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Review Article **Pharmacy**

Natural Product for Wound Healing: Systemic Review

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Abstract

Any injury to the body, including damage to the skin's outer layer and impairment of its normal structure and function, is referred to as a wound. Since the beginning of time, people have recognized the crucial nature of wound healing, and significant resources have been used to create cutting-edge wound dressings made of the best materials possible for quick and effective recovery. A vital part of this healing process is played by medicinal herbs. Many studies conducted recently have focused on developing novel wound dressings that contain infusions from medicinal plants or their purified active components, providing viable substitutes for conventional dressings. Several investigations have looked into how various herbal remedies aid in the healing of wounds. This article intends to explain and examine the molecular components of wound healing that are aided by natural plant-based products. The remedies made from herbs participate in various phases of wound healing and work through a variety of processes. Certain herbal medications also increase the formation of important factors that are involved in re-epithelialization, angiogenesis, granulation tissue development, and collagen fiber deposition, such as transforming growth factor-β (TGF-β) and vascular endothelial growth factor (VEGF). encouraging anti-inflammatory in nature and antioxidant qualities at different stages of the wound-healing process. The field of herbal medicine and other natural products are used in traditional and alternative medicine to treat wounds. These methods have various benefits over conventional treatments, such as enhanced efficacy owing to different ways in which they work action, antibacterial qualities, and long-term safety when using wound dressings.

Keywords: Wound healing, anti-inflammatory, angiogenesis.

INRODUCTION

The biological process of wound healing entails the regeneration and repair of damaged tissue. This procedure is necessary to keep the skin healthy and free from infection. According to [1], the process of healing a wound can be multifaceted and intricate, involving several cellular processes such inflammation, migration to the injured area, proliferation, angiogenesis, deposition, and remodeling of extracellular matrix, especially collagen. Ointments, lotions, and powders are only a few of the many synthetic and semi-synthetic wound healing products on the market [2]. However, because of their effectiveness and safety, natural products have drawn more attention in recent years as potential wound healers [3]. According to [4], natural ingredients have been utilized in traditional medicine for thousands of years and have demonstrated promising outcomes in accelerating wound healing.

According to [5], these natural ingredients can be applied directly to wounds or employed as drug delivery vehicles. They can aid in the healing of wounds by supporting the development of new blood vessels and serving as a scaffold for cell proliferation. The application of herbal remedies in contemporary medicine has grown in importance for tissue restoration, which includes the healing of wounds [6].

Furthermore, studies conducted by [7] have demonstrated the potential of plant-based nanomaterials in controlling the wound-healing process. Furthermore, studies conducted by [6,7] have demonstrated the potential of plant-based nanomaterials in controlling the wound-healing process. Given this, a thorough analysis of natural products for wound healing is required. The usefulness of natural compounds in wound healing as well as their methods of action will be examined in this review. Products with a natural basis may be very important in the healing of wounds [4]. They have antibacterial qualities that aid in preventing infection in addition to encouraging the regeneration of injured tissue.

We may increase the body's natural healing capabilities by using natural products to treat wounds. This allows us to harness the power of nature. The purpose of this study is to assess the effectiveness of natural ingredients in stimulating tissue repair and explore their potential for wound healing [8].

This study is to investigate the effectiveness of different natural products in encouraging tissue repair and controlling the intricate process of wound healing, with an emphasis on natural wound healing. Because natural products are safe, effective, and can quicken the healing process, their use in wound care has attracted a lot of attention [8,9]. Furthermore, by offering the patient both physical and psychological comfort, natural products offer a comprehensive approach to wound healing. In conclusion, because of their effectiveness, safety, and capacity to encourage tissue restoration, natural products have demonstrated encouraging outcomes in the healing of wounds. By harnessing the power of nature, these products can aid in the regeneration of damaged tissue and prevent infection, ultimately accelerating the healing process [9, 10].

Understanding Wound Healing Process

Hemostasis

Hemostasis, which is recognized as the earliest stage of wound healing, starts one to three hours after the damage. Vasoconstriction, the first stage of hemostasis, slows blood flow and causes platelets to clump together and form platelet plugs. Because of this, during the coagulation cascade, a fibrin mesh forms around the platelet plugs, assisting in the creation of a stable clot. Moreover, platelets start to release growth factors and cytokines [11].

