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## Review Article

# Assessing the Efficacy of Different Medicinal Plants in Promoting Wound Healing

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### ABSTRACT

The skin acts as a defence system against heat, chemicals & physical damage, protecting the internal organs the immune system of the skin shields the body from harmful diseases. The process of wound healing is the body's innate reaction to tissue damage (1). Healing of wounds is a natural process that occurs in the human body and involves four distinct and carefully regulated phases (2). For a wound to heal effectively, it is important for all four phases to take place in the correct order & time frame. The healing of skin wounds is Complicated & involves various cells, cytokines, mediators & the vascular system working together. It is a intricate & carefully regulated Procedure that is crucial for maintaining Skin regulatory function as well as the skin's protective function. If the skin is injured, bacteria can immediately enter the tissues beneath it, causing severe infections & long-lasting wounds that can be life (3). The ancient wisdom of plant-based medicine has yielded a treasure trove of Phyto-medicines, each imbued with remarkable pharmacological properties. These natural guardians of health have been employed with impressive results, fortifying the body's defences against wounds and infections. Numerous plants have been identified as having wound healing properties, working through various mechanisms to promote prevention, repair, and recovery. The Green Architects of Skin Regeneration: Unlocking Nature's Remedies: An Exploration of Botanicals in Wound Repair. This review charts the fascinating landscape of medicinal plants that have been leveraged to enhance skin healing, examining the multifaceted therapeutic properties and mechanistic strategies that enable them to accelerate wound recovery. By mapping the botanical terrain of skin regeneration, we aim to uncover the hidden patterns and connections that underlie the remarkable efficacy of these plant-based remedies.

### INTRODUCTION

A wound is any damage to the skin's barrier that lets pain and illness enter the body. A wound is an

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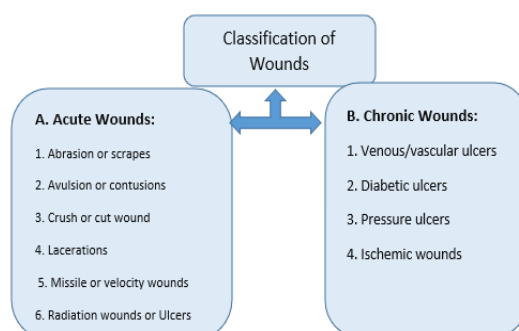
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interruption in the structure of the skin caused by a disease, trauma, or external injury Wound narrowing is the process of returning damaged tissue to its pre-damaged state, whereas wound healing is the process of the wound contracting. The sort and extent of the damage, the tissue's general health, and the tissue's ability to mend itself are the main determining factors. The Wound's Regenerative Niche: A Nexus of Cellular Transformation, At the wound's edge, a remarkable process unfolds, as undifferentiated mesenchymal cells, the blank canvases of tissue regeneration, differentiate into fibroblasts, the master builders of the extracellular matrix. These cells converge with collagen, the structural framework, edema, the transient yet vital influx of fluid, and the tiny, newly formed blood vessels, the lifelines of nutrient and oxygen delivery. Together, they form a dynamic, regenerative tissue that heralds the wound's transformation. The effects of methanol extracts of *K. rotunda*, *E. cannabinum*,

and their separated components were screened on, incision, excision and dead space wound models in addition to the control and reference standard fencyctin sulphate cream treated animals. Several of these drugs have been scientifically tested to see if they may heal wounds in different pharmacological models and people, but there is still unrealized Nature's Pharmacopeia: Unveiling the Hidden Potential of Herbal Wound Care, In the realm of traditional herbalism, a wealth of untapped potential awaits discovery. Active chemical components, hidden within the petals, leaves, and roots of ancient remedies, hold the key to enhanced wound healing. As we navigate the complex terrain of skin injuries, two distinct categories emerge: open wounds, where the skin's canvas is torn asunder, and closed wounds, where the subtle brutality of blunt force trauma conceals the damage, inviting the gentle touch of herbal restoration.

### Classification of wounds:



**A. Acute Wounds:** Acute wounds are the ultimate demonstration of the body's incredible healing velocity. These wounds are the fast lane to recovery, where the skin's self-repair machinery kicks into high gear, accelerating the journey from injury to restoration. With acute wounds, the body's natural repair processes are supercharged, propelling the healing process forward with remarkable speed and agility following a natural and organized process that restores both function and appearance. These wounds often occur after surgery or trauma.

**B. Chronic Wounds:** Chronic wounds, , are defined by their failure to heal within a month and their deviation from the normal healing stages, often getting stuck in one phase. This type of wound is more challenging to treat due to its abnormal healing process, slow progress, and tendency to persist, leading to significant consequences (5).

### Wound healing process:

"The Wound Healing Odyssey: A Harmonious Symphony of Four Distinct Chapters, The journey of wound healing unfolds as a beautifully orchestrated sequence of interconnected phases,

each building upon the previous one to restore the skin's integrity. This intricate process can be distilled into four distinct yet overlapping chapters (4).

