Electrospun Nanofibers with Natural or Synthetic Compounds

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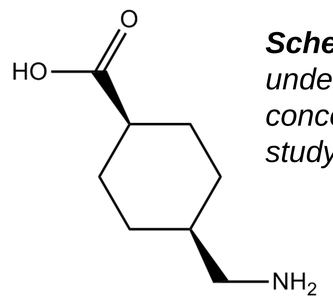
Introduction. Nanofibers containing synthetic substances (1) are well known, but nanofibers containing plant compounds or plant extracts (2) have attracted considerable attention due to their potential to combine the benefits of nanotechnology with the natural bioactivity of plants. Here we discuss two different fibers form: one with tranexamic acid (TXA, scheme 1) and another *Lavandula angustifolia* extract (lavender scheme 2) with polyvinylpyrrolidone (PVP) as a potential drugs in skin wound healing.

Material and Method:

- **Fiber Fabrication**: Electrospinning was employed, forming fine, bead-free fibers on a grounded collector.
- **Characterization** :
  - *Scanning electron microscopy* (SEM) for nanofiber morphology, ensuring uniform structures.
  - *X-ray diffraction* (XRD) and *differential scanning calorimetry* (DSC) for physical form analysis.
- **Drug release study**: Conducted in vitro to assess TXA's release kinetics from the fibers, aiming for rapid therapeutic action suitable for battlefield wound management.
- **Disintegration assay**: evaluating how quickly the fiber mat breaks down in simulated bodily conditions
- **Blood clotting assay**: Determining the acceleration of blood clot formation in response to the TXA-loaded fibers, thereby assessing their potential to control hemorrhage effectively in field conditions.
- **Stability testing**, looking to determine if performance deteriorates during storage for three weeks.



Scheme 1: *The underpinning concept of this study.*

Scheme 2: *lavender herb dry extract*

Results and discussion

Tranexamic acid fibers

TXA is critically important in wound treatment, especially for severe trauma, due to its ability to significantly reduce bleeding and improve survival rates. TXA has become a key component in massive transfusion protocols for treating severe hemorrhage in military combat trauma.

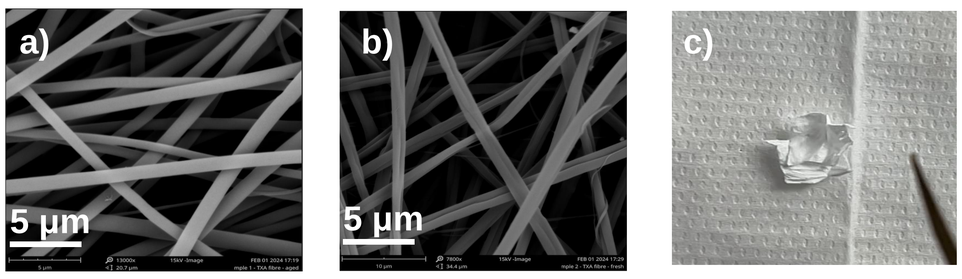


Figure 1. *SEM images of (a) fresh and (b) aged PVP-TXA fibers, with (c) a photographic image of the fibres*

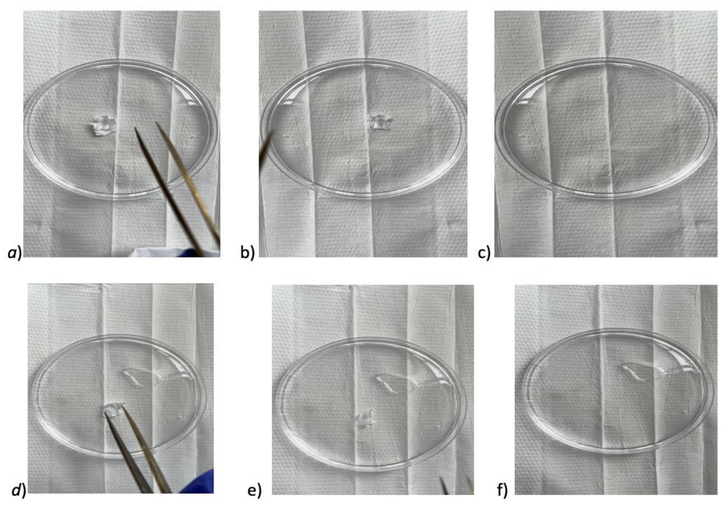


Figure 3*. Digital images depicting the rapid disintegration of the TXA-loaded nanofibers. The aged fibers are shown at a) 0 b) 2.13 c) 4.70 s after addition to phosphate buffered saline (PBS) and the fresh fibers after d) 0 e) 1.82 f) 3.03 s.*

