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Optimization of electrospun sodium alginate/polyethylene oxide nanofibers for potential biomedical application

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INTRODUCTION & AIM

Electrospinning provides a simple and efficient approach for fabricating nanofibrous structures with a high surface area-to-volume ratio, tunable porosity, and morphological similirity to the extracellular matrix (ECM). Such characteristics make electrospun fibers highly attractive for biomedical applications, including wound dressings, drug delivery systems, and tissue engineering.

Sodium alginate (SA), a natural polysaccharide derived from brown seaweed, has gained significant attention due to its biocompatibility, biodegradability, non-toxicity, and ability to promote cell adhesion and proliferation. However, poor electrospinnability, mainly due to high viscosity and polyelectrolyte nature, limits the electrospinning of pure alginate.

To overcome these limitations, SA is often blended with synthetic polymers such as polyethylene oxide (PEO), which provides chain entanglement, improved spinnability, and the ability to form uniform, bead-free nanofibers. Optimization of SA/PEO blends is therefore crucial for obtaining nanofibers with desirable structural and functional properties suitable for biomedical use.

The aim of this study is to optimize the polymer blend composition of SA/PEO nanofibers in order to achieve uniform morphology, suitable for biomedical applications.

METHOD

Solutions of different polymer concentrations and solvent mixtures were prepared.

Figure 1. Electrospinning process

- ***electrospinning technique*** - producing nanofibers
- ***microscopy*** - observation of the morphology of the obtained fibers under an optical microscope
- ***post-processing crosslinking*** - achieving fiber stability in an aqueous environment

RESULTS & DISCUSSION

Among over 40 tested compositions, only the optimized blend resulted in stabile process, and produced continuous, bead-free nanofibers.

Optimized combination:
- polymers - 3% SA and 3% PEO
- solvents - 80:20 water:DMSO
- surfactant - 15-20μl TritonX-100

- PEO enhanced the spinnability of alginate
- TritonX-100 improved spinnability and reduced surface tension

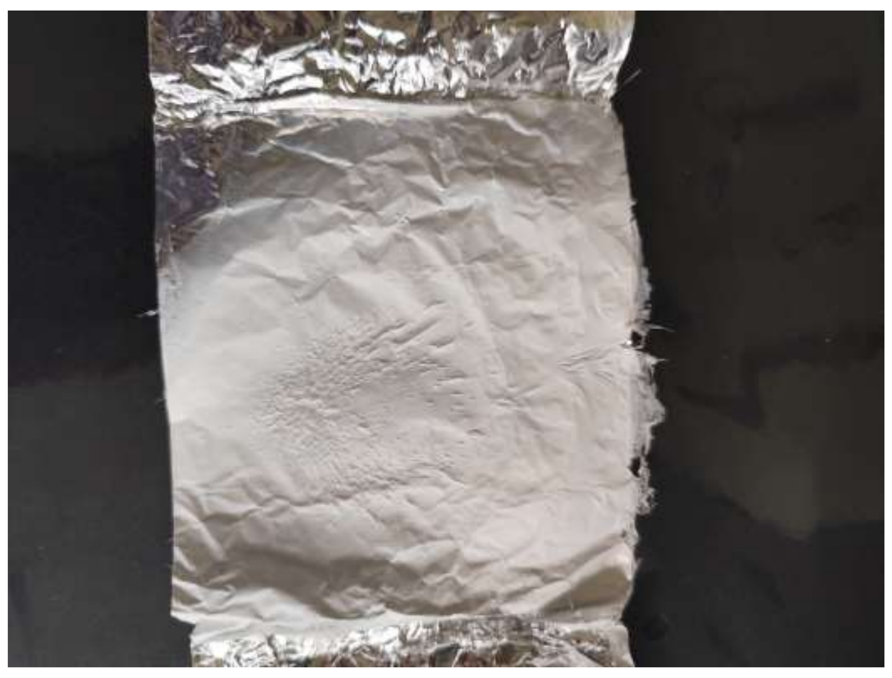

Figure 2. SA/PEO nanofibers

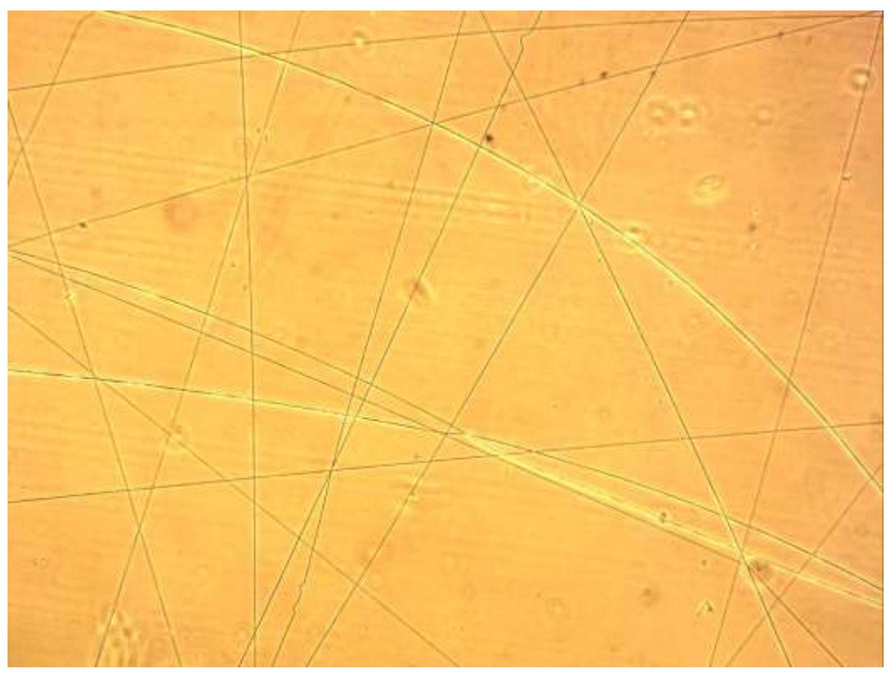

Figure 3. SA/PEO fibers under optical microsope

Observation under the microscope indicated a favorable fiber morphology and nanoscale diameter.

- Crosslinked fibers maintained structural integrity in water, confirming successful stabilization.

CONCLUSION

This study highlights the importance of systematic formulation screening in the development of electrospun alginate-based nanofibers. The optimized composition and processing conditions led to smooth and consistent fibers with potential applications in wound healing, drug delivery, and tissue engineering.

FUTURE WORK

Future research will focus on biological characterization, drug encapsulation studies, and in vitro performance assessment.

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