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Impact of phytochemical-based hydrocolloid dressings on wound healing: A comparative review

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Background: Wound healing is an important occurrence consisting of a myriad biochemical processes. The recent introduction of phytochemical-based dressings to expedite wound healing uses a multi-targeted approach including antimicrobial, anti-inflammatory and antioxidant activity.

Aim: The review aimed to conduct an exhaustive search of the existing literature on plant-based hydrocolloid dressings for wound healing and to evaluate the dressing efficacy in comparison to standard dressings.

Setting: The review offers a worldwide overview of plant-based hydrocolloid dressings and their use.

Methods: A systematic search using keywords was done to identify clinical and randomised control trials from 2019 to 2024. The following databases were queried: Cochrane Library, Embase, PubMed, Scopus, Science Direct and Web of Science. Data appraisal was done by an analysis of the data quality by the authors.

Results: Of a total of 866 records identified, 4 qualified for further assessment. The data retrieved showed that the use of phytochemical-based hydrocolloids is more effective compared to non-plant-based hydrocolloids.

Conclusion: The data analysis revealed that there are few research studies on plant-based hydrocolloids, and there is a need for further research in the area. In addition, the dressings significantly expedite wound healing offering a multifaceted approach because of the different mechanisms of action including antioxidant, anti-inflammatory and cell proliferation.

Contribution: This study highlights the need for further studies on hydrocolloids produced from plant extracts for effective wound healing.

Keywords: hydrocolloid; phytochemical; wound; wound healing; antioxidant; anti-inflammatory; cell proliferation.

Introduction

Wounds are damage to the skin which result in exposure of the epidermis, dermis and in some cases they can go deeper to the hypodermis. The progressive tendency of wounds to become chronic aggravates the condition and adds to the burden of finding the right treatment. Chronic wounds of mixed aetiologies have been reported to have a pooled prevalence of 2.21 per 1000 population (Martinengo et al. 2019). In 2009, the global burden of wounds was high, accounting for an estimated 40–50 million surgical wounds, 8–10 million leg ulcers, 7–8 million pressure ulcers and 7–10 million burns, worldwide (eds. Percival & Cutting 2009). To date, chronic wounds are reported to affect 40 million patients globally, significantly reducing the workforce (Le et al. 2023). In sub-Saharan Africa, over one million burn wound injuries are recorded annually thereby increasing the global burden of wounds (Collier et al. 2021). These statistics highlight the significant impact of wounds on public health and the need for effective wound care strategies.

Several dressings and solutions to address the burden of wounds have been developed. An ideal wound dressing should absorb excessive exudates, regulate moisture, have mechanical stability, allow gaseous transmission, minimise infections, be non-toxic, biocompatible, biodegradable and lastly painless, thus allowing effective skin regeneration (Le et al. 2023; Vivcharenko & Przekora 2021). The challenge is that different wounds require different healing conditions; hence, they need a dressing that allows for optimal healing of a specific type of wound (Le et al. 2023). Ongoing research is under way to develop dressings which are optimally effective, economically affordable and confer all the required therapeutic advantage for expedited would healing, resulting in skin regeneration.

Technological advances have allowed a paradigm shift from using inert conventional cotton bandages to modern wound dressings such as hydrocolloid, alginate, foam and hydrogel dressings (Cretu et al. 2023). A further advance is the use of biologic dressings which allows both the closure of the wound and the effective treatment of the injury and wound through interaction with active compounds in the dressing. Previous studies have reported on the formulation and characterisation of bioactive hydrogels, scaffolds and foams for dressings (Abdelazim et al. 2024; Cretu et al. 2023; De Brito et al. 2022; Wang et al. 2021; Zamora-Mendoza et al. 2023). In this study, we address the effectiveness of plant bioactive hydrocolloid dressings in conferring wound healing.