Inflammatory Response

Neutrophils are a subset of white blood cells that are present for two to five days during the early inflammatory response. Neutrophils are crucial to the process of healing. They eliminate local bacteria, which aids in the decomposition of dead tissue. Additionally, they release proases, an enzyme that catalyzes proteolysis, and active antimicrobials, which initiate debrideent [12].

Approximately three days following the injury, monocytes an additional subset of white blood cells appear during the late inflammatory response. Because they develop into macrophages large cells that consume germs, dead neutrophils, and injured tissue monocytes are crucial. Moreover, they secrete cytokines, chemokines, and growth factors. Thus, macrophages are crucial for the healing of wounds and the prevention of infection [13].

Proliferation

In this phase, the body produces a number of chemicals produced by macrophages that trigger angiogenesis, the process by which new tissue and blood vessels are created. The wound bed is subsequently filled with the new tissue. Six During the last phase of proliferation, the edges of the wound gradually begin to tighten and converge [14].

Remodelling

Remodelling commences during the proliferation stage and lasts for a considerable amount of time. In this phase of the healing process, collagen is crucial. The body simultaneously makes and degrades collagen throughout this phase. By doing this, it keeps the re-modelling of new tissue in harmony with the requirement for tensile strength. The final quality and appearance of the scar tissue are determined by this balance [15].

Importance of Natural Products in Wound Healing

1. **Antibacterial Properties:** A wide range of natural ingredients, including calendula, tea tree oil, and honey, have strong antibacterial qualities. These materials can aid in the prevention and treatment of wound infections, promoting a healthier and cleaner healing environment [16].
2. **Anti-Inflammatory Effects:** Aloe vera, chamomile, turmeric, and other natural ingredients have anti-inflammatory qualities. While inflammation is a normal reaction to damage, too much or too long of it can obstruct the healing process. Natural remedies have the ability to regulate the inflammatory response, fostering a steady and well-regulated healing environment [9, 17].
3. **Encouragement of Tissue Mend:** It has been demonstrated that a few natural items, such as coconut oil, comfrey, and aloe vera, assist tissue restoration. They might promote angiogenesis, collagen formation, and cell proliferation, aiding in the healing of injured tissues [9, 18].
4. **Minimal adverse Effects:** Natural products are typically well-tolerated and have fewer adverse effects than certain synthetic treatments. This is especially advantageous for those who are prone to allergic responses or have sensitive skin because natural therapies are less likely to have negative side effects [19, 20].
5. **Affordability and Availability:** A lot of natural goods are reasonably priced and easily accessible. They are feasible choices because of their accessibility, particularly in environments with little resources where access to traditional medical treatments may be limited [18, 21].
6. **Holistic Approach:** Natural products frequently adopt a holistic approach to healing, taking into account a person's psychological and emotional well-being in addition to the physical components of wounds. The idea of treating the full person rather than simply the specific injury is consistent with this integrated approach [22].
7. **Complementary to Conventional therapies:** Conventional wound care therapies can be enhanced

by the use of natural items. Combining natural therapies with conventional medical procedures may improve wound care's overall efficacy and promote stronger, quicker healing [23].

8. **Lessening of Scarring:** By encouraging more structured and regulated tissue repair, some natural agents, like vitamin E and aloe vera, may help lessen scarring. This aesthetic benefit is especially important for wounds in places where appearance is important [24].
9. **Cultural and Traditional Significance:** Cultural and traditional traditions are the foundation of many natural wound healing therapies. Including these well-known and culturally relevant therapies can improve patient compliance and involvement in their own recovery [25].

