Zn compounds are widely used in ointments and skin preparations from a very early age. Also, it was shown that PVP-I is firmly adsorbed on AC particles and that its release in the surrounding medium is negligible which is very important in regards of preventing often reported systemic iodine absorption after its prolonged medical usage [4].

CONCLUSIONS: The presented strategy enables further development of efficient multifunctional wound dressings with sustained release of one or more potent bioactive agents *in situ* for prevention and topical treatment of resistant infections and thus, addresses antibiotic resistance, one of the most significant clinical problems today.

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