

An Overview on Herbals used for Wound Healing

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ABSTRACT

Wound healing is a dynamic and normal biological process involving fibroblast activation and migration, re-epithelization, proliferation of endothelial cells, and angiogenesis, which are accompanied by inflammatory response and oxidative reactions in the damaged area. Herbs have been integral to both traditional and non-traditional forms of medicine dating back at least 5000 years. The enduring popularity of herbal medicines may be explained by the perception that herbs cause minimal unwanted side effects. More recently scientists increasingly rely on modern scientific methods and evidence-based medicine to prove efficacy of herbal medicines and focus on better understanding of mechanisms of their action. Preparations from traditional medicinal plants are often used for wound healing purposes covering a broad area of different skin related diseases. The main aim of this review article is potential of herbs for effective treatment of wound.

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I. INTRODUCTION

A wound can be defined as disruption or breakage of cellular tissue continuity with or without microbial infection^[1]. It can be generated by physical, chemical, thermal, immunological and microbial exploitation^[1,2]. Wound contain physical damage (pressure ulcer), thermal damage (burns), mechanical damager (cut, abrasion, lacerations) etc. If wound is untreated in earlier stages may lead to pain, inflammation, infections and sometimes organ failure^[3]. Wound healing occurs the moment the injury cause and extend according to the rate at which four stages completes: Hemostasis phase, inflammatory phase, proliferate phase and remodeling phase depending on extent of damage and eventually determines the appearance and strength of the tissue healed^[4]. Wound can compromise the patients well- beings, self-image ,working capacity and independence. Effective wound management should be necessary not only on the individual but also on the community level^[5].

1.1 Classification of Wound

Wound are included into three classes i.e. based on nature of wound, intensity of the wound and physiology of the wound.

- **Based on nature wound:**

Open wound: An open wound is break in skin's surface that may cause external bleeding and allow bacteria to enter in the body, causing an infection such as: contusions, abrasions, hematoma^[6], incision, laceration, abrasion etc^[7]. Closed wounds: When blunt object strikes the body, a closed wound happens such as: Incised, lacerated, penetrating and crushed.

- **Based on Intensity of wound:**

Simple wound: In this type, the damage is only to the skin.

Complex wound: In this type, the wound involves underlying tissues, tendons etc.

- **Based on Physiology of wounding:**

Acute wounds: Those wounds that get healed in short period of time and proceeds through series of steps that are necessary for wound healing for the restoration of anatomical integrity of injured site, such as: wound due to cut & surgical injury^[8].

Chronic wounds: These types of wounds takes a long period of time for their healing .For example: local infection, loss of oxygen supply, trauma, diseases such as diabetes, nutritional insufficiency and medication may contribute to development of chronic wounds^[9].

1.2 Mechanism of wound healing

The response to injury, either surgically or traumatically induced, is immediate and the damaged tissue or wound then passes through four phases in order to affect final repair^[10]:

- The Hemostasis Phase

- The Inflammatory Phase
- The Proliferation Phase
- The Remodeling Phase

Hemostasis: Hemostasis starts immediately after injury and cause arrest of bleeding by formation of platelets. It involves vascular constriction, Platelet aggregation & fibrin formation.

Inflammation: It lasts for 4-6 days. It involves hemostatic mechanism to prevent blood loss from the site of wound ^[11].

Proliferation: It starts after inflammation which lasts for 5-21 days. It involves the formation of granulation tissue, angiogenesis, re-epithelialization.

Remodeling: This phase lasts for 3 weeks -2 years. It involves the synthesis of collagen and scar formation ^[12].

Table 1: Phases of Wound Healing ^[13,14]

Sr. no.	Phase of healing	Time Post Injury	Cells involved in Phases	Function/ Purpose
1	Hemostasis	Immediate	Platelets	Arrest of bleeding
2	Inflammation	2-5 days	Neutrophils Macrophages	Removal of cell debris and infection causing agents
3	Proliferation (granulation contraction) and	5-3 Weeks	Lymphocytes Fibroblasts Keratinocytes	Granulation tissue formation, Angiogenesis
4	Remodeling (maturation)	21 days- 2years	Fibroblasts	Formation of collagen & maturation of Scars

