

# Evaluation of Medicinal Plants for Their Therapeutic Potential in Wound Management

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## ABSTRACT

*Herbal medicine describes a variety of plants that are used to treat wounds and promote healing. Wounds can be caused by chemical, physical, or microbiological agents. Healing is a survival process that aims to preserve normal anatomical structure and function. Wound healing is the process by which tissue regenerates. Plants and their extracts have a lot to offer when it comes to wound care and management. In addition to being economical and accessible, phyto-medicines for wound healing are also claimed to be safe because they are not commonly associated with hypersensitive reactions. Through a variety of actions, these natural chemicals support the regeneration and restoration of the missing tissue. We have made an effort to present a summary of the many plants that may be able to heal wounds.*

**Keyword:** *Wound, Mechanism of wound, Types of wound, Herbal plants,*

**1. Introduction:** India offers a diverse range of lush flora that is found all around the nation. In traditional medical practices like Ayurveda, Unani, and Siddha, herbal remedies have served as the foundation for the treatment and healing of a wide range of diseases and physiological conditions. Both conventional and western medicine use medicinal plant components extensively. For thousands of years, medications made from plants have been a component of the development of human healthcare. China and India were big users of plant-based medications. These days, a significant number of medications that are effective against a variety of disorders are made from plants. Most of this entail separating out the chemical molecule that is the active ingredient from a certain medicinal plant and then modifying it.

A wound is a breach or disruption in the skin's or the underlying tissues' normal anatomical structure and function. These breaks are usually brought on by disease processes, surgical procedures, or physical trauma. According to Siddiqui and Bernstein (2010), wounds might differ in severity, depth, and extent. Therefore, it is important to receive the right medical care to promote healing and avoid problems. A wound can be induced by physical, chemical, thermal, microbiological, or immunological assaults and is described as a disruption of the cellular, anatomical, and functional continuity of a living tissue. Put differently, a wound is a breach in the integrity of the epithelium and may cause abnormalities in the structure and function of the normal tissue underneath<sup>6, 7, 8</sup>To restore the structure of the injured tissue, a complex process must occur that includes the migration, proliferation, interaction, and differentiation of different cell types (such as epidermal, dermal, and infiltrating inflammatory cells), biomolecular interactions, matrix component synthesis, and a complex signaling network<sup>9-12</sup>

Current estimates place the number of people affected by chronic wounds at about 6 million globally. Unhealed wounds release inflammatory mediators, which often lead to discomfort and edema in the area of the wound. Wounds result from injuries, and wounds slow down the healing process for the injured person. People who have chronic wounds may eventually pass away from multiple organ failure. The altered functional state and disrupted anatomical continuity of the skin must be restored with an appropriate wound-healing procedure. Physical trauma that results in the skin breaking or opening up is called a wound<sup>13-15</sup>.

**2. Classification of wound:** Based on the underlying cause of the wound's growth as well as the mechanics of the wound's healing process, acute and chronic wounds differ from open and closed wounds.

**Open wounds:** In this instance, bleeding is obviously evident as blood escapes the body. It is additionally categorized as: cut wound, Tear wound or laceration, cuts or gouges in the skin, wounds from punctures, Gunshot and penetration wounds<sup>16</sup>.

**Closed wounds:** Blood in closed wounds leaves the body but escapes the circulatory system. It comprises crush injuries, haematomas or blood tumors, contusions or bruises, etc.

**Acute wounds:** An acute wound is a tissue injury that typically results from a prompt, systematic healing process that preserves the anatomical and functional integrity of the injured area. Cuts or surgical incisions are typically the source of acute wounds, which recover within the anticipated time range<sup>17</sup>.

**Chronic wounds:** Chronic wounds often take a long time to heal or reoccur frequently because they have not been able to move through the usual stages of healing and have instead entered a state of pathologic inflammation. The most common causes of chronic wounds are systemic issues including diabetes mellitus, malnutrition, immunodeficiency, or drug side effects, as well as local infections, hypoxia, trauma, and foreign substances<sup>18, 19</sup>.