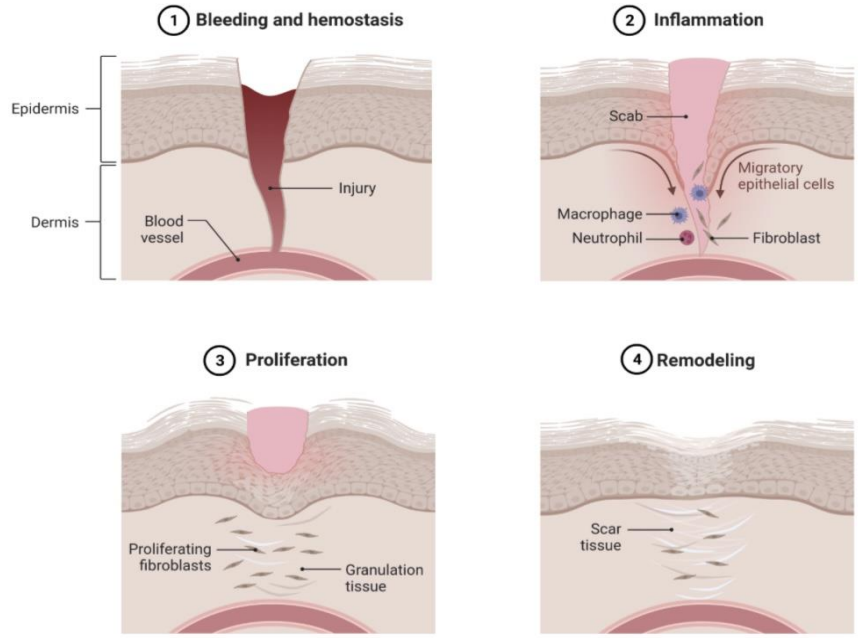

Figure 1: 4 Stages of wound Healing Bleeding and Hemostatis, Inflammation, Proliferation and Remodeling. This figure was created using bioRender (https://biorender.com/). Accessed on December 27, 2023

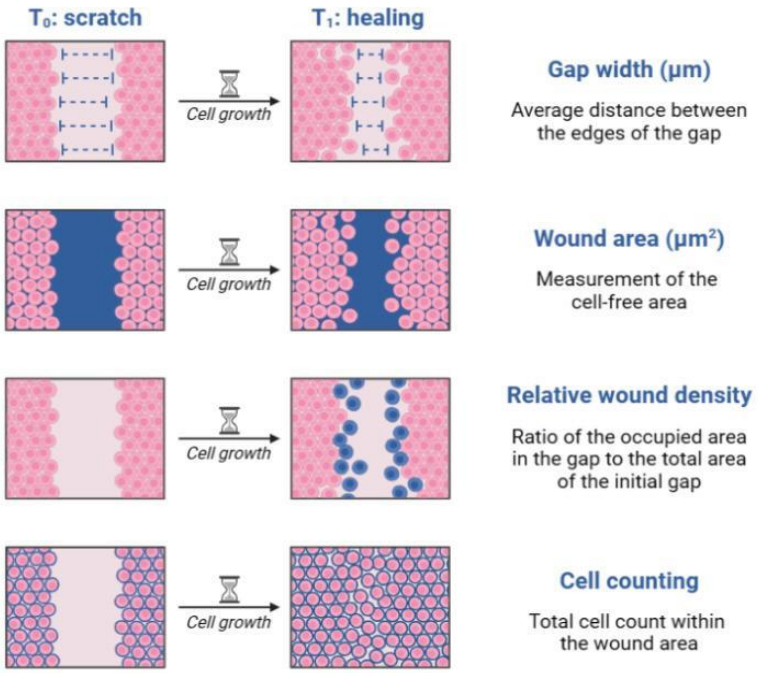

Figure 2: Wound Healing Assay Measurements. This figure was created using bioRender (https://biorender.com/). Accessed on March 10, 2024

Table 1: Growth factors involved in wound healing

Growth Factor	Description
Platelet-Derived Growth Factor (PDGF)	Facilitates the regeneration of tissues by stimulating angiogenesis, the growth of collagen, and cell proliferation [81].
Transforming Growth Factor-Beta (TGF-β)	Suppresses inflammatory and encourages the generation of the collagen and its extracellular matrix, both of which have significance for the closure of wounds [82].
Vascular Endothelial Growth Factor (VEGF)	Causes angiogenesis, which promotes the formation of new blood vessels to bring nutrients and oxygen to the injured area [83].
Epidermal Growth Factor (EGF)	Improves the process of tissue regeneration by promoting the development and relocation of epithelial cells to close wounds [84].
Fibroblast Growth Factor (FGF)	Plays a vital role in the formation of granulation tissue and the contraction of wounds by inducing fibroblast expansion and collagen synthesis [85].

Types of Natural Products Used in Wound Healing

1. *Aloe barbadensis*

The adaptable plant aloe vera is well-known for its therapeutic qualities. Its calming gel makes it a popular choice for skincare. Studies indicate that it has wound-healing and anti-inflammatory properties [26]. Aloe vera also has a number of bioactive chemicals that add to its medicinal properties [27]. Aloe vera continues to be a natural medicine with scientific backing, whether used for sunburn relief or to promote skin health.