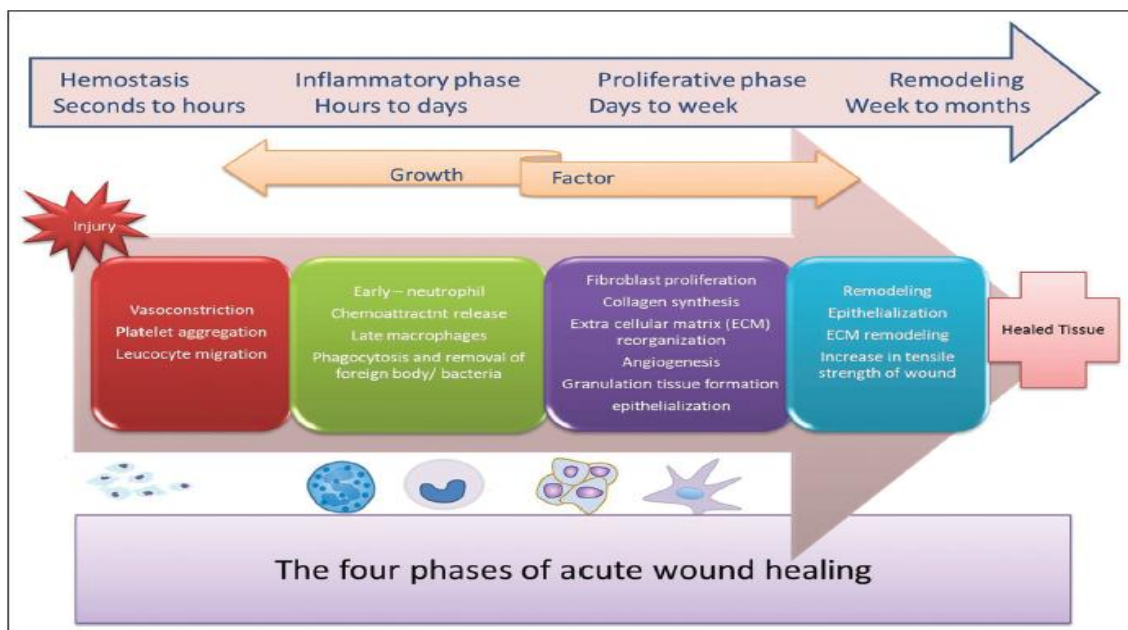


Figure 1: Physiology of Wound Healing

1.3 Factors Affecting Wound Healing

In general, wound healing is viewed as an interaction between a complex cascade of cellular and biochemical activities culminating in the restoration of structural, functional integrity, and increased strength in injured tissues. The phases of wound healing usually go on in a fashionable and time-dependent manner. Any disruption in the process of wound healing may potentially lead to chronic wound or pathological scarring ^[15,16]. There are various factors that affect wound healing, and a good understanding of these factors and their possible influence on wound healing may be important in the development of therapeutic agents for wound healing in diabetic and non-diabetic conditions. Factors that affect wound healing are discussed below.

Wound site

The site of the wound is an important factor in wound healing as wound infection is a common reason for impaired wound healing ^[17,18]. *Staphylococcus aureus* and *Pseudomonas aeruginosa* are few of the

organisms responsible for wound infection, and reports have found that *S. aureus* is the main pathogen associated with diabetic foot infection^[19,20].

Immune state

Various components of the immune system are affected in patients with diabetes. It has been reported that polymorphonuclear leukocyte function is reduced particularly in the presence of acidosis while leukocyte adherence, chemotaxis, and phagocytosis may also be negatively affected in diabetic state^[21,22], consequently causing delayed wound healing. Antioxidant systems that participate in bactericidal activity may be impaired in diabetic state, making the wounds in diabetic patients to be susceptible to infection^[23,24]. Diabetes is a risk factor for bacteria in patients with pneumococcal pneumonia and is linked to increased mortality^[25,26].

Age

There seems to be a relationship between the ages of an individual and wound healing process^[27]. Wound healing seems to be delayed in older age. This is possibly due to the fact that fibroblast growth and activity decrease in older people while collagen synthesis and wound contraction are also reduced in injured older people^[25,27].

Disease state

S. aureus and beta-hemolytic streptococci are treated as pathogens in early diabetic foot infections. Studies have reported a higher incidence of bacterial infection in diabetic women than in non-diabetic women^[27]. It seems that diabetic patients are more susceptible to wound infection. Greenhalgh^[28] reported a higher incidence (11%) in wound infection in diabetic patients than in the general patient population.

Reactive oxygen species (ROS)

The high concentration of ROS could induce serious tissue damage which could lead to neoplastic transformation, further leading to the impaired healing process by inducing cellular, DNA, proteins, and lipids damages^[29,30].

Diet

Diet has been reported to affect wound healing. It was observed that serum albumin level of 3.5 g/dl or more is required for adequate wound healing. Decreased level of protein could negatively affect collagen synthesis thereby impairing wound healing^[29,31].

II. METHODS ASSESSED FOR REVIEW

To collect all cases of herbs which are useful for wound healing activity, a selective literature search using publicly available electronic databases (especially the PubMed database, Scopus, and Korean databases) was performed. We used the search items including “Herbal for wound healing”, “classification and mechanism”, “Aloevera”, “Tulsi”, “Eucalyptus”, “Neem”, “Turmeric”, “Bael”, “Panaxginseng”, “German chamomile”, “Burdock *Arctium lappa*”, “*Calendula officinalis*”, “herbs induced wound healing in diabetic patients”. The search was primarily focused on English-language case reports, case series and clinical reviews, published till Nov. 2020. The literature with language other than English was used by converting them into English.