### 3. Mechanism of wound healing:

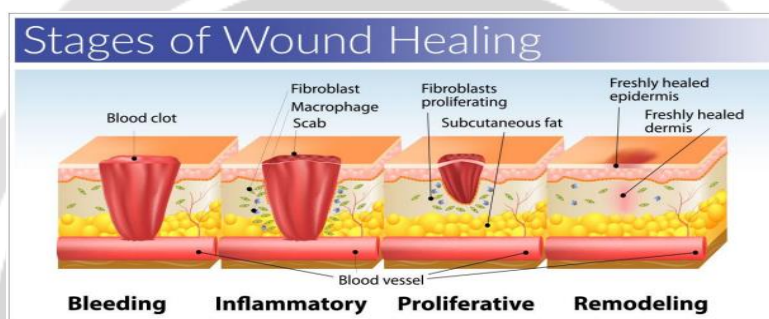


Fig 1 Stages of wound healing

Following an injury—whether medically or traumatically caused—the injured tissue or wound goes through three stages before complete repairs are made.

- The inflammatory phase
- The fibroblastic phase
- The remodelling phase

The inflammatory phase causes the wound to enlarge, become painful, and immobilize the area, limiting movement. This helps the area heal. The structure is rebuilt during the fibroblastic phase, and the final form is provided during the remodelling phase.

**3.1. The Inflammatory phase:** The inflammatory phase begins as soon as the damage and lasts for 24 to 48 hours on average, although in exceptional situations, it can last up to two weeks. The haemostatic processes are initiated during the inflammatory phase to promptly halt blood loss from the wound site. The result is the appearance of clinically identifiable cardinal signs of inflammation, rubor, Calor, tumour and function-lease. Vasoconstriction and platelet aggregation to cause blood clotting are the hallmarks of this phase, which is followed by vasodilatation and phagocytosis to cause inflammation at the wound site<sup>20</sup>

**3.2. The fibroblastic phase:** The fibroblastic phase, which follows the inflammatory phase by up to two or three weeks, is the second stage of wound healing. There are three phases in this phase: contraction, granulation, and epithelialization. Fibroblasts create a collagen bed and new capillaries during the granulation phase. Fibroblasts generate a number of materials, such as collagen and glycosaminoglycans, that are necessary for wound healing. In the third step, epithelial tissues grow over the wound site as a result of the contraction step, wherein the wound edges come together to reduce defects<sup>21</sup>.

**3.3. The Remodelling phase:** The duration of this phase ranges from two weeks to two years. During this period, the scar flattens, new collagen is produced, and because of the intermolecular cross-linking of collagen caused by vitamin C dependent hydroxylation, the scar tissues become 80% stronger than the original tissue<sup>22, 23</sup>. Since then, folklore has examined plants' capacity for wound healing. Using a variety of Ayurvedic herbal plants can help promote wound healing. Plants are better healers because they assist the body's natural healing mechanisms. A lot of research has been done on the use of medicinal herbs to control wound healing. Among the herbal remedies used to treat wounds include debridement, disinfection, and establishing a moist environment to encourage the body's natural healing process<sup>24</sup>.