Hydrocolloid dressings have been used as an alternative dressing for wound healing (Kaminska et al. 2020). The polymeric dressing is biodegradable and requires fewer changes compared to other types of dressings (Luu et al. 2024). The outer layer of hydrocolloid dressings encloses bacteria and contaminants, reducing the risk of infection. Additionally, the inner layer of the dressing has a gel-like matrix which absorbs exudate and adheres to the wound creating a moist environment that promotes the healing process. Previous studies have indicated that hydrocolloid dressings can benefit chronic wounds and may also improve scar appearance and overall comfort during the healing process (Jurić Vukelić & Jurić 2017).

Hybrid hydrocolloids such as nanocomposite, alginate-chitosan and cellulose-chitosan have been reported; which have two or more biomaterials added to enhance the action of the resultant dressing (Collins et al. 2021; Nosrati et al. 2023). The addition of plant bioactive material is one such modification which produces drug-loaded hydrocolloid dressings with better efficacy. Plant medicine has proved to be a source of therapeutics with approximately over 25% of prescription pharmaceuticals containing plant-derived ingredients (Miller 2001). Plant-based hydrocolloids in particular, present a promising cost-effective regenerative treatment option in the field of wounds. As the literature on phytochemical-fabricated hydrocolloid films shows enhanced wound healing activity on both cellular and animal models (Ajiteru et al. 2022; Kim et al. 2022; Le et al. 2023), the core focus of this review is on plant bioactive hydrocolloid dressings.

Although the design and use of hydrocolloid dressings has increased recently, there is no review about the effectiveness of plant-loaded hydrocolloid dressings on wounds. This study aims to collate and analyse the available evidence on the efficacy of plant-based hydrocolloids compared to non-plant-based hydrocolloids.

Methods

Search criteria

Databases queried for original research articles of randomised control trials and clinical trials include the Cochrane Library, Embase, Scopus, ScienceDirect, PubMed and Web of Science. The search was performed for 'all fields' for the Web of Science and PubMed, with PubMed including the Medical Subject Headings terms (MeSH-terms). For the ScienceDirect, Embase database and Cochrane Library registry, the search was applied using the title, abstract or keyword. The filters used for all searches were a 5-year period, clinical trial, randomised control trial and English language. The search strategy employed a broad range of keywords to capture the multifaceted nature of the research, which included:

- 'Wounds' OR 'Injuries' OR 'Skin regeneration'
- 'Plant' OR 'Plant extract' OR 'Phytochemical' OR 'Plant bioactive compound'
- 'Dressing' OR 'Bandage'

Inclusion criteria

We identified and included original research studies about randomised controlled trials and clinical trials which investigate plant-formulated hydrocolloid dressings on wounds. Studies which include all types of wounds were relevant. The primary outcome of interest was *in vivo*, *in vitro* and clinical trials.

Exclusion criteria

Studies on interventions produced by non-plant–based hydrocolloid dressings or studies that compared any interventions other than polymeric dressing were excluded. In addition, studies on formulation and characterisation of plant-based hydrocolloids lacking the wound healing assessment were excluded from the records.

Study selection and appraisal

Two reviewers (SS and RM) independently screened the article titles and abstracts, followed by a full-text review to confirm the study's relevance and quality.

Data extraction and analysis

The reviewers extracted data from the included studies, following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al. 2021). The main aim of this study was to assess records reporting on the use of plant bioactive compounds as the active therapeutic in hydrocolloid dressings for all wound types. To assess this, the wound type, test method and test subject were used to compare their effectiveness. In addition, the wound contraction area and the histological evaluations were considered for wound healing assessment.

Methodological limitations

One article did not have the keywords used to search for articles. Instead of using the term phytochemical or plant extract, the article made reference to the plant name myrrh (Ajiteru et al. 2022).

Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects

Results

A total of 866 records were identified from the database. After the removal of duplicates, review articles and case studies, 615 articles remained for screening. The screening and selection process was performed by checking the articles' titles and abstracts. This resulted in 610 records being excluded during the screening stage, and only 5 articles left for further analysis. The reasons for exclusion were mainly the use of alternative wound dressing, the use of a different wound healing assessment tool, or no assessment. Ultimately, 4 records qualified for the review report. Figure 1 describes the identification and study selection process and Table 1 summarises the characteristics of the analysed data.