III. NEED OF REVIEW

From the prevalence survey we estimated the point prevalence of all complex wounds to be 1.47 per 1000 people (95% confidence interval 1.38 to 1.56 per 1000 people). Pressure ulcers and venous leg ulcers were the most common type of complex wound. Herbs have been integral to both traditional and non-traditional forms of medicine dating back at least 5000 years. The enduring popularity of herbal medicines may be explained by the perception that herbs cause minimal unwanted side effects. More recently, scientists increasingly rely on modern scientific methods and evidence-based medicine to prove efficacy of herbal medicines and focus on better understanding of mechanisms of their action. However, information concerning quantitative human health benefits of herbal medicines is still rare or dispersed, limiting their proper valuation. Preparations from traditional medicinal plants are often used for wound healing purposes covering a broad area. Herbal medicines in wound management involve disinfection, debridement, and provision of a suitable environment for aiding the natural course of healing. An aim of this review is therefore to review herbal medicines, which pose great potential for effective treatment of minor wounds.

IV. Medicinal Plants in Wound Healing

Medicinal plant materials and herbal remedies derived from them represent a substantial portion of the global medicinal market. Herbal remedies and drugs have played a significant role in curing diseases throughout

the history of mankind. Though a large amount of literature is available on their curative properties, standard procedures for quality control of plant materials with respect to their identification (phytochemical, pharmacological, and therapeutic activity) are not available. Standardization of medicinal plants ensure their consistency and therapeutic effectiveness. Herbal products are evaluated for their identity (characterization), quality, and quantity of the extracts present, as it is required to evaluate their therapeutic efficacy, i.e., to know their pharmacological action to evidence authenticity^[32]. Herbal medicines have the potential to treat and cure illnesses like ulcers, healing of wounds, skin infections inflammation, scabies, leprosy, and venereal disease^[33]. Herbal medicines in wound treatment or care include disinfection, debridement, and providing a moist atmosphere which facilitates development of appropriate natural healing climate. Folklore cultures employ a significant number of plants to treat cuts, wounds, and burns^[34,35].

4.1 Aloe (Aloe vera)



Figure 2 : Aloe vera

Synonym – Aloe *Barbadensis* miller, cape aloe, curacao aloe.

Aloe vera, commonly known as Kumari, used as an herbal medicine found in all over India. Morphologically Aloe vera has short stem with shallow root system and large fleshy leaves. It grows as wild plant in deserts of India^[36,37]. There are more than 100 active components found in Aloe vera, possessing wound healing properties as well as astringent, hemostatic, antidiabetic, antiulcer, antiseptic, antibacterial, anti-inflammatory, antioxidant, anticancer, anti-diarrheal^[38]. According to a study by Saini, et al.^[39], Aloe vera leaves pulp has comparatively better and faster wound healing capacity than Povidone Iodine ointment (5% w/w) on excision wound model^[40]. It has also been reported that, Aloe vera not only speeds up healing but also protects affected surface from getting infected by microbes. Aloe vera is reported to enhance collagen turnover rate and enhance the level of lysyl oxidase which cross-links newly synthesized collagen^[41]. Aloe vera also have ulcer healing property (when taken internally) and gives protection to skin^[37]. Aloe vera gel if topically applied significantly increases wound contraction and wound closure. It has a significant influence on the level of collagen, which acts as the precursor protein for wound healing. Histological studies reported that Aloe vera gel accelerates epithelialization, neo-vascularization and increased wound contraction in the later stage of the wound healing process^[42]. Its healing property is attributed to a compound called glucomannan, which consists of polysaccharides. The mucilage of Aloe vera also increases transversal connections among collagen bands without changing collagen structure, therefore accelerates wound improvement^[43,44]

4.2 TULSI



Figure 3: Tulsi

Synonym – Sacred basil , Kali tulsi , Veranda.

