NANOCAPSULES-LOADED HYDROGEL FOR ENHANCED WOUND HEALING

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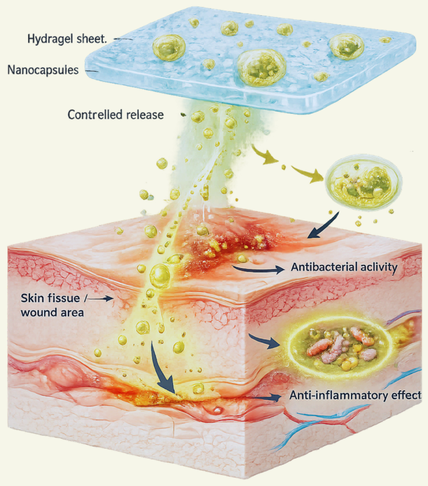
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Abstract

Hydrogels are promising wound dressings due to their high water content, which maintains a moist environment that promotes tissue repair. Incorporating nanoparticles into hydrogels can enhance the stability of bioactive compounds, reduce cytotoxicity, and enable controlled release. This study developed a hydrogel sheet loaded with essential oil nanocapsules containing bioactive compounds such as terpenes and phenolics with antibacterial, anti-inflammatory, and antioxidant properties. Nanocapsules were prepared using an emulsion method with sodium alginate, Tween 20, ultrasonication, and calcium chloride crosslinking. The nanocapsules were characterized by DLS, SEM, TEM, and FTIR. Cytotoxicity was evaluated using BJ-5ta human fibroblast cells to assess the potential of the developed system as an advanced wound dressing.

Introduction

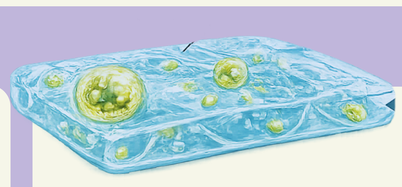


- Essential oil from Zanthoxylum myriacanthum possesses antibacterial, anti-inflammatory, and antioxidant properties but it shows high-toxic to the cell.
- Nanoencapsulation was used to decrease toxic, improve stability, and enable controlled release.
- The nanocapsules were incorporated into a hydrogel matrix for enhancing wound healing.

Objective

- To synthesize and characterize an essential oil–loaded nanoparticles.
- To fabricate nanocapsules-loaded hydrogel sheets for wound healing.
- To evaluate the in vitro cytotoxicity of nanocapsule and hydrogel.

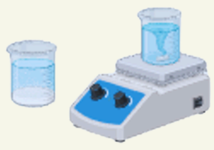
Methodology





Zanthoxylum myriacanthum essential oil

Nanocapsule synthesis



1. Preparation of polymer solution



2. Adding essential oil



3. Sonication



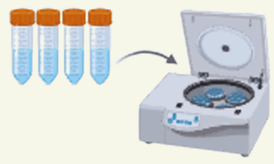
4. Cross linking



7. Freeze drying



6. Nanocapsules collection

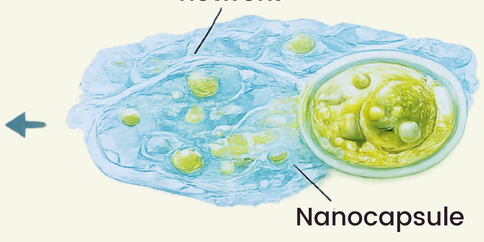


5. Centrifugation

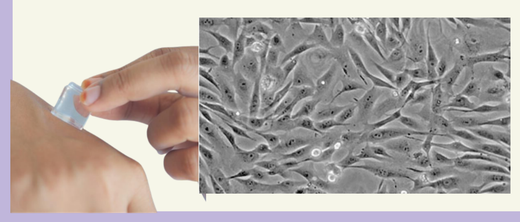
$$\text{Encapsulation efficiency (\%)} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Characterization (OM, DLS, SEM, TEM, FTIR)

Incorporation into hydrogel



Cytotoxicity test(CCK assay) to BJ-5ta (human fibroblast cells)



Results

Morphology

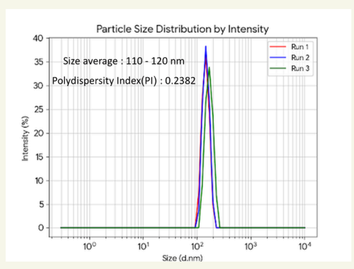


Figure 1: DLS: Particle size distribution (n = 3).