Research showing aloe vera's anti-inflammatory and antibacterial qualities supports the plant's effectiveness in healing wounds. Polysaccharides found in aloe vera leaf gel increase fibroblast activity, aiding in tissue repair [26]. Aloe vera also promotes collagen synthesis and angiogenesis, which speeds up wound healing [28].

There are several uses for aloe vera in the treatment of wounds. To lessen swelling and accelerate healing, its gel can be applied directly to burns, wounds, or surgical incisions [27]. Throughout the healing process, the plant's antibacterial activity also helps avoid infections.

Aloe vera is frequently used in topical formulations, such as lotions and ointments, to facilitate easy application. Research has confirmed that products containing aloe vera are effective in improving the results of wound healing [28]. Aloe vera stands out as a natural medicine with benefits in wound care that have been scientifically established, whether it is taken on its own or in formulations.

2. *Curcuma longa*

Curcumin, a substance with numerous health advantages, is found in turmeric, which is made from the Curcuma longa plant. Research emphasizes the antioxidant and anti-inflammatory qualities of curcumin [29]. Research on its possible application in the treatment of a number of ailments, such as cardiovascular disorders and arthritis, is still underway [30] Because curcumin is bioactive, including turmeric in your diet may have positive effects on your health in addition to its colorful flavors.

The effectiveness of turmeric, which contains the active ingredient curcumin, in promoting wound healing has been investigated. According to research, curcumin has antioxidant and anti-inflammatory qualities that help with tissue healing [29]. Turmeric can be topically administered as creams or ointments to encourage the healing of wounds and lower inflammation.

According to a study by [7] turmeric extract may be useful in the treatment of wounds since it helped rats' excision wounds heal more quickly. Turmeric is a versatile natural medicine backed by scientific research that can help with wound healing both locally and systemically when used topically or incorporated into the diet.

3. *Azadirachta indica*

Azadirachta indica, which is the scientific name for neem, has long been used for its therapeutic benefits. According to studies, neem is beneficial for wound healing since it has antibacterial and anti-inflammatory properties [31]. The bioactive chemicals included in neem aid in the healing process by inhibiting bacterial development and promoting tissue regeneration [32]. Based on scientific research, the vast medicinal potential of the neem tree provides a natural way to enhance wound healing.

Wounds can be topically treated with neem oil or paste made from neem leaves. This promotes the general healing process and makes it easier to limit the growth of bacteria [31]. Neem's effectiveness in wound treatment is attributed to its bioactive components.

The process of using neem to cure wounds entails making neem-based topical formulations, including ointments or lotions. Neem is a natural and promising choice for promoting wound healing processes because its traditional use in many cultures is consistent with scientific findings [32].

4. *Tridax procumbens*

Tridax procumbens, also referred to as coat buttons, indicates that it may have a part in wound healing. Research has indicated that the plant possesses anti-inflammatory and wound-closing characteristics,

which are ascribed to bioactive substances such as flavonoids and alkaloids [33]. Further research on the topic of natural wound care is warranted, as the use of Tridax procumbens extracts has demonstrated encouraging results in hastening the healing process [34]. Scientific research suggests that using this traditional medicinal plant to treat wounds may be a safe, natural solution.

Tridax procumbens can be applied and used in a variety of ways, such as extracts, creams, and poultices. In traditional techniques, a topical application for wounds is often made by crushing the leaves. It's important to remember that, despite encouraging data, more study is required to create uniform guidelines for dosage and application in clinical settings [29,33].

5. *Calendula officinalis*

The marigold plant yields calendula, which has been shown to have potential in the healing of wounds. Its anti-inflammatory, antibacterial, and wound-healing qualities are demonstrated by scientific research [35]. It has been discovered that calendula extracts improve tissue regeneration and help injured skin heal [36]. Calendula has been successfully used in topical formulations, such as creams or ointments, to promote wound closure and reduce inflammation. Calendula appears to be a potential natural medicine that can help the wound-healing process, according to the data [37].

Calendula has a variety of uses in the healing of wounds, including the management of small burns, cuts, and skin irritations. It can be used in tinctures, lotions, and ointments. Flavonoids, triterpenoids, and other bioactive components that contribute to the therapeutic benefits of calendula are responsible for its efficacy [35].