Discussion

The data collected show that research on hydrocolloids loaded with phytochemicals is in its infancy and much work still needs to be done. However, despite the low number of articles analysed in this study, these papers could provide insights on the wound type, formulation, characterisation and mechanism of action of the plant-based hydrocolloids as discussed in the following sections.

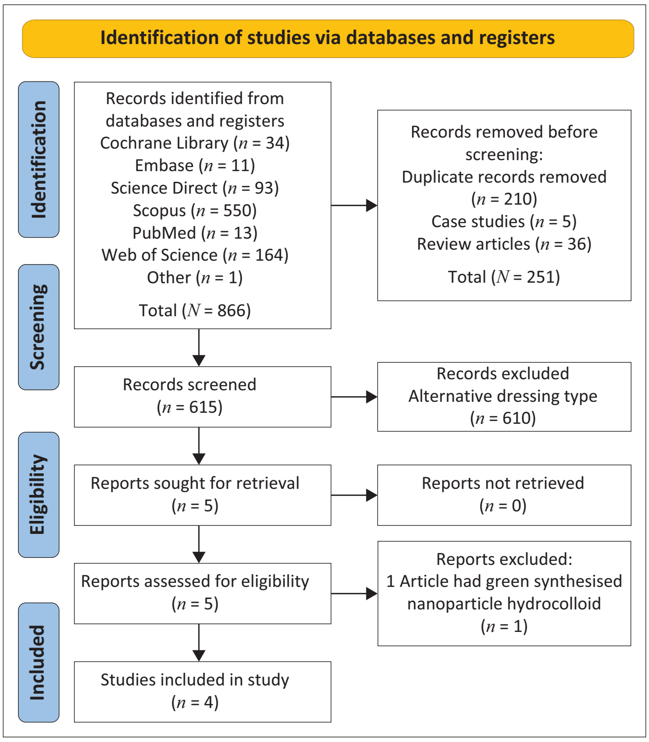
Characteristics of the test subject and wound type as a factor of wound healing

Wound formation is because of the loss of integrity of the skin tissue. The natural progression of wound healing starts with inflammation, followed by cell proliferation and/or migration, and lastly remodelling (Tan et al. 2020). Disruption of the normal stages of the healing process results in impaired healing and can promote the occurrence of chronic wounds. Wound healing is a complex process which is also affected by external factors such as wound depth, patient age, immune system and other comorbidities.

In this study, the four selected articles utilised male adult Sprague Dawley rats for the *in vivo* wound healing analysis. Three of the articles used rats aged 6–8 weeks (Ajiteru et al. 2022; Chin et al. 2019; Tan et al. 2019) and one article used 12-week-old rats (Sabando et al. 2020). The mass of the rats ranged between 150 g and 270 g for the four studies. Although the weight of individual rats does not significantly affect wound healing (Soybir et al. 2012; Yeng et al. 2019), age does, with smaller rats healing faster than adult rats (Jalilimanesh et al. 2021). The study conducted by Sabando et al. (2020) made use of 12-week-old rats which may thus have negatively influenced the healing potential of the rats compared to the other three studies. To counteract this potential bias, Sabando et al. documented a clinical trial of a 76-year-old, 62 kg female suffering from a pressure ulcer which healed after 21 days of treatment application. Although a sample of one cannot be considered as significant, the trial presents evidence of the healing effect of the plant-based hydrocolloid.

