

Modification of polyvinyl alcohol-based electrospun mats with naturally-derived halochromic molecules for potential applications in wound healing monitoring

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Introduction

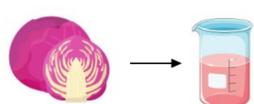
Chronic wounds (CW) are unable to follow the normal healing steps, stalling at a self-perpetuating inflammatory stage [1]. These type of wounds are highly prevalent worldwide, affecting 1-2% of the world population, including 1.5-2 million people across Europe (with a growing incidence) imposing a huge burden on healthcare systems [2].

Currently, the treatments used (conventional dressings) do not provide the necessary response, and new wound management approaches and innovations in dressings are needed, specially when it comes to antifungal profiles, a class of microorganisms that is often neglected in chronic wound healing.

The main goal focuses on the development of PVA electrospun mats, modified with halochromic molecules (anthocyanins) and natural extracts with antifungal properties. This bioactive dressing can assist with the monitoring of the healing progression through pH-sensitivity, without requiring frequent dressing removal, thus preventing the destruction of newly formed tissue.

Extraction of halochromic molecules

Solid-Liquid extraction



300 g of red cabbage in 500 mL of ethanol/H₂O (80:20)
24h under stirring at RT, protected from light

Filtration and lyophilization

Automatized extraction

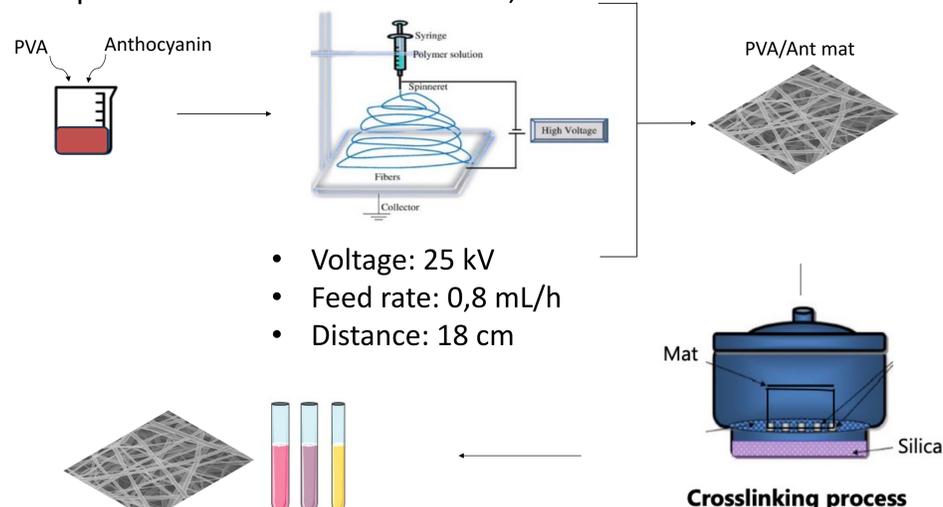
Prior to the extraction process, red cabbage was dried for 24 hours in an oven at 37°C to evaporate the maximum amount of water. 40 g of dry red cabbage was ground and 100 mL of dH₂O/ethanol (50:50) was added. Three 30-minute extraction cycles were carried out using a programme pre-set by the equipment. At the end, the solution was filtered and freeze-dried.

Table 1 – Quantification, expressed as mg/kg of the detected polyphenols and anthocyanidins in the red cabbage extract by LC-MS.

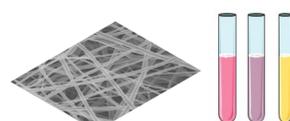
| Compounds | Red cabbage |
|---------------------------|-------------|
| 3-4-dihydroxybenzoic acid | 9 ± 3 |
| p-coumaric acid | 162 ± 2 |
| Kaempferol-O-glucoside | 5 ± 1 |
| Cyanidin | 19699 ± 384 |

Production of PVA/Ant mats

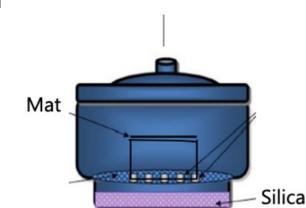
PVA (88% hydrolyzed and Mw 78,000) was purchased from Polysciences, Warrington, USA. For the extractions of anthocyanin, natural products were purchased on the local market, Guimarães.



- Voltage: 25 kV
- Feed rate: 0,8 mL/h
- Distance: 18 cm



PVA/Ant mats with halochromic behaviour in contact with different pH solutions (4-10)



Crosslinking process

- Temperature: 60°C
- Exposure time: 7h
- Amount of crosslinker: 6 mL
- Concentration: 2,56 M

Characterization

Comparison by FTIR analysis of the composition of the PVA mat without functionalization and with functionalization showed no major differences. However, visual tests show that there is a colour gradient at different pH levels (4-10).

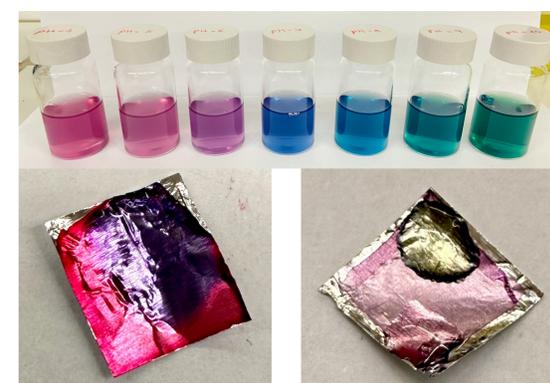
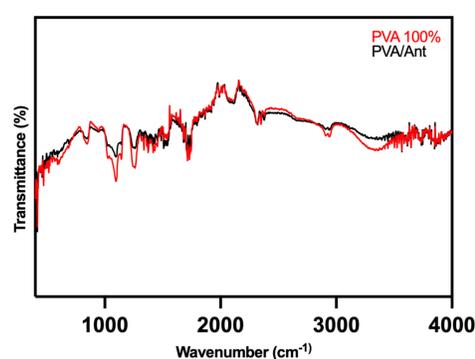


Table 2 – MIC results expressed in mg/mL of the natural extracts: cinnamaldehyde, geraniol and citral against *Candida spp.*

| | MIC | | |
|----------------|--------------------|------------------------|----------------------|
| | <i>C. albicans</i> | <i>C. parapsilosis</i> | <i>C. tropicalis</i> |
| Cinnamaldehyde | 0,04 | 0,64 | 0,04 |
| Geraniol | 10,24 | 10,24 | 5,12 |
| Citral | 10,24 | 10,24 | 10,24 |

Conclusions

Immobilization of anthocyanins via blending prior to electrospinning was the most impactful option, evidencing immediate and lasting effects of the halochromic properties, which mapped the antifungal extracts activity against the *Candida spp.*

References

- [1] Felgueiras H.P. et al., Appl. Polym., 137, 2020
- [2] Ongarora BG. Recent technological advances in the management of chronic wounds: A literature review. Health Sci Rep. 2022;5(3):e641