6. *Matricaria chamomilla*

The calming effects of chamomile have led to research into its potential for wound healing. Studies indicate that chamomile extracts have antibacterial and anti-inflammatory properties that promote wound healing [38]. The plant's therapeutic advantages are attributed to the presence of bioactive chemicals such as bisabolol and chamazulene [39]. It has been demonstrated that using chamomile to treat wounds can reduce inflammation, encourage tissue regeneration, and hasten the healing process [38]. Scientific studies support the notion that chamomile is a remarkable alternative for natural wound healing treatments due to its mild yet effective nature.

To speed up the healing of wounds, chamomile can be used in a variety of ways, such as compresses made from chamomile tea or ointments soaked with the herb. Research suggests that chamomile preparations can help speed up the healing process and enhance tissue restoration in general [40]. Because chamomile may be used in a variety of ways, it is a natural medicine that shows promise in promoting wound healing.

7. *Plantago major*

The plantain, or plantago major, has been shown to have potential for wound healing. Research has demonstrated that its anti-inflammatory and antibacterial characteristics enhance its effectiveness in the treatment of wounds [41]. According to [13], the plant has bioactive substances including aucubin that aid in tissue repair and reduce inflammation. Plantago major is a natural medicine that has been used for centuries and has scientific backing to speed up the healing of wounds.

Plantago, also referred to as plantain, has demonstrated effectiveness in wound healing because of its antibacterial and anti-inflammatory characteristics. Plantago's leaves are rich in bioactive substances such flavonoids and iridoids, which support the plant's medicinal properties [41].

Plantago is applied topically to cure wounds through the preparation of poultices or leaf extracts. By topically applying these formulations to wounds, they reduce inflammation and encourage tissue regeneration [42]. Scientific research supports the historic use of plantago in wound care, which makes it a promising natural treatment for a range of skin conditions.

8. *Moringa oleifera,*

The plant known as moringa oleifera, or moringa, is prized for its nutritious qualities; studies have also suggested that it may help heal wounds. According to [43], moringa extracts have shown anti-inflammatory and antibacterial qualities, which enhance its ability to promote the healing of wounds. Flavonoids and polyphenols, two of the plant's bioactive chemicals, aid in tissue healing and lessen oxidative stress [44]. Scientific studies suggest that including moringa into wound treatment may provide a natural and advantageous method. [43], There are several ways to use moringa for wound treatment. Topically applied moringa leaf extracts or oils made from its seeds can be used on the wound. According to [45], these applications have shown antibacterial action, which helps to prevent infections and foster an environment that is favorable for healing.

Incorporating moringa into wound healing procedures may give a natural and helpful approach, supported by its nutritional and therapeutic characteristics, while further research is need to fully understand the mechanisms.

9. *Gymnema sylvestre*

Though little study has been done, Gymnema sylvestre is mainly recognized for its ability to control diabetes. It also has a clear correlation with wound healing. The majority of research focuses on its anti-diabetic qualities, including effects on blood glucose levels [20]. Its possible influence on wound healing, however, need more research. The most recent research findings should always be obtained from reputable

sources, as scientific knowledge of plant qualities is always expanding.

Gymnema sylvestre has demonstrated potential in wound healing and is well-known for its traditional use in Ayurvedic medicine. Gymnema sylvestre is known for its anti-inflammatory and antioxidant qualities, despite the paucity of particular research on its direct effects on wounds [46]. These traits point to potential advantages in aiding the process of overall wound healing.

Gymnema sylvestre may be applied and used as a supplement or added to topical preparations to aid with wound healing. To create precise criteria for its efficient use in wound care, more research is necessary. To guarantee safety and effectiveness, medical specialists should be consulted before using Gymnema sylvestre for wound healing [46].

10. *Allium cepa*

The ability of onions, or Allium cepa, to heal wounds has been investigated. Its antioxidant and anti-inflammatory properties are facilitated by its bioactive constituents, which include sulfur compounds and quercetin [47]. According to research, onion extract aids in wound healing by promoting the synthesis of collagen and hastening the closure of wounds [48]. Scientific research supports the traditional usage of Allium cepa for wound care, demonstrating the herb's potential as a natural therapy to aid in skin healing.

Allium cepa for its ability to promote healing of wounds. Onion extracts may play a role in wound care because of research indicating they have anti-inflammatory, antibacterial, and antioxidant qualities [49].