The type of the wound also affects the healing potential of a wound. Two of the reviewed articles in this study focussed on diabetic wounds (Chin et al. 2019; Tan et al. 2019). Diabetes mellitus is a condition which leads to impaired healing because of hyperglycaemic conditions within cells. Hyperglycaemic conditions are reported to reduce the number and function of endothelial progenitor cells (EPCs) (Wan et al. 2022). In addition, hyperglycaemia affects the body by reducing oxygenation and perfusion within the cells leading to osmotic diuresis (Terranova 1991). As a result, normal tissue function is disrupted leading to diabetic neuropathy complications and subsequently ulcers and pressure wounds (Chin et al. 2019). Streptozotocin (STZ) was used to induce diabetes in two studies, with Chin et al. (2019) feeding the rats on a High Fat Diet (HFD) to maintain a Diabetes Type 2 model (Chin et al. 2019; Tan et al. 2019). The animals blood glucose levels of > 11 mmol/L and > 16.7 mmol/L were considered as diabetic in the studies. A higher blood glucose level suggested a higher risk of tissue impairment with the risk of diabetic patients developing foot ulcers in a lifetime reported to be 15% (Tan et al. 2019).

Diabetic wounds, similar to burn wounds, can result in unhealed gangrenous and necrotic tissue which are highly susceptible to microbial infection (Chin et al. 2019; Rose & Chan 2016; Tan et al. 2019). Coupled with antimicrobial resistance, healing of such wounds is further impaired. Deep skin lesions and open wounds reported by Sabando et al. (2020) and Ajiteru et al. (2022) also present similar significant healing problems; however, when compared, diabetic wounds stand out as a more robust problem. While hydrocolloid dressings are not significantly more effective than alternative dressings in treating pressure ulcers in adult



Source: Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D. et al., 2021, 'The PRISMA 2020 statement: An updated guideline for reporting systematic reviews', *British Medical Journal* 372, n71. https://doi.org/10.1136/bmj.n71

FIGURE 1: PRISMA flow diagram.

TABLE 1: Characteristics of the study.

Publication	Ajiteru et al. (2022)	Chin, Ng and Ng (2019)	Tan et al. (2019)	Sabando et al. (2020)
Test method	*In vivo*	*In vivo*	*In vivo*	*In vivo* and clinical trial
Type of wound	Open wound and excision wounds approximately 150 mm^2 full thickness	Diabetic wound, excision wound (full thickness) and abrasion wound (partial thickness)	Diabetic wound and full thickness open excision wound	Deep skin lesion
Subject	Adult male Sprague Dawley Rats	Adult male Sprague Dawley rats	Adult male Sprague Dawley rats	• Adult male Sprague Dawley rats • 76 year-old woman
Polymer	Carboxymethyl cellulose Sodium salt and polyurethane	Sodium Alginate-pectin	Sodium Alginate	• Pectin-Starch • Preparation of polyethylene glycol diglycidyl ether (PEDGE)
Plant/bioactive compound	*Commiphora myrrha*	*Moringa oleifera*	Vicenin-2 (bioactive compound from plants)	*Gunnera tinctoria* and *Ugni molinae*
Characterisation of fabricated hydrocolloid	• SEM • Integrity value • Absorptive capacity and swelling ratio • Tensile strength • Adhesion Testing	• Sterility assay • Drug release • Rheology studies • Mechanical properties • Moisture absorption • Moisture vapour transmission rate • Swelling studies (Chin et al. 2018)	• Mechanical strength • Rheology, expansion rate • Moisture vapour transmission rate (MVTR) and drug release profile (Tan, et al. 2020)	• SEM • FTIR • Thermogravimetric analysis • Tensile Mechanics properties • Release profiling
Control	• Negative control – Gauze • Positive control – commercial hydrocolloid	• Negative control – Cotton gauze • Positive control – Commercial alginate dressing (Kaltostat)	• Negative control – blank hydrocolloid film • Positive control –Allantoin film	Positive control – 3M Tegaderm
Biological assay	• Cell viability tests • Residual wound area analysis	• Blood biochemical analysis-Relative wound healing rate-Dermal hydroxyproline content-Rat collagen type 1 ELISA • Rat insulin ELISA • Magnetic bead-based ELISA	• Wound contraction • Nitrous oxide production • Cytokines and Growth factors (ELISA) • Detection of mediators (ELISA)	• Dermal anti-inflammatory assay • *In vivo* animal assay (4 days)
Result	• Wound contraction • Histology evaluations	• Wound contraction • Histology evaluations	• Wound contraction • Histological Evaluations	• Wound contraction • Histological Evaluations