TXA-loaded PVP fibers were successfully prepared. The fresh materials exist as amorphous solid dispersions, while a small amount of TXA crystallisation was noted upon aging. Both the fresh and aged fibers disintegrate and release TXA rapidly and appear able to an accelerate blood clotting

Lavandula angustifolia extract fibers

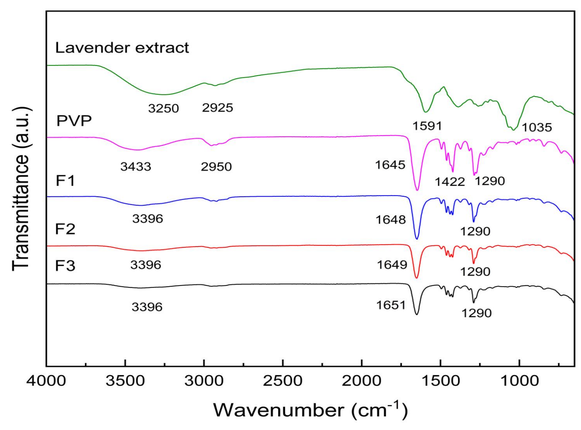
Many medicinal plants have a long history of therapeutic properties in wound healing. Lavender has excellent antimicrobial, anti-inflammatory, and antioxidant activities owing to various bioactive components init composition. Nanofibers help to enhance the therapeutic effectiveness of the extract.

Fabrication

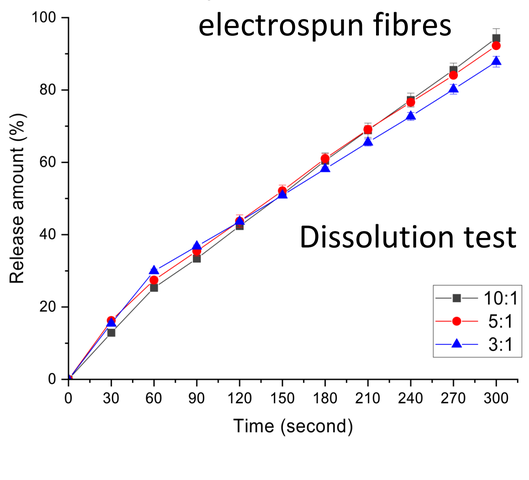
Obtain fibers with three different PVP-to-lavender-extract ratio, 10:1, 5:1 and 3:1

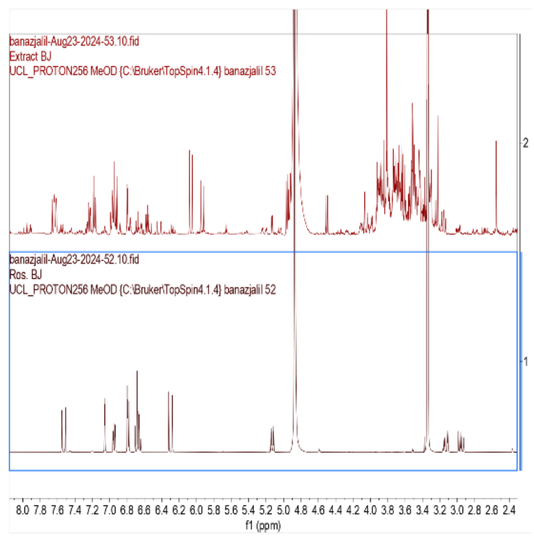
Characterisation

Good morphology
Amorphous dispersion
Great thermal stability
Fast dispersion process



FTIR-ATR spectra of raw materials and electrospun fibres





Comparative 1H NMR spectra of lavender extract and rosmarinic acid

Conclusions. Obtained results demonstrate the potential of electrospun PVP/lavender extract and NXA nanofibers as substrates for skin wound healing. ENs, combining both natural and synthetic compounds, offer numerous advantages across various fields, from medicine to environmental science. The formation of such ENs will pave the way for selecting electrospinning techniques for appropriate designing and fabricating nanofibrous materials with enhanced functional properties for biomedical applications.

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References

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