Allium cepa is applied in wound healing through the use of onion extract in different forms, like gels or creams. According to [50], these formulations have been demonstrated to promote tissue regeneration, lessen inflammation, and help with wound healing. Onion extract is a promising natural therapy since it can modify important components in the wound healing process.

In practical application, Allium cepa can be mixed into dressings or applied directly to wounds. Studies on burns, surgical wounds, and other skin injuries have shown its advantages in accelerating wound healing [49].

11. *Carica papaya*

The plant Carica papaya, or papaya, has remarkable wound-healing qualities. It has been established that the papain enzyme found in papaya can facilitate wound debridement and hasten healing [51]. Research indicates that papaya extracts may have an impact on improved tissue repair because of their anti-inflammatory and antioxidant properties [52]. Papaya-based formulations have demonstrated encouraging outcomes in the treatment of wounds, making them an appealing natural choice for promoting the healing process [53].

Carica papaya's several bioactive components have shown promise in wound healing. Papain, an enzyme included in papaya, has a proteolytic activity that facilitates the debridement of wounds and aids in the removal of dead tissue [51]. This helps the healing process as a whole and creates a cleaner wound bed. Whether it's papaya latex, extracts, or dressings, papaya is applied in wound treatment. Research has demonstrated the beneficial effects of papaya-based formulations on tissue regeneration, wound healing, and reduced inflammation [54].

Papaya can be used as an ingredient in wound dressings or applied directly to wounds. It may be used as an adjuvant to conventional wound care techniques because of its inherent enzymatic activity and bioactive components, which provide an environment favorable for wound healing [51].

12. *Mangifera indica*

The ability of mangos, or Mangifera indica, to heal wounds has been investigated. Mango leaves are therapeutically effective for wounds because, according to research, they contain bioactive chemicals that have antibacterial and anti-inflammatory characteristics [55]. Mango leaf extracts have demonstrated encouraging outcomes in speeding up the healing process and encouraging collagen formation [56]. Mangifera indica has a high phytochemical content, which points to its potential as a natural help for wound care; however, more research may be required to completely understand its mechanisms and uses.

Some studies point to the possible benefits of Mangifera indica (mango) in wound healing, notwithstanding the paucity of actual study on the subject. Mangos are rich in bioactive substances with anti-inflammatory and antioxidant qualities, such as terpenoids and polyphenols [57]. These characteristics might be part of the plant's ability to promote wound healing.

In many cultures, applying mango leaf or extracts directly to wounds has long been a custom. Mango extracts' antibacterial action against specific bacteria and fungi may help shield against infections while the body heals [58]. To determine the precise processes and best uses of Mangifera indica in wound care, more research is necessary.

13. *Melaleuca alternifolia*

The Melaleuca alternifolia tree yields tea tree oil, which is prized for its antibacterial and anti-inflammatory qualities. According to studies, substances

like terpinen-4-ol are responsible for its efficaciousness in wound healing [59]. According to [60], tea tree oil has demonstrated promise in both avoiding infections and encouraging the growth of granulation tissue throughout the healing process. However, when using it to wound care, use caution and the proper dilutions. According to scientific studies, tea tree oil's healing properties make it a viable natural remedy for promoting wound healing.

Tea tree oil (TTO), well known for its ability to promote healing of wounds. It is efficient against a variety of bacteria, fungi, and viruses because of its antibacterial qualities, which are mainly attributable to the presence of terpinen-4-ol [59]. TTO is therefore a useful tool in the prevention of infections during wound care.

Applying tea tree oil topically, either in its purified form or blended into ointments, lotions, or dressings, is common in the treatment of wounds. According to [61], its anti-inflammatory properties help to lessen inflammation at the site of the lesion. It has been discovered that tea tree oil works well to encourage tissue regeneration and quicken the healing process. Excessive concentrations should be avoided at all costs because large dosages might irritate skin. It is often advised to use diluted formulations for safety and efficacy. Tea tree oil is an intriguing natural alternative for wound healing applications due to its adaptability and antibacterial qualities [61].

14. *Symphytum officinale*

The scientific name for comfrey is Symphytum officinale, and it has been used traditionally to treat wounds. Studies indicate that the allantoin content of comfrey extracts may promote cell proliferation and hasten wound closure [62]. The plant's capacity to encourage tissue repair is further enhanced by its anti-inflammatory qualities [63]. Although comfrey has demonstrated potential for wound healing, it is important to remember that internal usage of this herb has given rise to safety issues, highlighting the need for external administration that is cautious [62]. Research into the safety and effectiveness of comfrey in wound treatment is still ongoing.

