

DOBOT MG400 Robotic Arm-Assisted Electrospinning: A Novel Hybrid Biofabrication Platform for Precise Manufacturing of PVA-Based Drug Delivery Films Containing Natural Active Compounds

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INTRODUCTION & AIM

- Conventional stationary electrospinning systems lack precise control over nanofibre deposition geometry and collector positioning, limiting film thickness uniformity. Integration of a programmable robotic arm with electrospinning represents a novel biofabrication approach enabling precise X-Y positioning control during fibre deposition. This hybrid system may improve manufacturing reproducibility for pharmaceutical films containing volatile natural compounds such as menthol (*Mentha piperita* L.) and capsaicin (*Capsicum annuum* L.).
- AIM: To develop and evaluate a DOBOT MG400 robotic arm-assisted electrospinning platform for manufacturing PVA-based pharmaceutical films containing volatile natural active compounds, and to assess its superiority over conventional manufacturing methods.

METHOD

- A custom hybrid electrospinning system was built using:
- DOBOT MG400 robotic arm (programmable X-Y positioning)
- Syringe pump LSP02-1B (Longer Precision Pump)
- Gamma High Voltage power supply
- Grounded aluminium collector (85 mm)
- Processing parameters: 15 kV | tip-to-collector 10 cm | flow rate 1 mL/h | duration 1 h
- PVA-based formulations (PVA 10%, glycerol 3%) containing menthol (5% w/w), benzocaine (5% w/w), and capsaicin (0-1% w/w) were electrospun onto PTFE substrates.
- Quality assessment: mechanical CV%, thickness uniformity (USP <731>), rib seal strength, SEM (x1,000 magnification)

RESULTS & DISCUSSION

- SEM confirmed reproducible nanofibrous PVA film architecture across all formulation variants (x1,000 magnification)
- Rib seal strength CV: 7.65% (DOBOT system) vs 26.8% (stationary casting) - 3.5x improvement in reproducibility
- Moisture content: 5.6% - lowest across all three manufacturing methods, attributed to high surface-area-to-volume ratio of nanofibrous matrix
- Programmable X-Y robotic movement eliminated edge-effect variability inherent to stationary electrospinning
- Uniform collector coverage achieved with consistent film thickness across the entire deposition area

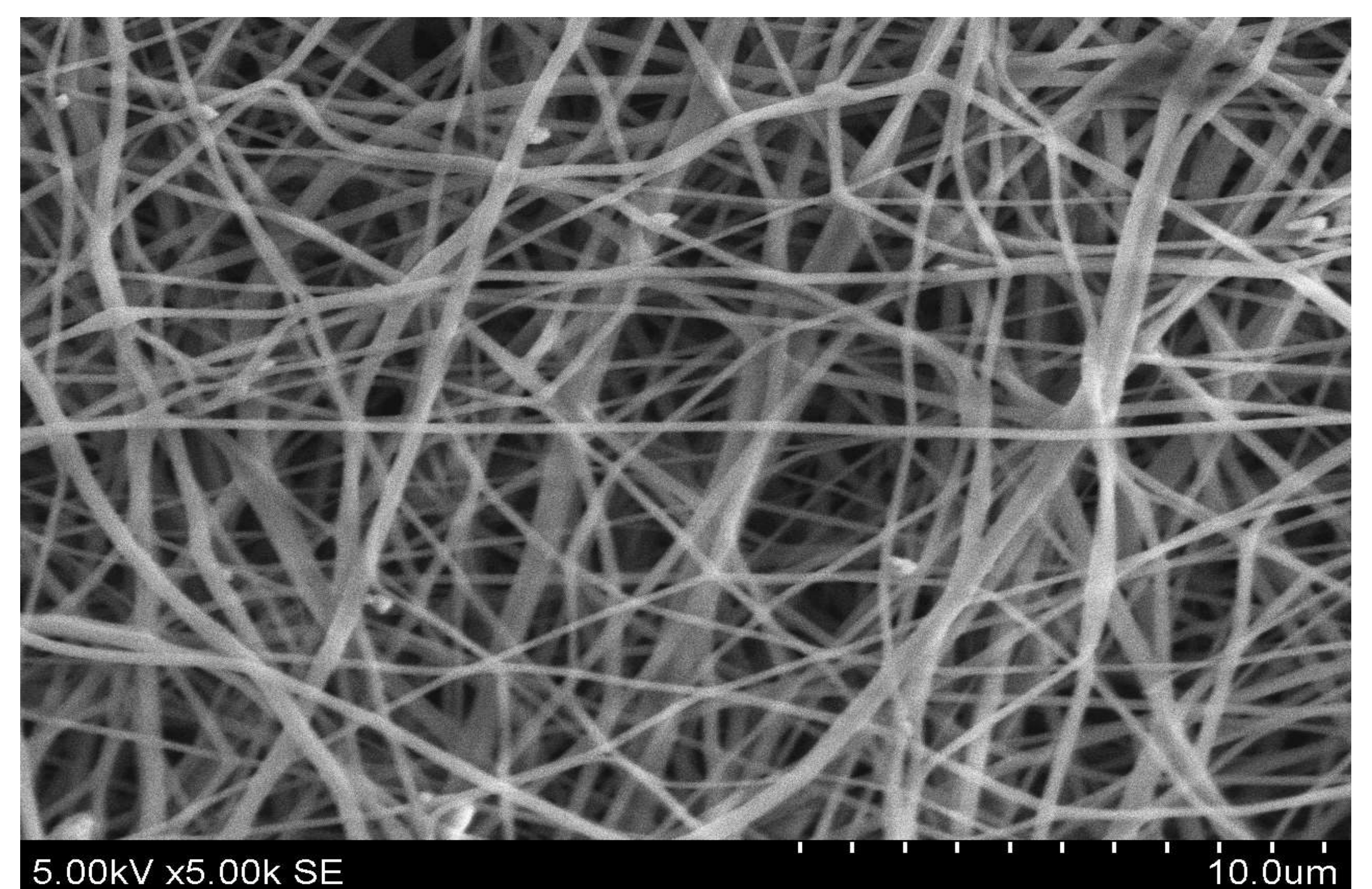


Fig. 1. SEM micrograph of DOBOT MG400 electrospun PVA film (×5,000)

FUTURE WORK/ REFERENCES/ACKNOWLEDGMENT

- DOBOT MG400 robotic arm-electrospinning hybrid is a cost-effective and scalable biofabrication platform
 - Superior moisture control (5.6%) and mechanical reproducibility (CV 7.65%) vs conventional methods
 - Addresses critical limitation of stationary electrospinning through programmable X-Y positioning
 - Promising basis for precision biofabrication of natural compound-based transdermal biomaterials
- References: 1. Bhardwaj N, Kundu SC. Electrospinning: A fascinating fiber fabrication technique. *Biotechnol Adv.* 2010;28(3):325-347. 2. Prausnitz MR, Langer R. Transdermal drug delivery. *Nat Biotechnol.* 2008;26(11):1261-1268. 3. USP <731> Loss on Drying. USP 46. 2023.
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