Note: Please see the full reference list of the article, Sibanda, S., Razwinani, M. & Motaung K.S., 2025, 'Impact of phytochemical-based hydrocolloid dressings on wound healing: A comparative review', *Journal of Medicinal Plants for Economic Development* 9(1), a267. https://doi.org/10.4102/jomped.v9i1.267, for more information.
SEM, scanning electron microscope; FTIR, Fourier transform infrared spectroscopy

patients, the presence of plant active compounds in these studies changed the trajectory (Kaminska et al. 2020). The results obtained in the referred studies showed that the antimicrobial and anti-inflammatory activity of plant bioactive formulated products offer a pro-healing advantage compared to non-plant–based products for diabetic and ulcer wounds.

Plant hydrocolloid formulation and its mechanism of action

The reviewed articles showed plants and plant materials having wound healing and tissue regenerative properties. These plants were characterised as rich in phenolic and polyphenolic compounds which are attributed for the wound healing functions. Of particular note are the following compounds which were common to two or more of the studies: catechin, rutin, quercetin, garlic acid, kaempferol and vicenin 2 (Ajiteru et al. 2022; Chin et al. 2019; Tan et al. 2019). These compounds fall under the phytochemical class of flavonoids, with a few alkaloids and terpenes known for wound healing.

Flavonoids have been reported to promote wound healing by up-regulating the basic fibroblast growth factor in wound granulation tissue, increasing the expressions of collagen type 3 and also the vascular endothelial growth factor (Subramanian et al. 2023). Consequently, an upregulation of growth factors and collagen deposition is evident in the study by Tan et al. (2020). In another study, the presence of alkaloids enhanced wound healing by stimulating cellular proliferation, collagen deposition and angiogenesis through the SRC/MEK/ERK signalling pathway (Shi et al. 2022). Ultimately, the phytochemicals accelerate wound contraction, epithelialisation, increase tensile strength, improve re-epithelialisation, collagen formation and vascularisation of damaged skin samples. This literature-based evidence thus further reinforces the action of the plant bioactive compounds-loaded hydrocolloid and explains its significance in treating wounds. However, the action and properties of the biopolymers used for the formulation add to the efficacy of the wound dressing.

Different biopolymers have been conjugated with plant bioactive compounds including chitosan scaffolds, sprayable films, injectable hydrogels and normal base hydrogels (Cakmak et al. 2023; Changsan et al. 2023; Hu et al. 2023). The bulk of plant bioactive loaded polymers have been fabricated using a hydrogel base as evidenced by approximately 152 articles on this topic, all indicating better efficacy compared with non-plant based hydrogels.

In this study, pectin and sodium alginate were the most common biomaterial used for the formulation in three of the studies (Chin et al. 2019; Sabando et al. 2020; Tan et al. 2019). Pectin and sodium alginate are polysaccharides used because of their favourable properties which include safety levels, high biocompatibility, cross linking gel-like formation, low toxicity and being biodegradable. Pectin is also known to have efficient encapsulation and a sustained release of the therapeutic compound (Koshy & Sangeetha 2024). Because of its speed of decomposition, pectin is conjugated with another material to enhance it, such as in the pectin-starch and pectin-sodium alginate hydrocolloids (Chin et al. 2019; Sabando et al. 2020). Sodium alginate is hydrophilic in nature, allowing the formation of a gel with the potential to draw moderate exudate within a wound bed. The negative control in these studies showed that even without bioactive products, biopolymers can still render wound healing activity, although to a lesser degree than with plant bioactive compounds.