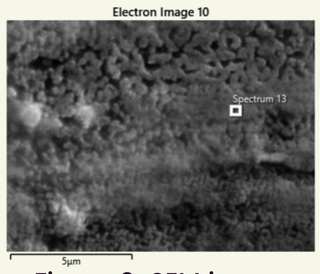


Figure 2: SEM image and EDS analysis.

Element	Signal Type	Line	Wt%	Wt% Sigma	Atomic %
C	EDS	K series	7.72	0.25	32.9
O	EDS	K series	0.93	0.07	2.98
Cl	EDS	K series	0.84	0.05	1.22
Ca	EDS	K series	0.48	0.05	0.61
Cu	EDS	L series	71.32	0.29	57.44
Au	EDS	M series	18.71	0.23	4.86
Total			100		100

Table 1: Elemental composition from EDS.

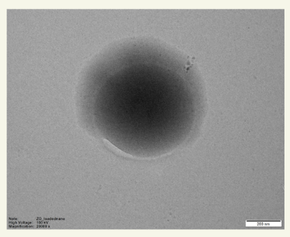


Figure 3: TEM image of nanoparticles(200nm).

Encapsulation efficiency

ครั้งที่	น้ำหนักก่อนฟรีซดราย	น้ำหนักหลังฟรีซดราย	%encapsulationในกาก	%encapsulationในน้ำ
ครั้งที่ 1	6.6056	0.8289	87.45%	12.55%
ครั้งที่ 2	5.6885	1.4207	75.02%	24.98%
ครั้งที่ 3	2.4361	1.4632	60.06%	39.94%

Table 3: Encapsulation efficiency of nanoparticles.

Chemical structure

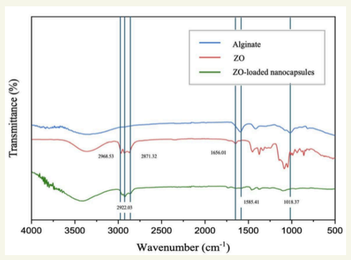


Figure 4: FTIR spectra of nanoparticles.

เลขคลื่น (Wavenumber, cm−1)	ลักษณะพีค (Peak Shape)	พันธะที่พบ (Bond Assignment)	หมู่ฟังก์ชัน (Functional Group)
3300 – 3500	พีคกว้าง (Broad)	O-H Stretching	Hydroxyl group (จากน้ำ)
2850 – 2930	พีคแหลมชัด (Sharp)	C-H Stretching	Aliphatic Hydrocarbons (จากน้ำมันหอมระเหย)
1630 – 1650	พีคแหลม (Sharp)	C=O / C=C Stretching	Carbonyl/Double bond (จากAlginate)

Table 2: Functional group and Wavenumber of alginate, ZO_oil and nano.

Biocompatibility test by CCK assay

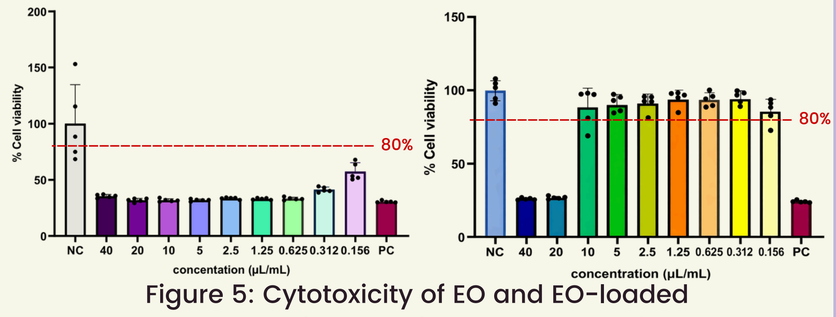


Figure 5: Cytotoxicity of EO and EO-loaded nanoparticles against to BJ-5ta cell.

Conclusion

Essential oil–loaded nanoparticles were successfully synthesized using the emulsion (oil in water) method.The chemical functional groups of the essential oil–loaded nanoparticles were confirmed by FTIR analysis.Cytotoxicity results demonstrated that the nanoparticles showed good biocompatibility.

Acknowledge

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