**(1) Coagulation:** In this initial phase, a protective blood clot forms, serving as a makeshift shield to stem fluid loss and block the invasion of harmful microorganisms. It helps restore hemostasis, serves as a storage for bioactive substances and antimicrobials, creates a provisional extracellular matrix that aids in immune cell movement, and kickstarts the process of tissue repair.

**(2) Inflammation:** In this phase, the body responds to injury by sending signals that attract immune cells, increase blood flow, and release antimicrobial substances to combat potential infections. The body's response is activated by a combination of molecular triggers, including specific patterns, free radicals, and other reactive compounds. As a result, immune cells infiltrate the area, releasing alarm signals and activating nearby cells, including keratinocytes (skin cells) and fibroblasts (connective tissue cells), to initiate the healing process.

**(3) Proliferation/migration/reepithelialization/granulation:** The healing process advances to a new level, characterized by a harmonious convergence of multiple cell types, leading to: Cell growth and movement (migration and proliferation), Inflammation subsiding, Production of collagen and connective tissue framework

(ECM synthesis), Reduced leakage from blood vessels, Formation of new tiny blood vessels (angiogenesis), Restoration of the skin's surface layer (re-epithelialization), Creation of new tissue (granulation tissue formation).

**(4) Remodelling/maturation:** The changes in collagen/ECM balance (production and breakdown); reorganization and alignment of ECM; contraction of ECM; apoptosis of endothelial cells and fibroblasts; and restoration of pigmentation.

**Different wound healing models:**

- A. In-vitro Studies:
  1. Chick chorioallantoic membrane assay
  2. Fibroblast assay
  3. Keratinocytes assay
  4. Collagen assay
  5. Scratch assay
  6. Endothelial cell in-vitro tube formation assay
- B. Ex-vivo studies:
  1. Human organotypic skin explanted culture (hosec)
  2. Porcine model
  3. Human ex-vivo skin culture (HESC)
  4. Organotypic culture (OTC)
- C. In-vivo studies:
  1. Excision wound model
  2. Incision wound Model
  3. Burn wound model
  4. Dead space wound model (6)

**Table: Plant based medicines on wound healing:**

Sr. no.	Medicinal Plant Name	Type of assay used	Experimental Models	MOA	Reference
1.	Curcuma longa	In vivo	Albino Rats	Anti-bacterial, anti-fungal, and anti-inflammatory activities. Increased collagen secretion, fibroblasts migration and angiogenesis	7
2.	Aloe vera	In vivo, Punch biopsy,	Sprague Dawley Rats	Immunomodulatory Antiviral, Anticancer, Antidiabetic, Anti-	8



				inflammatory, Increased collagen formation and neovascularization.	
3.	Sesamum indicum L seed and oil	In vivo	Excision, Incision, Dead space & burn wound models on Albino rats	Enhances epithelisation, antipoxidants	9
4.	Artemisia pallens	In vivo	Burn wound	antioxidant activity, antimicrobial activity	10
5.	Gymnema sylvestre	In vitro/In vivo	Burn Wound & excision	Enhanced reepithelialization, fibroblast proliferation and antioxidant activity	11
6.	Carica papaya	In vivo	Excision & dead space	Antimicrobial	12
7.	Sphaeranthus indicus	in vivo	Albino rats	Antimicrobial, protection against microbial invasion	13
8.	Glycyrrhiza glabra	In vivo	Sprague- Dawley rats	Accelerated Wound Healing: Angiogenesis, collagen secretion and tensile strength, fibroblast proliferation of the wounds	14
9.	Bacopa monnieri	In vivo	Albino rats	Enhanced re-epithelialization and collagen secretion.	15
10.	Azadirachta indica	In vitro/In vivo	Diabetic rats/ Wistar rats	Triple Threat Against Wound Infection: Antimicrobial, cell proliferative and anti-inflammatory activity	16
11.	Andrographis paniculata	In vivo	albinos Wistar rats (Excision model)	Antimalarial, Antimicrobial, Antioxidant, Antiviral, Hepatoprotective, Hypotensive, Immunostimulatory	17
12.	Blumea balsamifera	In vivo	Mice (Excision wound model)	Antifungal, Antiobesity, Antiplasmodial, Antitumour	17
13.	Boswellia sacra	In vivo & in vitro antibacterial assay	Excision wound model in diabetic C57BL/6 mice	Antiallergic, Antibacterial, Anti-inflammatory	17
14.	Calendula officinalis	in vitro/In vivo	Rats Scratch assay, Excision wound model in BALB/c mice, Punch wound model	Anticancer, antifungal, anti-inflammatory, Antibacterial,	17

