

Local resource botanicals used in wound care

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ABSTRACT

Botanical and other natural products have been used for centuries for medicinal purposes including treating skin lesions and wounds. However, formal research into the efficacy of many traditional remedies is sparse. The Wound Healing and Management (WHAM) Node within the Joanna Briggs Institute (JBI) and Wounds Australia conducts evidence summaries on traditional wound care strategies as a resource for local wound care practitioners and staff and students on exchange programs in developing countries. This paper presents an overview on a number of botanicals used in wound care in countries with limited access to contemporary wound care products. The available evidence on effectiveness and potential adverse events for tea tree oil, turmeric, banana leaves, aloe vera, papaya and calendula used in wound care is presented. There is a need for further good quality research into many of the interventions presented in this review in order to increase the evidence base and understanding of any risks in incorporating natural resources into wound care.

Keywords: Wound care, traditional, low resource, plants.

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INTRODUCTION

Wounds need to heal quickly, with minimal scarring, pain and infection, even in areas with limited resources. In low resource countries where access to contemporary wound care products is limited or cost-prohibitive, botanical and other natural products are frequently used as both home remedies and by health care workers in promoting wound healing. The use of natural botanical products in wound care has a long history, and traditional wound care practices provide low-cost, simple and realistic options for managing wounds in geographic settings where there is often little alternative.

Some plant products used in wound care appear to have active components that contribute to wound care through antioxidant, antimicrobial, anti-inflammatory and tissue regeneration effects¹, while others are used primarily for their practical abilities to provide a protective covering for the wound. Despite the common use of many botanical products for wound care in low resource countries, formal research into their efficacy in promoting wound healing is in its infancy.

Consistent with evidence-based practice, both local wound care practitioners and staff and students on exchange programs in developing countries have identified a need for documented evidence on the effectiveness of natural products in common use. In response, The Wound Healing and Management (WHAM) Node within the Joanna Briggs Institute (JBI) and Wounds Australia has undertaken research on some of these practices. In conducting WHAM evidence summaries, comprehensive literature searches are conducted in the major health care databases Medline, Cumulative Index to Nursing and Allied Health Literature (CINAHL), EMBASE, Cochrane library, Rural Health, Allied and Complementary Medicine Database Allied and Complementary Medicine Database (AMED) and the World Health Organization (WHO) Regional Office for Africa (AFRO) Health Sciences Library.

Supplementary searches are conducted in Google Scholar. Searches use Medical Subject Headings (MESH) and keywords describing wound management combined with terms related to the specific wound dressing/topical product of interest to the evidence summary. No publication date restriction is used, but searches are restricted to publication in English language.

To date, 12 evidence summaries and two related recommended practices have been developed. These are available in the JBI database in Ovid via the World Health Organization's HINARI online library (<http://extranet.who.int/hinari/en/journals.php>) to institutions in eligible countries (www.who.int/hinari/Global_HINARI_registered_2016.png?ua?1_map). Given continued support, the WHAM Node aims to develop additional summaries of existing evidence on topics useful to low resources communities.

The aim of this paper is to provide an historical background and overview of some lesser-known botanical products used for treating wounds in low resource settings and to present laboratory and clinical evidence related to wound healing outcomes. For many botanical products, efficacy is not inferior to advanced wound care products¹, and documented evidence supports the historical development of their traditional use in wound care.

TEA TREE OIL

Tea tree oil is an essential oil distilled from an Australian native plant, *Melaleuca alternifolia*, and traditionally used for its antibacterial and anti-inflammatory properties. The earliest use of tea tree for wound care is traced to the Indigenous *Bundjalung* people of eastern Australia. Indigenous Australians applied crushed leaves of the tree as a poultice for minor wounds and insect bites, as well as using brewed leaves (hence the name 'tea tree') for other medicinal purposes². In the 1920s, Australian chemist Arthur Penfold isolated and characterised the chemical compounds of over 100 active ingredients in tea tree oil and documented reports of its antimicrobial properties, stimulating interest in using distilled oil as a therapeutic agent³. Today the formulation of tea tree oil is regulated by the International Organisation for Standardisation (ISO), which defines the chemical composition required for 15 primary components (ISO 4730)³.

An extensive body of evidence documents the efficacy of tea tree oil in managing common skin conditions (for example, dermatitis, acne and tinea), upper respiratory tract infections and ear infections. Laboratory studies have demonstrated tea tree oil's activity against bacteria, fungi and herpes simplex virus⁴ and one *in vitro* study⁵ has also reported efficacy in decreasing Methicillin-resistant *Staphylococcus aureus* (MRSA) biofilm activity. However, there is minimal literature reporting its clinical effectiveness in relation to wound care⁴.

