Antimicrobial peptides-loaded smart chitosan hydrogel: release behavior and antibacterial potential against antibiotic resistant clinical isolates

Nourollah Rezaei1,2, Hatef Ghasemi Hamidabadi1,2, Sadjad Khosravimelal3,4,5, Maria Zahiri6, Zahra Aliakbar Ahovan7, Maryam Nazm Bojnordi1,2, Behnaz Sadat Eftekhar8,9, Ali Hashemi7, Fatemeh Ganji3,4, Shahram Darabi10, Mazaher Gholipourmalekabadi3,4*

1Immunogenetic Research Center, Department of Anatomy & Cell Biology, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari, Iran
2Department of Anatomy & Cell Biology, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari, Iran
3Cellular and Molecular Research Centre, Iran University of Medical Sciences, Tehran, Iran
4Department of Tissue Engineering & Regenerative Medicine, Faculty of Advanced Technologies in Medicine, Iran University of Medical Sciences, Tehran, Iran
5Department of Medical Biotechnology, Faculty of Allied Medicine, Iran University of Medical Sciences, Tehran, Iran
6The Persian Gulf Marine Biotechnology Research Center, The Persian Gulf Biomedical Sciences Research Institute, Bushehr University of Medical Sciences, Bushehr, Iran.
7Department of Microbiology, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran
8Department of Biomedical Engineering, Amirkabir University of Technology, Tehran, Iran.
9Department of Physiology and Institute for Medicine and Engineering, University of Pennsylvania, USA.
10Cellular and Molecular Research Center, Qazvin University of Medical Science, Qazvin, Iran

*Dr. Mazaher Gholipourmalekabadi (ORCID: 0000-0001-6287-6831)

Dr. Mazaher Gholipourmalekabadi
Department of Tissue Engineering & Regenerative Medicine, Faculty of Advanced Technologies in Medicine, Iran University of Medical Sciences, Tehran 1449614535, Iran
Tel: (+98 21) 8862 2755; Fax: (+98 21) 8862 2533
E-mail: mazaher.gholipour@iums.ac.ir; mazaher.gholipour@gmail.com

Abstract

In this study, we synthesized thermo-responsive chitosan (TCTS) hydrogels, and loaded with different concentrations of antimicrobial peptide (AMP) (0, 4, 8 and 16 µg.ml−1) to fabricate an antibacterial wound dressing against resistant clinical isolates. Physico-chemical properties, release behavior, cytobiocompatibility and antibacterial activity of the AMP-TCTS hydrogels against standard strain and resistant Acinetobacter baumannii were fully determined in vitro. The TCTS-40% β-glycerolphosphate hydrogels showed a gelation time of 15 min at 37 °C. 80% weight loss at day 35 with no changes in pH value was observed. AMP-TCTS hydrogels showed a burst release of AMP (around 40%) at day 1, and a controlled release up to day 7. A dramatic water uptake was observed at first 4 h, and then continued for 10 h in a steady manner. All the AMP-TCTS hydrogels showed excellent cytobiocompatibility for human fibroblasts. The TCTS showed no antibacterial activity against both standard strain and clinical isolates. All the AMP-TCTS hydrogels had strong antibacterial activity against standard strains, but only 16 µg.ml−1 showed antibacterial behavior against resistant A. baumannii. Our results strongly suggest the 16 µg.ml−1 AMP-TCTS hydrogel as an excellent antibacterial wound dressing against resistant A. baumannii, and now promises to proceed with pre-clinical investigations.

Keywords: chitosan; hydrogel; thermos-responsive; resistant bacteria, post-wound infection; wound dressing;