Development of Bioactive Nanogels for Wound Dressing Systems

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Abstract

Nanotechnology has become an interesting domain in biomedical technology which is expected to have a great impact on healthcare systems. The development of nanogels has opened up enormous potential towards the fabrication of biomedical devices ranging from drug delivery systems to organ reconstruction. We have been working on the preparation of the nanohydrogel system which may be used to coat on a device or may be added to a system where it would offer resistance against the various microbes. One of the ways to prepare these nanogels is to carry out polymerization of methacrylic acid monomer as nanoemulsion using radiation as the polymerization approach. The bioactive component may be added to the aqueous monomer phase in nanoemulsion prior to the polymerization. Alternatively, a polymer such as polyvinyl alcohol (PVA) may be added to the water phase in a nanoemulsion and may be subsequently crosslinked to get the nanogel particles. These nanogels are unique in terms of their hydrophilicity, bioreceptivity and bioactivity.

In one of these two approaches, we developed PVA nanogels by fructose induced reduction of silver nitrate within PVA gel to develop nanosilver nanogel (nGel). The formation of nanogels and their particle size, as monitored by transmission electron microscopy (TEM), was observed to be in the range of 10-50 nm. Glycerol was added to the nGel system as the hydrophilic base matrix. The size of the nanogel is precisely controlled by the reaction conditions, such as the water phase and surfactant concentration. The nanomaterial prepared by both approaches has been found to be interesting coating material for wound care systems. This composition, nGel/Glycerol was coated on the woven cotton fabric to develop a composite wound dressing with varying nanogel content. The surface morphology and topography of composite dressing was observed by field emission scanning electron microscopy and atomic force microscopy.

Wound dressings have been found to be antimicrobial in nature against both the Gram negative and Gram positive bacteria. The cumulative release of silver from the dressing was found to be ~36% of the total loading after 48 h. Even at such low concentrations, high antibacterial efficiency was achieved against both gram positive and gram negative bacteria. Skin irritation tests were also conducted on these dressing sample and were found to be non-irritating in nature. *In vivo* wound healing studies were carried out over a period of 21 days as full-thickness skin wounds on Swiss albino mice. Fast healing was observed in nGel/Glycerol treated wounds with minimum scarring, as compared to other groups. These results suggest that nGel/Glycerol based materials could be promising candidates for wound dressing applications.

References

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