Clinical evidence on tea tree oil's role in wound healing is limited to small randomised controlled trials (RCTs),

uncontrolled trials and case studies that report on its association with wound healing and ability to facilitate wound debridement and reduce local inflammation⁴. Studies report healing in a variety of wound types (surgical wounds, fracture blisters, acute and chronic wounds of mixed aetiology, and pressure injuries) using tea tree oil in concentrations from 1% to 10%⁴. For example, one RCT found that compared with a saline gauze wound dressing, which is the most commonly used dressing in most low resource facilities, tea tree oil placed on gauze and applied to the wound bed was associated with superior healing outcomes over 10 days⁶. Only small studies^{6,7} have explored the antibacterial effect of tea tree oil in clinical wounds, and the current evidence suggests its effects may not be superior to saline wound dressings. Both studies^{6,7} explored efficacy with respect to action against MRSA, a notoriously difficult bacterial strain to manage, and given the findings are contradictory to the results of *in vitro* finding⁵, further research is warranted in this field.

Commercial preparations of tea tree oil including sprays, solutions and impregnated dressings are available⁴, but not always accessible in low resource nations. More traditional use of tea tree oil in wound care includes application as a wash (two drops of pure essential oil diluted in 250 ml of warm water or saline) or directly to the wound bed (two drops of pure essential oil placed on a gauze swab and applied to the wound) — the second method is associated with increased irritation, stinging and wound-associated pain⁸.

TURMERIC

Turmeric derives from a perennial plant of the ginger family, *Curcuma longa*, and its active chemical ingredient is curcumin (diferuloylmethane). Although turmeric is native to tropical southern Asia, over 130 species have been identified globally. Use of turmeric as a medicinal product is traced back to 250 BC, with its earliest use documented in Sanskrit medical texts as an ointment for relieving food poisoning documented in south Asia⁹. In Indian and Asian cultures, turmeric has historically been used as a treatment for arthritis, biliary disorders, rheumatism and wounds, due to traditional description of the spice as having anti-inflammatory, antioxidant, antimicrobial and anti-cancer effects¹⁰⁻¹². Historical use of turmeric in wound care is traced to India, where tribal groups used turmeric topically to promote wound healing^{9,10,13}.

Despite a long history of its use in wound care, there is only a limited body of evidence investigating the efficacy of turmeric in promoting wound healing^{14,15}, and this evidence is limited to laboratory and animal studies.

Few studies investigate the efficacy of topically applied curcumin preparations that best replicate the traditional use of turmeric in wound care. In a small RCT conducted in rats, application of curcumin-impregnated collagen to full-thickness wounds was associated with significant reduction in wound area over seven days when compared with non-

impregnated collagen. Histological examination of wound beds showed an increase in inflammatory cells, fibroblasts and collagen in wounds, suggesting that curcumin triggered a faster process of inflammation, proliferation and scar formation¹⁶. Other animal studies have presented evidence indicating that oral, intravenous and intraperitoneal curcumin regimens are also associated with positive wound healing outcomes¹⁵; however, these trials do not reflect the most common historical or traditional use of the plant in wound care. Local inflammation is reported as a minor side effect from application of turmeric to skin¹².

A range of turmeric-based powders, oils and tablets/capsules are marketed in Europe, generally as curatives for digestive symptoms and cancer prevention¹⁴. More traditional use in wound care is through direct application of a paste prepared from turmeric rhizome, mustard oil and water^{9,10,13}; however, in India commercial dressings impregnated with turmeric are also available¹⁷.

BANANA LEAVES

As one of the oldest cultivated crops that is abundant in many low resource countries, banana plants (*Musa* species), including the fruit, flowers, sap and leaves, have a long history of medicinal use. Banana flowers are traditionally used to treat dysentery and bronchitis, roots and seeds have been used for digestive disorders and the astringent sap is used for a range of medical issues including fever, insect bites and haemorrhoids. One of the earliest uses of banana in wound care was a paste of ripe banana fruit, applied directly to a wound as pain relief¹⁸.

Banana leaves, which have a waxy, non-adherent surface, are documented as being used as wound dressings by the *Banyoro* people in western Uganda¹⁹ and are still used today in many countries including Egypt, India, the Philippines and Thailand. Animal research suggests that chemical properties of banana plant may contribute to wound healing through stimulation of collagen proliferation and anti-microbial effects²⁰.