15.	Ficus benghalensis	In vivo	Excision & incision, wistar albino rats	Increased wound tensile strength	18
16.	Capparis zeylanica	In vivo	Excision, incision	Wound healing activity	19
17.	Acalypha indica	In vivo	Albino rats	Activated TNF-alpha and increase cell proliferation	20
18.	Brugmansias uavelens Bercht. Presl. Leaves	In vivo	Albino rats, excision, incision & dead space model	Promote wound healing activity	21
19.	Allium sativum (garlic)	In vivo	Incision on rabbits	Anti-inflammatory & wound healing activity	22
20.	Eucalyptus oil	In vitro & in vivo	HFB4 invitro test, rats	Antimicrobial activity	23
21.	Tridax procumbens	In vivo	Excision, rats	Wound healing activity, prohealing potential & anti-inflammatory activity	24
22.	Chromolaena odorata (L.) (Siam weed)	In vitro/In vivo	Male Sprague Dawley rats, Fibroblast, keratinocytes and endothelial cells, adult	Hemostasis, vasoconstriction, anti-inflammatory, antimicrobial, and Antioxidant	25
23.	Margina oleifera Lam	In vivo	Excision, incision	Wound healing activity	26
24.	Ceologyne cristata	In vivo	Excision & incision	Anti-inflammatory	27
25.	Musa sapientum (banana)	In vivo	Excision, incision, ulcer	Wound healing activity	28
26.	Calotropis gigantea	In vivo	Rats, incision	Increase breaking strength of incision wounds	29
27.	Cinnamomum cassia	In vitro and in vivo	Rats (Excision wound model)	Anticancer, Anti-inflammatory, Antimicrobial, Antioxidant, Antidiabetic	30
28.	Scoparia dulcis	In vivo	Excision, incision	Anti-inflammatory & wound healing activity	31
29.	Panax ginseng	In vivo	Laser burn, excision cell migration, wound healing assay	Antiaging, Antiallergic, Anticancer, Anti-inflammatory	32
30.	Cassia fistula	In vitro/In vivo	Male Wistar albino rats	Anti-bacterial, increased re-epithelialization and collagen secretion	33

31.	Commiphora myrrha	In vitro	cell migration assay	Analgesic, Antibacterial, Anti-inflammatory, Antioxidant	34
32.	Ocimum sanctum	In vivo	Excision, incision	Wound healing activity	35
33.	Gmelina arborea	In vivo	Wistar albino rats	Anti-inflammatory and antioxidant activity	36
34.	Rubia cardifolia	In vivo	Excision, incision	Wound healing activity	37
35.	Ipomoea batatas (sweet potato)	In vivo	Excision, incision	antioxidant activity, antidiabetic activity	38
36.	Salvia officinalis	In vivo	Wistar rats, Swiss albino rats	Anti-inflammatory, anti-nociceptive and inhibited ROS production, increased blood vessels formation	39
37.	Panax notoginseng	In vitro	Rats	Anticancer, Antidiabetes, Anti-inflammatory, Antioxidative, Immunostimulatory	40
38.	Hibiscus rosasinensis	In vivo	Rats (Excision, incision and dead space wound models)	Antibacterial, Antitumour,	41
39.	<i>Acanthus polystachyus</i>	In vivo	Excision & incision	Analgesic, antitumor, immunomodulatory, and anti-inflammatory effects, antioxidant, antimicrobial	42
40.	Malva sylvestris	In vivo	Wistar rats, BALB/c albino mice and Diabetic rats.	Increased collagen synthesis, reduce fibrosis, increased reepithelialization time and antiinflammatory	43
41.	Rheum officinale	In vivo	Excision on rats	antiinflammatory, antioxidative, hemostatic	44
42.	Salvia miltiorrhiza	In vitro	Rats	Anticancer, Anti-inflammatory, Antimicrobial, Antioxidant, Antiplatelet aggregation	45
43.	Ganoderma lucidum	In vivo	Mice	Antihyperlipidemic, Anti-infective, Anti-inflammatory, Antioxidant, Cardioprotective	46

44.	<i>Terminalia arjuna</i>	In vivo	Excision incision on rats	rapid healing of the wound	47
45.	<i>Sanguisorba officinalis</i>	In vivo	Burn wound model in mice	Antioxidant, Haemostatic, Immunomodulatory	48
46.	<i>Camellia sinensis</i>	In vivo	Excision, Sprague Dawley rats	Anti-inflammatory, wound healing activity	49
47.	<i>Punica granatum</i>	In vivo	Burn wound model, rats	antioxidant, anti-inflammatory, and anti-bacterial effects, increased fibroblast production	50
48.	<i>Glycyrrhiza glabra</i>	In vivo	Sprague-Dawley rat, burn wound	Anti-bacterial, antioxidant, anti-arrhythmic, anti-viral, antioxidant and anti-inflammatory,	51
49.	<i>Merremia tridentata</i>	In vivo	Excision, incision & dead space models	effective wound healing activity.	52
50.	<i>Lonicera japonica</i>	<i>In vivo</i>	Rat excision wound model	Anti-inflammatory, Antimicrobial, Antioxidant	53

## CONCLUSION:

Changes in one of the healing phases or disruptions to skin integrity cause the wound healing process to be delayed. Modifiable risk variables need to be understood and optimized in order to manage wounds efficiently. These reviews include information about medicinal plants, many of which are gifts from nature that have exceptional wound-healing properties. Because these plants have strong active components that have antibacterial, anti-inflammatory, and antioxidant qualities, they can be utilized to treat wounds in a variety of ways

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