Development of *Zingiber cassumunar* oil-Loaded Microneedle for Musculoskeletal Disorder

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Background

Musculoskeletal conditions are injuries or disorders of the muscles, nerves, tendons, joints, and cartilage. Globally, musculoskeletal disorders were found to be the most prevalent disease in 2019. Approximately 1.71 billion people with musculoskeletal disorders have been reported recently [1]. *Zingiber cassumunar* Roxb. (Plai) is a local medicinal herb in Asian countries, it has a strong benefit characteristic. For Thai traditional medicine, volatile oil from *Z. cassumunar* has been used to directly apply and penetrate the skin to remedy muscle stress and joint pain. In addition, this volatile oil has been used for a long time for the treatment of muscle inflammation according to its oil contains (*E*)-1-(3,4-dimethoxyphenyl) butadiene (DMPBD) (Fig 7) as an active ingredient which has been proven as an anti-inflammatory agent [2]. This volatile oil has been developed in various dosage forms such as creams or gels, however, these take a long time for pain relief due to the slow penetration of molecules into the skin as a cause of protective epithelial barrier. Therefore, microneedle patch with micro-scale needles bypasses the stratum corneum, to deliver molecules. Providing painless skin insertion and effective muscle pain relief.

Methods

Figure 1. Preparation of *Zingiber cassumunar* volatile oil

Figure 2. Fabrication of MNs

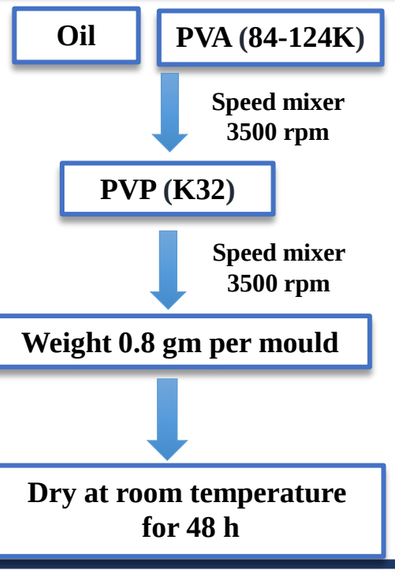
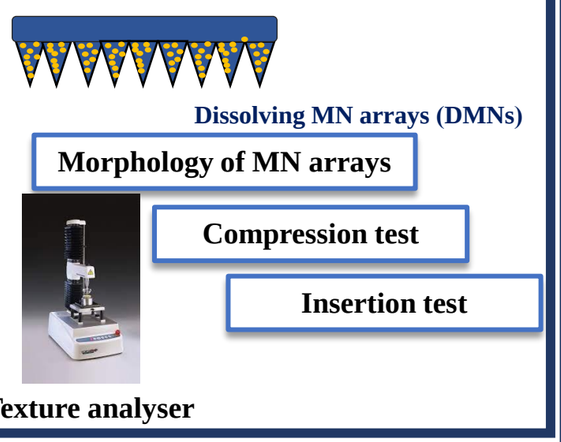


Figure 3. Characterization of MN arrays



Results and discussions

All cone-shaped needles were formed entirely, sharp needles with a strong base plate and elegant appearance (Fig 4). A compression test was conducted to evaluate the mechanical strength that DMNs can withstand before they deform; after a 32-N compression, the average height reduction rates of the formulated displayed the height reduction with a value of 5.31 ± 0.32%. The force of 32 N was applied to assess the effects of insertion on needle height, using Parafilm M® as an artificial membrane to mimic the skin. It was found that volatile oil-loaded bilayer DMNs penetrated to the third layer of Parafilm M® (Fig 5). MN patches possessed the capability to be inserted into neonatal porcine skin, reaching insertion depths of approximately 250–300 µm (Fig 6). In the case of Parafilm M®, it was penetrated down to the third layer (approximately 370 µm. These results are very similar to previous insertion studies of polymeric MN into Parafilm M®.

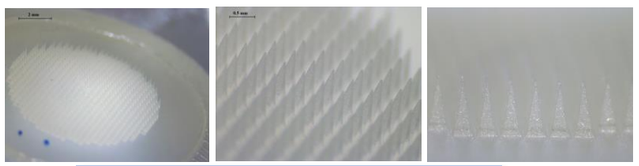


Figure 4. Morphology of MN arrays

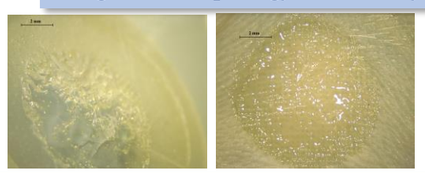


Figure 6. MNs after Insertion test into full thickness porcine skin

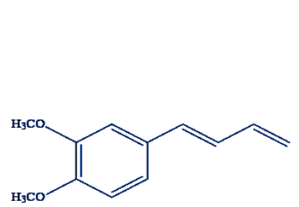


Figure7: Chemical structure of (*E*)-1-(3,4-dimethoxyphenyl) butadiene (DMPBD)

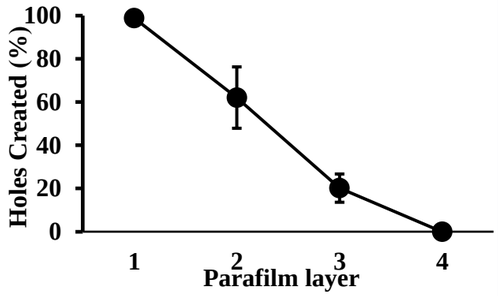


Figure 5. Parafilm.M® insertion test. (Mean± SD) n=3

Conclusion

The successful formulation and mechanical characterization of dissolving MN arrays containing *Z. cassumunar* oil. Future work will focus on *in vitro* permeation of *Z. cassumunar* oil permeation using Franz cells.

[1] Cieza, Alarcos, et al., Global estimates of the need for rehabilitation based on the Global Burden of Disease Study 2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet, 396(10267), 2006-2017. [2] Jeenapongsa, Rattima, et al., Anti-inflammatory activity of (*E*)-1-(3, 4-dimethoxyphenyl) butadiene from *Zingiber cassumunar* Roxb. *Journal of ethnopharmacology*, 2003. 87(2-3): p. 143-148.