A small number of studies²⁰⁻²² provide evidence that banana leaf dressings are an effective wound dressing for skin graft donor sites and partial-thickness burns. In one RCT wounds treated with the banana leaf dressing healed significantly faster than those treated with Vaseline gauze (mean 8.67 days versus mean 11.73 days, $p < 0.001$)²¹. In another RCT banana leaf dressing and povidone-iodine ointment was shown to be as efficacious as another natural dressing (potato peels)²⁰. In a third study²², banana leaf dressings were associated with significantly faster healing of burns than a gauze dressing (mean 8.4 days versus 13.4, $p = 0.02$) without any increase in infection rates. Because of the waxy surface, banana leaf dressings are associated with significantly lower levels of pain when removed²⁰⁻²².

Historical documentation of the banana leaf as a dressing for burns details the patient lying directly on large banana leaves

in order to cover the wound bed and to receive pain relief from the presumed chemical properties and the cool surface. In contemporary use, the leaves are cut to size, washed in tap water, prepared with slits along their surface to allow exudate drainage and either autoclaved or steamed before being stored in refrigeration^{20,21,23}.

ALOE VERA

Aloe vera (*Liliaceae* family) is a tropical succulent native to tropical and southern Africa. Its medicinal use dates back at least to 4th century BC when records show its use by the ancient Greeks^{24,25}. Early Egyptian records indicate that aloe vera was used in cosmetics, as a laxative, and for treating burns and insect bites over 3,500 years ago^{24,26}. Traditional use of aloe vera includes reduction of perspiration and treatment of sunburn, asthma, conjunctivitis and hypertension²⁷.

'Aloe' means dried juice, indicative of the active component of the plant. When the lower leaves of the plant are cut open, a clear, odourless, gel-like substance is obtained. Although the plant is 99% water, aloe vera contains glycoproteins, polysaccharides (including acemannan, which is often named in commercial products) and monosaccharides that are the active components of the gel substance. Laboratory studies indicate that the gel stimulates fibroblast activity and promotes collagen synthesis, suppresses inflammation and has antioxidant effects^{27,28}.

Despite its widespread use in wound (especially burn) care, clinical research documenting the effectiveness of aloe vera gel remains sparse and existing studies have conflicting findings^{25,27,29}. A recent Cochrane review²⁹ identified seven clinical trials exploring the efficacy of aloe vera in managing acute and chronic wounds. There was a high risk of bias for most of the included studies and the findings were conflicting. Aloe vera in a gel form was found to be superior to placebo (acute surgical wounds) but not significantly different to a hydrogel (skin biopsies), saline gauze dressing (pressure ulcers) or sodium hypochlorite (post-operative wounds) for wound healing outcomes. Aloe vera gel was superior to silver sulphadiazine for complete healing of burns (risk ratio 1.24, 95% confidence interval [CI] 1.03 to 1.50) in one of the studies²⁹. The contrasting findings between studies may relate to the differing aloe vera products that were used, many of which may not be stable²⁸.

Traditionally, aloe vera is applied by removing the outer layer of the leaves and placing the leaf pulp directly to the cleansed wound bed on a daily basis. Today in low resource countries the pulp is pasteurised for less than three minutes at 75–80°C, as heating for longer periods or higher temperatures alters the chemical composition of the gel, potentially rendering it inert²⁸. Commercial gel preparations are available, and in some countries creams and aloe vera-impregnated dressing are marketed. Application of aloe vera gel can cause burning, erythema and stinging and prolonged use may lead to contact dermatitis^{25,28}.

GREEN TEA

Brewed tea (*Camellia sinensis*) is globally one of the most common beverages and the green variety is associated with a range of medicinal qualities. Its earliest use as a medicine is proposed to be by Buddhist monks in the 8th century^{30,31}, although others estimate medicinal tea use to have commenced in the 10th century³². In traditional Chinese and Indian medicine green tea was used as a diuretic, digestive, mental stimulant, astringent for bleeding control and wound healing, and for regulation of body temperature and sugar levels³³.

The chemical composition and properties of green tea have been studied extensively. Green tea is high in polyphenols (flavonoids) known as catechins, in addition to tannins, vitamins and minerals, and alkaloids (for example, caffeine). Epigallocatechin gallate is the predominant catechin and associated with the antioxidant effects of green tea^{30,34}. A range of laboratory and animal studies suggest that the chemical components of green tea have anti-carcinogenic and anti-inflammatory effects, and clinical studies in humans have supported the contribution of green to weight³⁵, blood pressure and cholesterol reductions³⁴. With respect to wound care, laboratory studies have identified that green tea has antioxidant, anti-inflammatory, anti-carcinogenic and ultra-violet light protective effects^{36,37} and contributes to epithelial growth³⁰.