#### 4. Medicinal plant with significant wound healing activity:

- ***Carica papaya*:** is a member of the Caricaceae family. The active ingredient papain, which has a preventive action against ulcers, is the basis for the traditional medicine's usage of *Carica papaya* Linn. The *Carica papaya* has anti-inflammatory, antioxidant, and antibacterial properties. It is also said to treat persistent ulcers. Using excision and dead space wound models, the aqueous extract of *Carica papaya* fruit was assessed for its ability to promote wound healing in streptozotocin-induced diabetic rats. Compared to the control group, the animals treated with extract showed a 77% decrease in the area of the wound. In comparison to controls, wounds treated with the extract were shown to epithelize more quickly. In comparison to controls<sup>25</sup>, there was a substantial increase in the hydroxyproline concentration and wet and dry granulation tissue weight<sup>25</sup>.
- ***Cordia dichotoma*:** Growing in India, Sri Lanka, and other warmer regions, a medium-sized tree with a short trunk, is a member of the Boraginaceae family. It has long been known that *Cordia dichotoma* has medicinal properties. Its fruits have purgative, anthelmintic, expectorant, cooling, astringent, and emollient properties. The herb has also been shown to have hepatoprotective, analgesic, and anti-inflammatory properties. The group treated with *Cordia dichotoma* displayed a significant increase in granulation that began on the surface. The wounds in the treated group healed completely and had nearly normal collagen and reticulin architecture. The alcoholic extract of *Cordia dichotoma* has been shown to promote collagen synthesis, which could explain the increase in tensile strength of the treated group wound<sup>26</sup>.
- ***Lepidium sativum*:** (Cruciferae) was widely known in European societies as *Herba Lepidii Sativi*. Its use as a vitamin source, diuresis agent, bile function stimulant, and cough reliever has increased in the former Soviet Union and Western European nations. Furthermore, this plant was a key component of Saudi folk medicine and was utilized in the Saudi Arabian population for a variety of purposes, the most common being the treatment of fractures. Traditional uses of the plant included its roots, leaves, and seeds; however, the influence of the seeds on the healing of fractures was observed in folk medicine and has been documented in rats. In Saudi Arabia and some other Arabic nations, the *Lepidium sativum* plant and its seeds are widely recognized<sup>27</sup>.
- ***Catharanthus roseus*:** a native of the Caribbean Basin and member of the Apocyanaceae family, is often referred to as *Vinca Rosea*. It has long been used as a remedy for a variety of ailments. More than 400 alkaloids are known to exist in *Catharanthus roseus*, some of which are licensed as anti-neoplastic drugs to treat cancer, rhabdomyosarcoma, neuroblastoma, Hodgkin's disease, leukemia, and other diseases. Alzheimer's disease and vascular dementia have been demonstrated to be lessened by its vasodilating and memory-boosting qualities. In certain rural cultures, plant extracts, either wet or dried, are used as a paste on wounds. When compared to placebo controls, an ethanol extract of *Catharanthus roseus* flowers can expedite wound healing activity due to certain properties<sup>28</sup>.
- ***Helianthus annuus*:** is a member of the Asteraceae family. An attractive annual herb with a hairy, rough, and upright stem is frequently seen in swampy parts of Indian gardens. Tribal people utilize this plant in traditional medicine to treat bone fractures, tiger bites, colic, ulcers, and irritation of the eyes. In one study, the total healing time was significantly shortened when an ointment made from the alcoholic extract of the complete *Helianthus annuus* plant was administered to a rat's excised wound. Histology, which showed earlier fibroblast presence, has verified this. Mucopolysaccharide buildup and early presentation have been identified as markers of accelerated repair<sup>29</sup>.
- ***Sesamum indicum*:** One of the world's first cultivated plants, *Sesamum indicum* Linn. (Pedaliaceae) is primarily planted for its edible seeds, which are rich in oil. The seeds' high content of sesame gives them a strong antioxidant effect. Sesame seeds have long been used to cure wounds, particularly burn burns.

The granulation tissue's hydroxyproline content, dry weight, and breaking strength were significantly increased in the dead space wound model after the addition of seeds and oil therapy. The findings imply that oral or topical application of *Sesamum indicum* oil and seeds has wound-healing properties<sup>30</sup>.

