Novel Biocompatible Nanofibers for Wound Dressing Applications

Wesam A. Sarhan and Hassan M. Azzazy

Novel Diagnostics & Therapeutics, YJ-Science & Technology Research Center,

The American University in Cairo, New Cairo, Egypt 11835

Abstract

Wounds, due to burns, cuts, surgery and chronic infections, have major socioeconomic impact [1]. With over 25 billion dollars annual cost of non-healing wounds, alternative wound healing strategies are urgently needed [2]. One of the major trends witnessed by the Global Wound Dressing market is the increasing demand for advanced, combination dressings for the treatment of various chronic and acute wounds [3]. In a combination wound dressing, the antimicrobial agent (such as antibiotics), wound healing therapeutics, and promoting growth factors are loaded within a matrix, which allows their sustained and prolonged release. Combination wound dressing allows delivery of the therapeutics needed for efficient wound healing in a single dressing that does not need to be changed frequently and sometimes is biodegradable.

Available combination wound dressing, however, suffer from two major drawbacks. First, they are expensive, making them out of reach of most patients, especially in developing countries. Second, they are not designed to treat specific wounds. This makes them ineffective due to the great heterogeneity of different wounds and their microbial loads.

There is no doubt that developing an effective combination wound dressing that is cost effective and can be tailored to manage different kinds of wounds, will not only decrease the socioeconomic burdens of non-healing wounds but will also meet a serious need of the global wound dressings market which is expected to increase at a compound annual growth rate of 5.3% over the next five years [3, 4].

Novel biocompatible cost effective antimicrobial nanofiberous wound dressing have been developed. Through the present study, for the first time, chitosan (CH) and a natural material with biomedical effect (NM) were electrospun with poly (vinyl alcohol) PVA via biocompatible solvents. The problem of chitosans' high viscosity that limits its spinnability except by using toxic or hazardous solvents is resolved through the synergistic effect of (NM) and (CH) allowing for fabrication of novel nanofibers with (NM) reaching to ultimate high concentrations of 30% and chitosan reaching to 5.5% in the final fibers via biocompatible solvents. A series of PVA/CH, PVA/,NM and PVA/CH/NM blend nanofiberous membranes with different concentrations were electrospun to reach to the highest concentrations of CH and NM in the 3 nanofiberous membranes. The viscosity of the precursor solutions were determined. And the morphology and structure of electrospun nanofibers were investigated by scanning electron microscopy (SEM) and fourier transform infrared (FT-IR). Chemical and physical crosslinking strategies

were performed resulting in different degrees of crosslinked PVA/CH/NM nanofiberous mats. Upon testing the swelling and weight loss of the PVA/CH/NM nanofiberous membranes, the results revealed enhanced swelling ability in addition to different degrees of swelling and weight loss with different weight blending ratios of the PVA/CH/NM. The antibacterial activity of the developed nanofibers was evaluated against *Stapylococcus aureus* and *Escherichia Coli* at 24 and 48 hours. Pronounced antibacterial activity was observed with the increase in the incorporated chitosan concentration within the PVA/CH/NM nanofibers against *S.aureus* whereas weak antibacterial activity was observed against *E.coli*. (Specific compounds are not disclosed due to patent filing).

Cell culture studies as well as animal testing is now undertaken for the developed antimicrobial, cost effective, biodegradable nanofiberous wound dressing.

References

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Figures

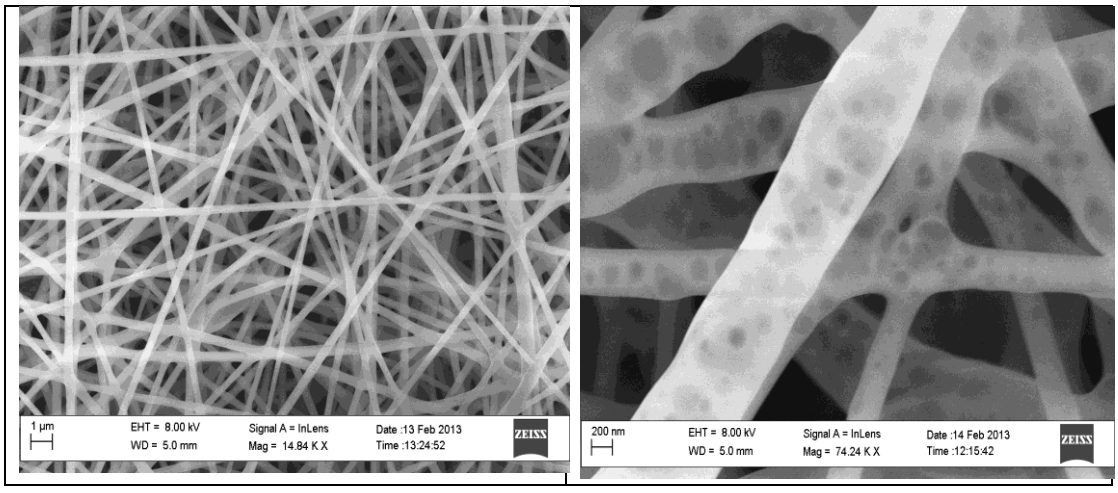

Figure 1: SEM images of natural nanofiberous dressing made of high concentration of (NM) and (CH) co-spun with PVA via the electrospinner using biocompatible solvent.