Characterisation of hydrocolloid films

After the formulation of the hydrocolloid films, the studies went on to analyse the morphological, chemical and physical properties of the dressings. This was done to ensure the potential of the dressing in conferring wound healing activity. Morphological analysis included the use of a scanning electron microscope (SEM) by Sabando et al. (2020) and Ajitero (2022). Sabando et al. revealed that the formulated hydrocolloid had a uniform morphology of structures of size 50 µm owing to the pectin amorphous nature. In the myrrh hydrocolloid dressing for dermal wound (Mirderm) study, there were observable patches of myrrh resin on the carboxy-methyl cellulose-coated styrene-isoprene-styrene surface which gave it a rough texture compared to the commercial dressing sample (Ajiteru et al. 2022). The rough texture is attributed for the adhesive properties of the hydrocolloid. Despite the importance of the film morphology, the other two articles did not report on the prepared hydrocolloid morphology. This presents a lack in the two articles, which could have assisted in the explanation of the wound healing results.

Chemical analysis of the films was done by Fourier transform infrared spectroscopy (FTIR). The FTIR results of the plant-loaded hydrocolloid confirmed the presence of polyphenolic-OH groups from polyphenolic compounds (Sabando et al. 2020). Again, no other study reported on a chemical analysis of the hydrocolloid films, a critical step in the design and formulation of a wound dressing. Physical properties were addressed by analysis of the following: thermogravimetric analysis, tensile mechanical properties, drug release properties, swelling studies, moisture vapour transmission and rheological studies. In addition, thermal stability of the films was reported by Sabando et al. (2020). Interestingly, it was reported that for hydrocolloid films loaded with plant extracts, a third thermal decomposition effect appeared in the temperature range 435 °C to 439 °C compared to the non-plant-loaded which had two temperature ranges. This could be attributed to the polymer cross-linking in the presence of polyphenolic compounds allowing improved stability of the plant-based hydrocolloid compared to the blank.

Moisture vapour transmission rate (MVTR), an important aspect of wound dressings, was reported by the authors of the prior selected articles (Chin et al. 2018, Tan et al. 2020). Furthermore, MVTR affects the performance of porous membranes and multi-layered structures; hence, it is important for hydrocolloid production. It has been shown that water condensation on membranes can block pores, reducing vapour transmissibility and diminishing performance (Khakpour, Gibbons & Chandra 2022). The MVTR value of hydrocolloid films containing VCN-2 and allantoin was higher compared to blank film thereby making it a more favourable hydrocolloid (Tan et al. 2019; 2020). This characteristic could be attributed to the poly phenolic nature of plant compounds which provide an added advantage compared to non-plant–based hydrocolloids.

Water uptake assays and swelling studies were also communicated in the articles as they play an important role in determining the ability of the hydrocolloid material to absorb fluids and maintain its structural integrity. The material's absorbent capacity is essential for creating an optimal environment for the wound healing process (Garcia-Orue et al. 2019). In the Mirderm study, the presence of myrrh patches on the biopolymer decreased the water retention potential of the fabricated hydrocolloid thereby making it less absorbent compared to the control (Ajiteru et al. 2022). This is also similar to the results by Sabando et al. (2020) who suggest that the water uptake action of Nalca (Gunnera Tinctora) be attributed to the polyphenolic-OH nature of the matrix allowing interpenetrating networks. There was, however, no significant difference in swelling capacity of all groups in the study by Chin et al. (2018), suggesting that swelling capacity is subject to the chemical nature of the plant compounds and their alignment within the matrix. Ultimately, there is no significant difference in the exudate absorbance from the plant or non-plant–based hydrocolloids.

Mechanical characterisation of the formulated hydrocolloids was also explored in the studies. This was done to assess the mechanical properties and potential of the film. The tensile strength for skin ranges between 2.5 and 16 MPa, and elongation at break in most flexible zones of skin would be approximately 70%. The Mirderm studies focussed on investigating tensile strength and adhesion capacity. In both cases, Mirderm presented a higher performance (1180.92 ± 84.05 kPa), compared to the commercial dressing. The tensile strength of *Moringa oleifera* leaf (MOL) dressing is only commented on in a previous publication focussing on standardisation of the film (Chin et al. 2018). Similarly, the MOL dressing also exhibited a high tensile strength capacity. However, Sabando et al. (2020) reported no significant difference between the tensile strength of the hydrocolloid and the control. All results obtained were below the required standards suggesting that while phytochemicals may increase the mechanical tensile strength, they do not have a negative impact on wound healing.