- ***Tribulus terrestris***: is a flowering plant that belongs to the Zygophyllaceous family and is endemic to Africa and warm temperate and tropical parts of southern Asia. *Tribulus terrestris* has long been used in Indian ayurvedic tonic formulations. Research conducted on rats, rabbits, and primates has indicated that the injection of *Tribulus terrestris* extract produces an increase in testosterone levels, which in turn produces an aphrodisiac effect. Protodioscin is probably *Tribulus terrestris*' active ingredient. In addition, it possesses cytotoxic, anthelmintic, diuretic, antimicrobial, and antifungal properties. The whole plant can be decocted to treat anuria, burning micturation, urinary tract infections, and growth-related obstruction. The gel that contained unrefined leaf extracts from *Tribulus terrestris* encouraged wound contraction, breaking strength, and the epithelialization phase<sup>31</sup>.
- ***Tridax procumbens***: Asteraceae has naturalized in tropical Africa, Australia, and Asia, including India. The primary components found in *Tridax procumbens* leaves include crude protein (17%), crude fibre, (39%), soluble carbohydrates, and 5% calcium oxide. The villagers use the plant's leaf juice to stop animals from bleeding from wounds and bruises. This juice slows down granulation and scar formation but speeds up the epithelialization and collagenization phases of healing<sup>32</sup>.
- ***Lantana camara***: Verbenaceae, a shrub native of tropical America has completely been naturalized in many parts of India as an ornamental plant. The plant has abortifacient, antimalarial, anti-inflammatory and wound healing properties. The hydro-alcoholic extract and fresh juice of leaves have favoured wound contraction<sup>33</sup>.
- ***Moringa oleifera***: The plant's leaves have also been noted to have diuretic, antioxidant, hypotensive, anti-inflammatory, radioprotective, and anti-tumour effects. Following an investigation, the aqueous extract was found to significantly improve granuloma dry weight, hydroxyproline content, skin-breaking strength, wound closure rate, and granuloma breaking strength. It also resulted in a decrease in scar area<sup>34</sup>.
- ***Terminalia bellirica***: also called belliric myrobalan, is a member of the Combretaceae family. Fruit is laxative, expectorant, brain tonic, astringent, antiseptic, and rejuvenating. Coughs, sore throats, diarrhoea, dysentery, and liver problems are all treated with it. Leprosy, fever, and hair care are among its other benefits. It has been applied as an antiseptic to all kinds of new wounds and used in traditional medicine to treat skin conditions. *Terminalia bellirica* ethanol extract Fruit's characteristics allow it to expedite the healing process of wounds when compared to placebo controls<sup>35</sup>.
- ***Vernonia arborea***: is a moderately sized member of the Asteraceae family. Among the many therapeutic uses of the plant are the infusion of roots or the decoction of bark for fever and the use of bark juice to treat worms. The rate of wound contraction, length of epithelialization, skin breaking strength, granulation strength, dry granulation tissue weight, estimation of hydroxyproline, and granulation tissue histology were used to evaluate the wound's healing. In every wound model examined, the use of bark extracts, both aqueous and methanolic, greatly enhanced the wound healing activity<sup>36</sup>.
- ***Lawsonia inermis***: commonly called as henna are used in the form of a decoction or ointment in the treatment of burns, skin inflammations, wounds and ulcers. The leaves also possess antifungal and antibacterial activities. Henna is reported to contain a naphthaquinone, lawsone, which is a natural dye. It was observed that the oral administration as well as topical application of ethanol extract of henna leaves and lawsone exhibited significant healing response in both the wound models. Further, it was found that the topical application of ethanol extract as well as isolated lawsone was more effective than the same given by the oral route. Thus, topical application of ethanol extract can be successfully formulated for the wound healing activity<sup>37</sup>.
- ***Adhatoda vasica***: known as chue Mue, grows as weed in almost all parts of the India. Leaves and stems of the plant have been reported to contain an alkaloid mimosine, leaves also contain mucilage and root contains tannins. *Adhatoda vasica* is used for its antihyperglycemic, anti-diarrhoeal, anti-convulsant and cytotoxic properties. The plant also contains turgorins, leaves and roots are used in treatment of piles and fistula. Paste of leaves is applied to hydrocele. The methanolic, chloroform and Diethyl ether extract ointment (10%w/w) of *Adhatoda vasica* has significant wound healing activity. In both extract ointment,



the methanolic extract ointment (10%w/w) showed significant effect when compare to standard drug and other two extract in excision wound model <sup>38</sup>.