The effectiveness of comfrey in healing wounds has been investigated. It is well-known for its traditional therapeutic purposes. Studies reveal that the compound allantoin, which has the ability to heal tissue, is present in comfrey [61]. Because of its ability to hasten tissue repair and lessen inflammation, comfrey has been used topically in a variety of formulations, including ointments and creams, to aid in the healing of wounds [63].

Although comfrey seems promising, it's important to remember that internal use has sparked worries about possible liver toxicity, particularly when taken as oral supplements [64]. As a result, topical treatment is typically seen as safer and caution is suggested. The use of comfrey for wound healing is consistent with its historical utilization; nonetheless, it is vital to be aware of any hazards related to specific forms of administration.

15. *Arnica montana*

Arnica, which comes from the Arnica montana plant, is frequently used to treat wounds and reduce inflammation. Studies indicate that chemicals with anti-inflammatory properties, such as sesquiterpene lactones, may be present in arnica [65]. According to some research, arnica may be helpful in the treatment of bruises, edema, and discomfort from wounds [27,65]. A fascinating topic in the field of natural wound healing, arnica is supported by some scientific evidence and has a long history of use. However, further research is necessary to completely grasp its mechanisms [66].

Arnica is a common herb in homeopathic and conventional medicine, however it's crucial to remember that more convincing clinical data is required to prove its effectiveness in healing wounds. As with any treatment, it's best to speak with a healthcare provider to ensure proper and safe use [65].

16. *Leptospermum scoparium*

The potential wound-healing qualities of manuka oil, which is extracted from the Manuka tree (Leptospermum scoparium), have drawn interest. According to research, manuka oil has antibacterial action against a variety of germs, which helps explain why it works so well for wound treatment [59]. Studies have demonstrated the oil's capacity to encourage tissue repair and lower inflammation, suggesting that it may be a useful natural wound care remedy [67]. Based on scientific research, using Manuka oil topically may provide an alternative to conventional wound care methods.

Manuka oil showed promise in the treatment of wounds. Its antibacterial qualities, ascribed to substances such as β-triketones, aid in preventing wound infections [59]. The anti-inflammatory properties of manuka oil could help lower inflammation while the body heals [68]. Manuka oil can be added to ointments and lotions or administered topically, diluted, to wounds. This is one way that manuka oil is used in wound treatment. It is a topic of interest in natural wound healing due to its historical use by indigenous populations and new scientific data [69].

Research indicates that manuka oil may have a role in promoting wound healing due to its special qualities; nevertheless, more investigation is required to completely comprehend its workings and maximize its use in therapeutic contexts.

17. *Echinacea purpurea*

The well-known plant echinacea has drawn interest due to its possible ability to heal wounds. Research indicates that by encouraging tissue regeneration and lowering inflammation, echinacea extracts may improve the healing process of wounds [70]. Alkamides and polysaccharides found in echinacea have immunomodulatory properties that enhance their therapeutic value for wound healing [71]. Based on available scientific data, Echinacea is still a topic of interest in the field of natural wound healing, even if further study is required to completely grasp its mechanisms.

Echinacea has been investigated for its potential in wound healing due to its well-known immunomodulatory qualities. According to studies, echinacea extracts may strengthen the immune system and aid in the body's natural healing process [72]. In order to take use of Echinacea's immunostimulatory properties, topical preparations or oral supplements are used in the treatment of wounds [68].

Echinacea's capacity to control inflammatory reactions and encourage tissue regeneration may account for some of its effectiveness in wound healing. While additional investigation is required to determine precise mechanisms, using echinacea in wound care may provide a natural way to aid in the healing process.

The resinous material called propolis, which bees gather from plants, has drawn interest due to its possible ability to heal wounds. According to studies, propolis has tissue-regenerating, antibacterial, and anti-inflammatory properties that speed up the healing of wounds [73]. Propolis is a good natural medicine for wound care because of its numerous bioactive components, which enhance its therapeutic properties [74]. According to research in this area, including formulations based on propolis may be a viable way to assist wound healing.

