



Review article

FOOD-WASTE-DERIVED BIOACTIVE, GREEN EXTRACTION TECHNOLOGIES AND GEL-BASED WOUND HEALING FORMULATIONS: A PRISMA-GUIDED SYSTEMATIC REVIEW

Nurhaslina Che Radzi ^{1,2✉}, Halisa Syamimi Binti Haslim¹, Ainul Nelisa Hani Binti Mohamad Alias¹, and Naziratul Abqariyah Binti Ramli¹

¹Faculty of Chemical Engineering, Universiti Teknologi MARA, 40450
Shah Alam, Selangor, Malaysia

²Integrated Separation Technology Research Group (i-STRonG), Universiti Teknologi MARA, Selangor,
Malaysia

Corresponding author: Nurhaslina Che Radzi E-mail: nurhaslina483@uitm.edu.my ; Mobile: +60194776051
ORCID: 0000-0002-8969-5608

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ABSTRACT

The valorisation of food-waste-derived bioactive materials offers a potential route for developing wound-care products while supporting more sustainable resource utilisation. This PRISMA-guided systematic review synthesised 33 Q1/Q2 original research articles published between 2019 and 2024 that investigated natural waste- and related plant-derived bioactive sources relevant to extraction technologies, formulation strategies, and wound-healing applications. Maceration was reported in nine studies, followed by ultrasound-assisted extraction in eight, Soxhlet extraction in five, microwave-assisted extraction in four, pressurised or accelerated solvent extraction in two, and supercritical fluid extraction in one. These categories were not mutually exclusive because some studies employed multiple extraction techniques. Nineteen studies were classified as *in vitro*, seven as *in vivo*, and seven had insufficiently reported experimental designs and were therefore classified as unclear. Wound-healing or regenerative outcomes were reported in 23 studies, anti-inflammatory activity in 21, and antimicrobial and antioxidant activities in 20 studies each. Extracts and natural bioactive materials were incorporated into gels, hydrogels, films, nanofibrous dressings, and related delivery systems. However, direct comparisons were limited by substantial heterogeneity in feedstock characteristics, extraction conditions, analytical procedures, formulation composition, bioactive concentration, experimental models, and outcome measures. Evidence concerning stability, safety, scale-up, environmental performance, and clinical effectiveness was also limited. Overall, the findings demonstrate preclinical therapeutic potential but do not establish the superiority or clinical effectiveness of the reviewed extraction technologies and formulations. Standardised extraction and chemical-characterisation procedures, complete formulation testing, stability and safety evaluation, and well-designed clinical investigations are required before reliable translation into wound-care applications.