Research on the effects of green tea in promoting wound healing is sparse; however, there are some clinical studies investigating its role in managing wound malodour. In low resource countries commercial products generally used for managing wound malodour, such as metronidazole powder and activated-charcoal dressings, are not always accessible due to availability or cost³⁸. Two papers^{37,39} report case studies in which green tea bags were applied to malignant fungating wounds of the breast of women located in Malaysia and Indonesia. Women reported clinically significant reduction in wound malodour associated with application of the green tea that had positive lifestyle and health outcomes including increasing socialisation and appetite³⁷. For one woman, the green tea bag also reduced exudate, reportedly absorbing up to five times the initial weight of the tea bag³⁷.

Green tea is applied to the wound after cleansing and application of an appropriate contact wound dressing; the leaves are not applied directly to the wound bed^{37,39}. Dried green tea leaves are enclosed in a gauze square and placed on top of the contact wound dressing, followed by absorbent padding and stretchable tube bandage. The wound dressing is changed before wound exudate strikes through the absorbent padding³⁷.

PAPAYA (PAWPAW)

As an abundant crop in tropical regions, including South America and Africa, the papaya tree (*Carica papaya*) has a range of traditional uses. Historically, tribes in tropical regions

have used all components of the tree for medicinal purposes including as a diuretic (root leaves and unripe fruit); to treat digestive disorders including dyspepsia (unripe fruit); as a potion to treat tonsillitis (roots and leaves); to treat parasitic worms (seeds); and to relieve asthma attacks (smoking the leaves). Latex from the unripe fruit has been also been used to treat a wide range of skin conditions such as warts, psoriasis and tumours^{40,41}.

Laboratory studies confirm various chemical properties of components of *Carica papaya*. Most relevant to wound care are the protease enzymes papain and chymopapain in the unripe fruit (latex) that have digestive and anticoagulant properties. However, these enzymes decrease as the fruit ripens, suggesting better efficacy of green papaya fruit^{41,42}. This contributes to rapid de-sloughing and wound healing promotion, confirming the traditional use of the unripe papaya fruit⁴³. Antibacterial activity against gram-positive and gram-negative bacteria of ripe and unripe fruit and seed extract has also been demonstrated in the laboratory^{44,45}.

As with most other natural botanical treatments, the clinical research on the use of *Carica papaya* in wound care is limited. A number of smaller case series and study reports document positive effects of slough removal and wound bed granulation of papain extract as an irrigation fluid or in ointment forms⁴². In a larger descriptive study, 118 wounds of various aetiology treated with papain in solution form showed reduction in necrotic tissue and increase in granulation and epithelialisation after 28 days, supporting the de-sloughing actions attributed to papaya⁴².

Some studies document the use of papaya fruit applied directly to wounds. In a recent RCT conducted with women in India who had poor wound closure following caesarean section, the efficacy of *Carica papaya* in debriding the wound prior to surgical correction of the suture line opening was explored. Compared with hydrogen peroxide, wounds treated with *Carica papaya* achieved healthy granulation tissue significantly faster (mean 2.5 days versus 6.2 days, $p < 0.05$) and the women had significantly shorter total hospital stays (mean 12.92 days versus 19.2 days, $p < 0.05$)⁴³. In a small trial, papain-soaked gauze was compared to mashed papaya fruit as a wound packing agent for 15 necrotic wounds. Five wounds achieved complete healing and five achieved partial healing without additional surgery⁴². Papaya flesh prepared by grinding into paste and then cooled was reported as a cost-effective strategy for managing burns in an African paediatric department, reducing the requirement for surgical debridement⁴⁶.

Carica papaya can be applied to the wound as papain abstract diluted in normal saline and used as an irrigant or soaked in gauze. When resources to prepare extract are not available, papaya flesh can be mashed or grated and applied directly to the wound bed or, for easier removal, placed in gauze and packed into the wound^{42,43}. The wound dressing is replaced daily or second daily when the wound is infected⁴⁶.