Because of its antibacterial, anti-inflammatory, and tissue-regenerating qualities, propolis, a natural resin that bees gather, has demonstrated effectiveness in the healing of wounds [73]. Propolis is used to make gels, ointments, or creams that can be topically applied to the injured region in order to treat wounds. Propolis is used to treat a variety of wounds, such as cuts, burns, and surgical incisions. Research indicates that it speeds up wound closure by encouraging cell proliferation and collagen formation [74]. Propolis's antibacterial activity aids in the prevention of infections, and its anti-inflammatory qualities serve to lessen inflammation at the site of the wound [73]. This organic compound presents a potentially fruitful path in wound care, serving as a substitute or adjunct to traditional therapies.

18. *Zingiber officinale*

Zingiber, sometimes referred to as ginger, has shown promise in the treatment of wounds due to its anti-inflammatory and antioxidant characteristics. Research indicates that by encouraging tissue regeneration and lowering inflammation, ginger extracts may hasten the healing process [75]. Applying formulations containing ginger, like lotions or poultices, may be a safe and efficient way to promote the healing of wounds [76].

Using ginger in topical formulations or directly applying ginger extracts to the afflicted region are two ways that ginger is used in wound care. Due to the therapeutic properties of its bioactive components, such as gingerol, it may be considered as a potential adjunctive wound healing strategy [77].

19. *Lawsonia inermis*

The potential of Lawsonia inermis, also referred to as henna, in wound healing has been investigated. According to research, henna has antibacterial and anti-inflammatory qualities, which makes it a potential aid in wound healing [78]. The beneficial effects of henna extract treatment on collagen synthesis and tissue regeneration two important components of the wound healing process have been examined [36].

Henna is traditionally used to cure wounds by making a paste out of its leaves and applying it to the injured region. Research on this natural therapy is being pursued since it has the potential to expedite the healing process [79, 80].

Table 2: Medicinal Plant for wound healing and key effect

Botanical Names	Family	Part Use	Key Effect
Aloe barbadensis	Liliaceae	Leaves	Anti-inflammatory, Cell Proliferation, Collagen Production
Carica papaya	Caricaceae	Fruit, Latex, Leaves	Antioxidant, Anti-inflammatory, Collagen synthesis, Enhanced Angiogenesis
Azadirachta indica	Meliaceae	Leaves, Barks	Anti-inflammatory, Cell Proliferation, Collagen synthesis
Allium cepa	Liliaceae	Bulb	Anti-inflammatory, Cell Proliferation, Collagen synthesi, Antimicrobial
Gymnema sylvestre	Asclepiadaceae	Leaves	Antioxidant, Anti-inflammatory
Moringa oleifera	Moringaceae	Leaves, Barks, Seeds	Antioxidant, Anti-inflammatory, Collagen synthesis, Antimicrobial
Tridax procumbens	Astraceae	Leaves	Anti-inflammatory, Cell Proliferation,

Botanical Names	Family	Part Use	Key Effect
			Collagen synthesis, Antioxidant
Curcuma longa	Zingiberaceae	Rhizomes	Antimicrobial, Antioxidant, Anti-inflammatory
Calendula officinalis	Astraceae	Leaves, Flower	Anti-inflammatory, Cell Proliferation, Antimicrobial
Lawsonia inermis	Lythraceae	Leaves	Anti-inflammatory, Collagen synthesis
Symphytum officinale	Boraginaceae	Leaves, Root	Anti-inflammatory, Collagen synthesis, Cell Proliferation

CONCLUSION

Achieving effective wound healing is essential to raising patients' standards of living. The focus of this overview is on natural compounds that are derived from tropical flora and fauna and are well-known for their ability to heal wounds, modulate immunity, and inhibit bacteria. Research has proved their efficacy and safety in the past, but more documented clinical trials are required to confirm their safety and effectiveness in human application. Finding the active ingredients that cause their effects on wound healing and comprehending the underlying mechanisms present the biggest hurdle. It is imperative to investigate the possibility of increasing the production of these compounds due to the growing demand for wound healing agents. One of the biggest obstacles to wound healing is continuing to control bacterial growth, exudates, and wound contracture. even though a certain quantity of wound contraction is normal throughout the healing process, too much contraction can result in physical abnormalities and functional restrictions. Furthermore, it is frequently not possible for current wound dressings to completely absorb viscous and heavy exudates. It is important to investigate the potential of natural products in managing exudates, limiting wound contraction, as well as effectively preventing infections at the wound sites in light of the emergence of multi-resistant bacteria.

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