- ***Napoleona imperialis***: is of the family of plants called Lecythidaceae. It is a woody plant, several meters high, found mainly in tropical rain forest. The leaf is used locally as analgesic, tonic, anti-tussive, anti-asthmatic, and wound dressing. The various ointments prepared with *Napoleona imperialis* exhibited a good wound healing effect, a standard antibiotic used in wound healing <sup>39</sup>.
- ***Trigonella foenum-graceum***: is a member of the Liliaceae. commonly referred to as fenugreek, have been known for a long time. The seed is astringent and is useful for treatment of dysentery and diarrhoea. It is a purgative tonic and carminative, and enriches the blood. Furthermore, it is effective in the treatment for ophthalmia, spleen disease, piles, and paralysis. The seeds of the plant are also used as an emollient and antidiabetic. It is reported to promote milk secretion in nursing mothers, probably through increased prolactin secretion. The seeds also contain a large quantity of folic acid, and they are used as wound healing agent in households. The seed suspension of *Trigonella foenum graceum* promoted epithelization and an early decrease in the wound surface area. The kinetics of wound contraction and epithelization were improved to a significant level upon oral as well as topical administration of the seed suspension <sup>40</sup>.
- ***Morinda citrifolia***: also known as noni or Indian mulberry, is a small evergreen tree. *Morinda citrifolia* has been heavily promoted for a wide range of uses; including arthritis, atherosclerosis, bladder infections, boils, burns, cancer, chronic fatigue syndrome, circulatory weakness, colds, cold sores, congestion, constipation, diabetes, drug addiction, eye inflammations, fever, fractures, gastric ulcers, gingivitis, headaches, heart disease, hypertension, immune weakness, indigestion, intestinal parasites, kidney disease, malaria, menstrual cramps and irregularities, mouth sores, respiratory disorders, ringworm, sinusitis, sprains, stroke, skin inflammation and wounds. A significant increase in the wound-healing activity was observed in the animals treated with the *Morinda citrifolia* extract compared with those who received the placebo control treatments. The extract treated animals showed a more rapid decrease in wound size and a decreased time to epithelialisation compared with the control rats which received plain water <sup>41</sup>.
- ***Anthocephalus Kadamba***: is widely distributed throughout the greater part of India and is used as a folk medicine in the treatment of fever, anaemia, uterine complaints, blood diseases, skin diseases, leprosy, dysentery, and for improvement of semen quality. The leaves are recommended as a gargle in cases of stomatitis. The major constituents of bark are triterpenes, saponins, indole alkaloids cadambine, 3adihydrocadambine, cadamine, isocadamine and isodihydrocadambine. The wound healing activity results showed that upon application of hydro-alcoholic ointment there was a decrease in the epithelization period, along with a visibly decreased scar area. There was also a significant increase in the tensile strength and hydroxyproline content. The crude hydro-alcoholic extract showed significantly stimulated wound contraction. Thus, the plant extract might be useful as a wound healing agent <sup>42</sup>.
- ***Allium cepa***: A member of the Liliaceae family, which has over 250 genera and 3700 species, is *Allium cepa* Linn. It has been demonstrated that *Allium cepa* Linn. has anti-diabetic, anti-oxidant, anti-hypertensive, antithrombotic, hypoglycaemics, and anti-hyperlipidaemic properties. *Allium cepa* bulbs are rich in prostaglandins, ferulic acid, myristic acid,  $\beta$ -sitosterol, and Kaempferol. Rats have demonstrated the ecboic impact of bulb extract. Plants with these ingredients have historically been employed as abortifacients; in mice and rats, the extract from the bulb of *Allium cepa* had an ecboic effect. The group treated with *allium cepa* displayed a significant increase in granulation that began on the surface. The wounds in the treated group healed completely and had nearly normal collagen and reticulin architecture. An increase in collagen concentration may be the cause of the treated group wound's increased tensile strength of treated group wound may be due to increase in collagen concentration, alcoholic extract of *Allium cepa* increase the collagen synthesis<sup>43</sup>.
- ***Sphaeranthus indicus***: *Sphaeranthus indicus* Linn. is a member of the Asteraceae family. Hemiparalysis, mental disease, and epileptic illnesses (convulsions) are the principal conditions for which the plant is utilized. This paste is applied externally to treat edema and pruritus, arthritis, filariasis, gout, and cervical adenopathy. Ocimene,  $\alpha$ -tempinene, methyl-chavicol,  $\alpha$ -citrol,  $\alpha$ -ionone,  $\beta$ -ionone, d-cadinene,  $\rho$ -methoxycin, anisaldehydes, and alkaloid are its primary constituents. Phaeranthine <sup>44,45</sup>.
- ***Musa sapientum***: is a member of the Musaceae family. It has sitoindisides I–IV, sterylacyl glycosides, and flavonoids (leucocyanidin). According to reports, peritoneal macrophages can be activated and

