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AIT Research

Development of electrospun PVA nanofibers via freeze-thawing method

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Introduction

The polyvinyl alcohol (PVA) hydrogels are proven to have the benefits of improving water retention ability, cell attachment and controlled drug release in medical device materials for pharmaceutical applications. Due to these promising potentials, the addition of electrospinning technology to hydrogels is an ideal combination to allow the properties of the materials to be further tailored [1]. In this study, PVA electrospun nanofibers were found to be very hard to handle and fragile without using any chemically or physically crosslinking method. It is believed that the PVA nanofibers underwent simple freeze-thawing process can introduce crystallisation and further increase its mechanical properties [2]. In addition, higher PVA crystallinity can provide a slower drug release rate. Propolis is being selected as the active pharmaceutical ingredient to investigate the wound repair process because it has abundant phenolic compounds, particularly the antioxidant component, flavonoids that can speed up the healing process.

Methods

- Propolis extract is prepared by grounding the raw propolis to a fine powder and dissolved in 70% ethanol at 70 °C using an ultrasonic bath [3].

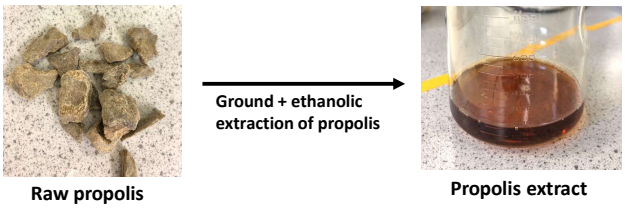

Figure 1: *Ethanolic extraction of propolis*

- The PVA and PVA/propolis nanofibers (i.e. 7:3, 8:2 and 9:1 ratio of PVA and propolis) were prepared using electrospinning technique. The freeze-thawed nanofibers were prepared by freezing the electrospun nanofibers using liquid nitrogen and then th

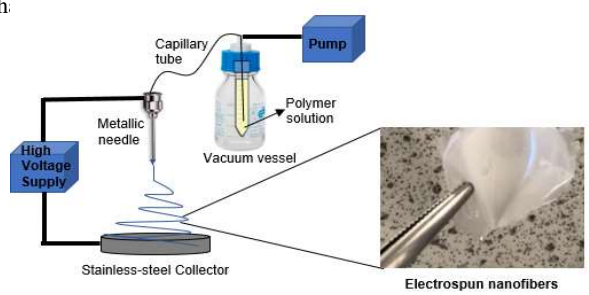

Figure 2: *Schematic diagram of the electrospinning*

Discussion

- The PVA/propolis nanofibers were randomly aligned and the diameter of nanofibers were not uniform. The average diameter of 7:3 PVA/propolis, 8:2 PVA/propolis and 9:1 PVA/propolis is 200-400 nm, 1000-5000 nm and 100-400 nm, respectively.
- The PVA/propolis nanofibers without freeze-thawed have an immediate drug release. Therefore, it is suggested to undergo freeze-thawing cycle for slower drug release.
- The PVA/propolis nanofibers with one freeze-thawing cycle have extended the time for the drug to be fully released. However, additional freeze-thawing cycles needed to have a more stable drug release mechanism.
- Propolis can accelerate the cell growth which is encourage to be used for wound healing.
- Further testing such as DSC, XRD, tensile testing, rheometer etc. will be performed to prove the increase of crystallinity in PVA nanofibers after several freeze-thawing cycles.

Results

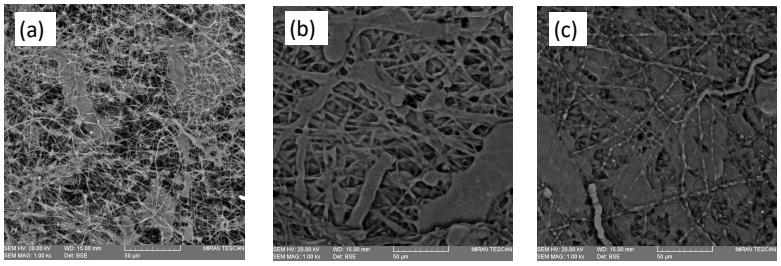

Figure 3: *SEM micrographs of (a) 7:3, (b) 8:2, (c) 9:1 PVA/propolis nanofibers.*

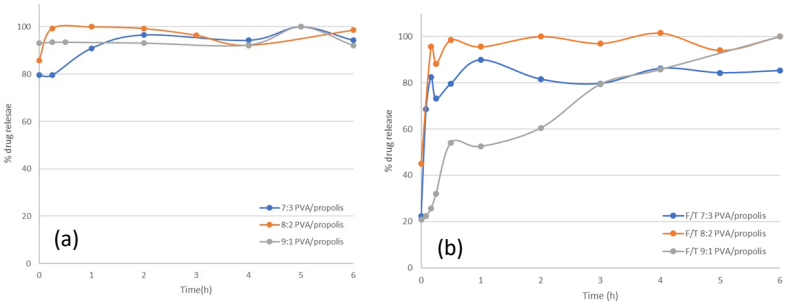

Figure 4: *Drug releasing rate of PVA/propolis nanofibers (a) without freeze-thawed, (b) with freeze-thawed*

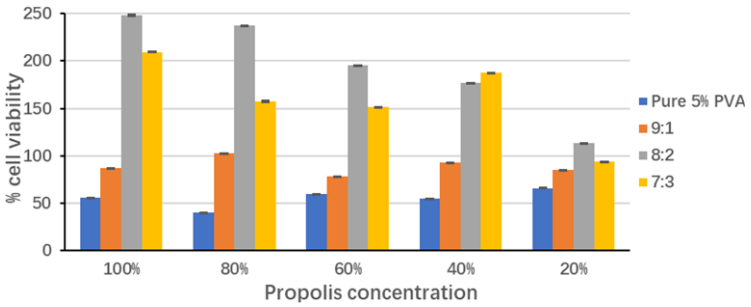

Figure 5: *Cytotoxicity testing for PVA/propolis nanofibers*

Conclusion

The freeze-thawed PVA/propolis nanofibers can provide a stable drug release system with increase mechanical integrity. These nanofibers have the potential to use in sustainable drug delivery and tissue engineering, mainly in wound healing application.

References

1. Chee et al., Electrospun hydrogels composites for bone tissue engineering. Elsevier Inc., 2018.
2. Lee *et al*., RSC Adv., 7: pp. 43994–44000, 2017.
3. De lima *et al*., J of Pharm. Sci., 105(3):pp. 1248-1257, 2016.