The drug release mechanism in *in situ* gelling delivery systems and transdermal drug delivery systems is affected by the viscosity levels. Studies have shown that changes in rheology, such as gelation and dissolution, can have a direct impact on drug release rate (Senjoti et al. 2020). Two of the reviewed studies assessed the rheology and drug release aspect of the prepared hydrocolloid. Chin et al. (2019) hypothesised that the higher the viscosity of the film, the lower the healing potential, as seen by the action of 1% MOL compared to 0.5% and 0.1%

MOL. This was confirmed by the Franz diffusion cell drug release assay (Sabando et al. 2020). Furthermore, the physicochemical properties of drugs, such as swelling, solute diffusion and matrix degradation play a pivotal role in drug release behaviours in adhesives. This was evident in the fast initial release and sustained slow release of the polyphenols in Sabando et al. (2020). As highlighted in these studies, drug release and rheology are important considerations when formulating and characterising hydrocolloid dressings as they have a direct effect on wound healing.

Biological mechanism of action of the formulated phytochemical-based hydrocolloids

Biological assays were carried out to ensure the therapeutic potential of the plant-based hydrocolloids. Studies by Ajiteru et al. (2022), Chin et al. (2019) and Tan et al. (2019) used animal studies to assess the residual wound area or the rate of wound contraction. In all three cases, the plant-fabricated hydrocolloid presented expedited wound contraction. While wound contraction area and residual wound are important metrics in determining wound healing, wound closure does not include all aspects of the healing process (Andjic et al. 2022). Furthermore, measuring tools for the calculation of the wound area may vary, leading to errors in the overall wound healing assessment (Masson-Meyers et al. 2020). In order to counteract incomplete evaluation and errors of the wound healing progression, histology studies are performed on the skin tissue.

A variation in the number of days for histological evaluations was noted for the articles. The variation of the number of days in skin tissue regeneration is visible under histology as seen by the presence or absence of specific appendages and their level of maturation. This allows for the assessment of tissue characteristics such as collagen formation, granulation tissue appearance and inflammatory cell infiltration. However, there are also limitations to evaluating histological results on wound tissue. For instance, histological examination may not always accurately reflect clinical outcomes, as seen in a study where there were no significant histological differences between control and phenytoin-treated wounds despite improved healing outcomes (Abd, Abd & Aldabagh 2020). Furthermore, histological evaluations do not capture all aspects of wound healing, such as pain levels or patient-reported outcomes.

An investigation into wound healing mediators by Tan et al. (2019) determined the levels of cytokines, growth factors and chemokines, and confirmed the regulation of inflammatory and antioxidant activity mediators, indicating the action of the plant bioactive compound (Vicenin 2) compared to the hydrocolloids without plant extracts.

Implications and recommendations

In this study, the articles reported an enhanced mechanism of action demonstrated by the use of phytochemical-loaded hydrocolloid for wound healing compared to the commercial and non-plant–based hydrocolloid. Based on the results, further research is required on formulations with the potential for expediting wound healing. In addition, the pre-clinical studies must be followed up by clinical trials in order to assess the action of the plant-based hydrocolloids on humans. Policy makers and funders should also be made aware of the current work in this field in order to prioritise this area of research.

Conclusion

The review showed that phytochemical-based hydrocolloid research is still low with only four animal-based studies and one clinical trial. There is a need for more work to be done in this field. While there is little literature published on this topic, this study highlighted that plant-based hydrocolloids have a significant effect on wound healing of all types. It is important to note that the success of a phytochemical-based hydrocolloid can be attributed to its characteristics, which include antioxidant, anti-inflammatory and cell proliferation activities. Furthermore, the formulation of these hydrocolloids, which imparts both chemical and mechanical properties, ensures their biocompatibility.

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Competing interests

The authors declare that they have no financial or personal relationship(s) that may have inappropriately influenced them in writing this article.

Authors' contributions

S.S., M.R. and K.S.M. contributed to study conception, design, interpretation of data and the writing of the article.

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Data availability

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