mobilized by sitoindoside IV, leading to an increase in DNA and [3H] thymidine absorption. Since flavonoids have astringent and antibacterial properties that cause wound contraction and an accelerated rate of epithelialization, they are also known to minimize lipid peroxidation and to aid in the healing process of wounds.

Over the past 30 years, numerous studies have been conducted to determine the plantain banana's anti-ulcerogenic and ulcer-healing properties. When compared to the control group, both methanolic and aqueous extracts (100 mg/kg) decreased the percentage of wound area, scar area, and lipid peroxidation and increased wound breaking strength and levels of hydroxyproline, hexuronic acid, hexosamine, and superoxide dismutase. They also reduced glutathione in the granulation tissue<sup>46,47</sup>.

- ***Kigelia pinnata Sausage***: is a tiny tree that grows in India, South, Central, and West Africa and is a member of the Bignoniaceae family. Naphthoquinones, lapachol, phenyl propanoid, stigmasterol,  $\beta$ -sitosterol, and trace amounts of free ferlic acid, p-coumeric acid, and 6-methoxymelenin are the principal components of *Kigelia pinnata* bark. Additionally, pharmacological studies have demonstrated the bark's antibacterial, antifungal, antiulcer, antiamebic, and antioxidant properties. It also exhibits a notable capacity for wound healing<sup>48</sup>
- ***Tephrosia purpurea***: is a member of the Leguminosae family. Another name for it is "Sarwa Wranvishapaka." Glycosides, rotenoids, isoflavones, flavonoids, chalcones, flavonoids, and sterols are all present in it. Many parts of this plant are utilized as remedies for rheumatism, ulcers, gonorrhea, asthma, impotence, and urinary diseases in the Ayurvedic medical system. Moreover, it treats disorders of the kidneys, liver, spleen, heart, and circulation. The dried herb's roots and seeds are used as an insecticidal, vermifuge, and leprosy wound remedy. It is also a tonic, laxative, and diuretic, and it is used to treat bronchitis, boils, bleeding piles, and acne. Additionally, the juice is utilized to treat skin eruptions. When vomiting, take a decoction. An extract from the pods reduces inflammation and pain<sup>49</sup>.

**Conclusion:** The natural process of wound healing begins with trauma and finishes with the production of scars. The current analysis unequivocally demonstrated that a vast array of plants found in nature exhibit noteworthy wound-healing properties. These natural systems provide a wealth of opportunities for the creation of synthetic medication substitutes. Better medications with fewer adverse effects can be created by combining traditional and modern expertise. Nevertheless, before using traditional medicinal herbs to treat wounds, they must first undergo scientific validation, standardization, and safety assessment.

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