Despite *Carica papaya* being commonly used in wound care in low resource regions, controversy exists over its use in some countries. In people with papaya sensitivity there is a risk of severe allergic reaction when applied to the skin or wounds. Because of cross-reactivity, people who have latex allergy are also at risk of anaphylaxis associated with papain⁴³. In 2008 the US Food and Drugs Administration (FDA) banned the marketing of topical skin preparations containing papain^{47,48}, after receiving 37 reports of adverse events (4 of which described anaphylaxis) over the preceding 39 years⁴⁸. In clinical research, papain is generally reported to be well tolerated; however, the anaphylactic reaction rate for papain has been reported as 1%⁴². Further research is required to establish the level of risk and associated factors. Extracted products may have a higher concentration of papain than the papaya fruit, and both the age and the gender of the tree are associated with the quality of papain that is extracted from the fruit latex⁴⁹. Studies conducted in South America, Africa and Eastern Europe predominantly report papain-extract products with concentrations of less than 4% (often less than 1%)⁴² compared to 10% concentrations reported for many commercial topical products that have previously been available in the US. These factors may contribute to the rate of adverse events.

POT MARIGOLD (CALENDULA)

Pot marigold, generally referred to by its botanical name *Calendula officinalis*, is a commonly cultivated garden flower that is native to the Mediterranean region. Its use in textile and cosmetic production in ancient Greece and Rome and in early Indian and Arabic cultures is documented. The earliest use of calendula as a herbal remedy appears to originate in the Middle Ages (12th century) when it was used to treat digestive problems, menstrual pain and various skin lesions^{50,51}.

The primary active ingredients in calendula are flavonoids and terpenoids. These ingredients are associated with anti-inflammatory and antioxidant effects that have been confirmed in laboratory and animal studies⁵². Methanol extracted from calendula has demonstrated antibacterial and antifungal activity against gram-positive and gram-negative organisms⁵³. Wound healing promotion through anti-inflammatory and antibacterial effects and stimulation of angiogenesis and fibroblast activity has been demonstrated in animal studies⁵⁴.

Clinical trials demonstrating wound healing outcomes are sparse. A 2008 systematic review reported only six RCTs that were primarily at high risk of bias. In one trial venous leg ulcers, burns or skin lesions irrigated with a distilled water solution containing 10% calendula followed by application of a gel containing 2% calendula had superior healing outcomes to wounds receiving only the calendula irrigation. In another trial, total surface area of venous leg ulcers treated with 7.5% calendula ointment decreased significantly ($p < 0.05$) compared with ulcers treated with saline dressings for three

weeks. In other studies, products applied to wounds have combined calendula with other potentially active ingredients, precluding evaluation of its clinical effect⁵⁰.

Although some traditional remedies incorporate calendula in oral preparations, it is primarily used as an external topical product⁵⁰. In some countries calendula is available as commercial ointments and tinctures. In low resource countries calendula oil is extracted by steeping the dried flowers in a cold carrier oil placed in a jar in the sun for four weeks and then draining the oil for application directly to the wound bed. No serious adverse events have been associated with calendula, and a large study investigating contact sensitivity to 10% calendula ointment found a sensitivity rate of less than 0.2%⁵⁰.

CONCLUSION

Traditional healing with local botanical products plays a significant role in wound care in many low resource countries. This review has presented some of the more robust research conducted on popular interventions that utilise local plant products in wound healing. As described above, the body of laboratory and clinical research that is gradually increasing for the most part provides at least some support for traditional beliefs related to the efficacy of plants in healing.

Dissemination of research through the development of evidence summaries contributes to evidence-based practice in geographic areas in which clinical decisions are complicated by lack of access to contemporary wound care products. Consideration to safety and the notion of doing more good than harm is paramount to all clinical care. Developing a written body of evidence on potential harms and complications associated with local resource wound care strategies is as important as documenting the evidence for efficacy. Although few cases of serious side effects have been noted in clinical research on the botanicals presented above, contact dermatitis and hypersensitivity associated with these and other plant products have been noted^{25,26,28,43}. The importance of close supervision after application of a local resource wound dressing, particularly on first application, has been highlighted⁴³.

Traditionally, as the use of local resources as medicine is passed down the generations through demonstration and verbal description⁵⁵; there is minimal written evidence of ancient use of many botanical products, despite the use of these strategies for centuries. A study conducted in one Indian tribe noted that knowledge associated with healing was predominantly confined to older generations who fulfilled the role of traditional healer and had expert knowledge on preparation and application of plants, as well as the potential harms. With gradual industrialisation, research indicated that traditional knowledge related to the background of natural resource interventions was declining, despite an ongoing faith and use of these practices⁵⁵. Documentation is important in maintaining the full body of knowledge associated with local wound care practices.

The available research on the natural botanical interventions presented above is of varying, but generally low quality (that is, at high risk of bias). Good quality ongoing research into traditional healing strategies, including comparisons between different local resource wound care strategies is needed to provide guidance to clinicians located in low resource settings, practitioners visiting those regions, and families who are often responsible for managing wound care in the home and passing traditional strategies on to the next generation.

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