Antibacterial Natural Polymers

Alexandra Paxinou[1,2], Elena Marcello[1,3], Isabel Orlando[1,3], Sheila Piarali[1,2] Pooja Basnett1[1], Rinat Nigmatullin [1], Jochen Salber[2], Wenxin Wang[3], Ipsita Roy[1]*

[1]Applied Biotechnology Research Group, FST, University of Westminster, UK
[2]Universitaetsklinikum Knappschaftskrankenhaus GmbH, Germany
[3]Vornia Ltd., Synergy Centre, Institute of Technology, Tallaght, Dublin, Ireland

royi@wmin.ac.uk

Natural Polymers have the potential to be used in a variety of medical applications due to their excellent biocompatibility, varied mechanical properties and sustainable resourcing. These include polymers such as alginate, chitosan, collagen, gellan gum, silk and chitin. This work has focused on two main types of natural polymers produced by bacteria including Polyhydroxyalkanoates (PHAs)[1] and Bacterial Cellulose (BC)[2]. These are a distinct class of natural polymers produced by controlled bacterial fermentation.

PHAs are polymers of 3,4,5 and 6-hydroxyalkanoic acids produced by bacteria, mainly under nutrient limiting conditions. These are divided in to two main types, short chain length PHAs, with monomer chain length, C_4-C_5, which are normally hard and brittle in nature; and medium chain length PHAs, with monomer chain length, C_6-C_{16}, which are normally soft and elastomeric in nature. In this work we have modified PHAs with various natural antibacterial agents including antimicrobial peptides and active factors from garlic, among others. In addition, a naturally antibacterial class of PHAs, Thio-PHAs have also been produced[3]. All of these antibacterial polymers have been characterised with respect to their antibacterial activity against *Staphylococcus aureus* ATCC 6538 and *Escherichia coli* ATCC 8739 following ISO22916. The biocompatibility of these materials have been assessed using C2C12, L929, and NG108, a myoblast , fibroblast and neural cell line respectively. These antibacterial polymers have been used for the development of tissue engineering scaffolds and medical devices.

BC is produced by several bacteria including *Gluconacetobacter xylinus* and has an inherent hydrogel-like structure. This particular feature enables it to incorporate more than 90% of its weight by water, thus providing an optimal level of moisture and turning the material into a natural wound dressing. Moreover, BC is highly pure as it does not contain lignin and hemicellulose, ensuring a great degree of biocompatibility without needing harsh purification treatments. In this work the surface of cellulose was functionalized by wet chemistry to introduce active groups. Antibacterial studies showed a decrease in the bacterial growth after 24 hours of contact with the samples. The cytotoxicity evaluation using HaCaT cells (keratinocytes) confirmed the cytocompatibility for both modified and unmodified BC.

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