

Formulation of Hydrogel Patch Incorporated with Medicinal Plant and Evaluation of Their Antibacterial Activity

Nor Zulaikha Farhana Mohd Zaid^a, Mohd Taufiq Mat Jalil^{a*}

Structured Abstract

Background: Hydrogel patches are frequently used for wound care because of their ability to retain moisture and provide comfort. However, many commercial hydrogels are ineffective at preventing infections from pathogens like MRSA, *Staphylococcus aureus*, *Streptococcus pyogenes* and *Pseudomonas aeruginosa* because they lack crucial antibacterial properties. The arise of antibiotic resistance underscores the necessity for new antimicrobial techniques. Natural substances derived from plants such as *Melastoma malabathricum* L. (senduduk), *Azadirachta indica* (neem), and *Aloe vera* have been shown to have antibacterial, anti-inflammatory, and wound-healing characteristics. By exhibiting synergistic activity, incorporating these extracts into hydrogels may improve their therapeutic impact while providing a biodegradable, biocompatible, and environmentally friendly wound care solution. This study investigates the formulation of a hydrogel patch infused with medicinal plant and evaluates its efficacy in combating bacteria.

Methods: The study used ethanol-based maceration to extract bioactive components from the leaves of *Melastoma malabathricum* L. and *Azadirachta indica*. A rotary evaporator was used to concentrate the extracts, and their antimicrobial properties were studied. The agar well diffusion method was used to assess antibacterial activity, and broth microdilution experiments were used to estimate the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC). FICI calculations and checkerboard experiments were used to evaluate the synergistic interactions amongst plant extracts. The plant extracts were mixed with sodium alginate, glycerol, and propylene glycol to create a hydrogel patch. The hydrogel patch's antimicrobial activity against MRSA, *Pseudomonas aeruginosa*, *Streptococcus pyogenes*, and *Staphylococcus aureus* was evaluated using a disc diffusion assay.

Results: The preparation of ethanol extracts from *Melastoma malabathricum* L., and *Azadirachta indica* produced 6.51 g and 12.36 g, respectively. Utilizing MBC, MIC, and agar well diffusion assays, antibacterial activity was evaluated. Most effective against *P. aeruginosa* (15.0 mm), with MIC values as low as 1.56 mg/mL, was *A. indica*, whereas *M. malabathricum* L. showed substantial suppression against *S. aureus* (27.0 mm). The checkerboard assay showed that combining extracts had additive effects (FICI = 1.0). These extracts produced a hydrogel patch demonstrating strong antibacterial activity against *S. pyogenes*, with inhibition zones up to 26.3 ± 3.21 mm. The outcomes highlight the potential of hydrogel patches made from plants as all-natural, biodegradable wound treatments with significant antibacterial qualities.

*Correspondence: taufiqjalil@uitm.edu.my.

^a School of Biology, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia

Conclusion: This study proved the development of a hydrogel patch that contained extracts of *Melastoma malabathricum* L., *Azadirachta indica*, and *Aloe vera*, all of which showed potent antibacterial activity. *A. indica* was more efficient against Gram-negative than *M. malabathricum* L., which demonstrated substantial suppression against Gram-positive bacteria among the studied extracts. Incorporating the extracts into a hydrogel matrix demonstrated increased efficacy and additive antibacterial properties. Broad-spectrum action shown by the finished hydrogel patch points to its potential as a natural, biodegradable, and reasonably priced substitute for synthetic wound dressings. These results encourage more research into plant-based hydrogels for wound care and infection prevention.

Keywords: *Azadirachta indica*, *Melastoma malabathricum* L., *Aloe vera*, antibacterial, hydrogel patch, multidrug resistance, wound healing.

*Correspondence: taufiqjalil@uitm.edu.my.

^a School of Biology, Faculty of Applied Sciences, Universiti Teknologi MARA, Shah Alam, Malaysia