Ocimum sanctum (Sanskrit: Tulasi; family: Labiaceae), is found entirely in subtropical and tropical parts of India. Different parts of the plant are traditionally used in Ayurveda and Siddha systems for the treatment of various ailments like infections, skin diseases, liver diseases and as an antidote for snake bite and scorpion sting^[45,46]. *Ocimum sanctum* leaves consists of tannins like gallic acid, chlorogenic acid, etc. and contain alkaloids, glycosides, and saponins along with the volatile oil. The major active component of basil leave is urosolic acid. It consists of 70% eugenol, carvenol and eugenol-methyl-ether^[47]. The free radical scavenging activity of *Ocimum sanctum* products is the major mechanism, by which it protects against cellular damage^[48]. *Ocimum sanctum* plays a key role in wound healing process by actively involving at various levels of immune mechanisms, such as antibody production, release of hypersensitivity reaction mediators and response of tissues to these mediators in the target sites^[49]. It has been reported that, *Ocimum sanctum* shows various activities such as gastroduodenal ulcer protection, antisecretory and gastric mucosal defense enhancement. The leaves of *Ocimum sanctum* contain volatile oil, which is composed of limonene, borneol, copaene, caryophyllene and elemol; phenolic compounds (rosmarinic acid, apigenin, cirsimaritin, isothymusin), flavonoids (orientin, vicenin) and aromatic compounds (methyl chavicol, methyl eugenol)^[50,51] that are responsible for wound healing. *Ocimum sanctum* products increase the level of TNF-alpha in the wound healing phase^[52]. Phytochemical screening revealed that the presence of flavonoids in *Ocimum sanctum* helps in free radical scavenging, which helps to decrease oxidative stress, responsible for acute and chronic inflammatory conditions^[53,54]. Since *Ocimum sanctum* grows ubiquitously or abundantly, it could be a cost effective therapeutic for wound management as a prohealer and abnormal healing controller^[47].

4.3 Eucalyptus



Figure 4 : Eucalyptus

Synonym – Dinkum oil , lemon gum tree, blue gum tree.

Eucalyptus (Eucalyptus globulus) is widely grown in Southern and some parts of Northern and Western India. It is a tall and evergreen tree, which grows well in deep, fertile, and well-drained rich soil having adequate moisture. It attains the height of more than 300 feet. Leaves of the tree on adolescent shoots are inverse, sessile, cordate-praise and secured with a somewhat blue white blossom^[55]. The oil obtained from *Eucalyptus globules* by steam distillation of fresh leaves, is known as Dinkum Oil. It is used in skin care to treat wounds, herpes, burns, skin infections, blisters, cuts, and insect bites. Moreover, it boosts immune system and helps in the treatment of chicken pox, common cold, flu and measles. An oil extracted from *Eucalyptus*, is utilized against irritation, as an antiseptic and expectorant^[37,56]. The extracts of *Eucalyptus citriodorais* are very effective for treating dermal wounds, both by topical and oral administration. These extracts accelerate wound healing in all the phases^[57]. The mechanism of action of these concentrates was proposed by means of angiogenesis, collagen deposition, granulation tissue formation, epithelization, and wound contraction at the proliferative stage. These actions are attributed to the synergistic effects of the phytoconstituents like phenolic compounds, flavonoids, and tannins in the extract.^[57]. The antibacterial activity of *Eucalyptus* extracts is majorly due to their compounds such as 1,8-cineole, citronellal, citronellol, citronellyl acetate, p-cymene, eucamalol, limonene, linalool, β -pinene, γ -terpinene, α -terpinol, alloocimene and aromadendrene^[58,59]. In the international pharmacopeia, *Eucalyptus* species are represented as well-known medicinal plants because of their biological and pharmacological properties.^[60], because of their applications in anesthetic, anodyne, antiseptic, astringent, deodorant, diaphoretic, disinfectant, etc. activities. It is also used as a remedy for arthritis, asthma, boils, bronchitis, burns, cancer, diabetes, diarrhea, diphtheria, dysentery, encephalitis, fever, flu, inflammation, laryngalgia, laryngitis, leprosy, malaria, sores, sore throat, spasms, trachalgia, worms and wounds^[60,61].

4.4. Neem



Figure 5 : Neem

Synonym - *Azadirachta indica*., margosa

Neem (*Azadirachta indica*) is an evergreen tree with small green leaves, grows up to 100 feet tall. The neem tree is found throughout India and is also known as the Herbal Indian Doctor^[55]. *Azadirachta indica* (AI) A. Juss (the neem tree), member of the Meliaceae family is a popular and common tree in India. The benefits of various parts of the neem tree are mentioned in the earliest Sanskrit medical writings and therefore, since Vedic times, the neem tree is closer to human culture and civilization^[62,63]. The bark acts as an analgesic and is a cure for fever; twigs for cough, asthma, piles, worms, urinary disorders, diabetes; leaves for leprosy, eye problems, intestinal worms, anorexia, skin ulcers, cancer; flowers for elimination of intestinal worms, bile suppression, phlegm; fruit for piles, intestinal worms, urinary disorders, diabetes, wounds, eye problems, leprosy, seeds for leprosy, intestinal worms, cancer; and oil for leprosy, intestinal worms, gum for scabies, wounds, ulcers, skin diseases, etc.^[64]. Various phytochemical constituents such as alkaloids, triterpenoids, and their glycosides, limonoids, flavonoids, fatty acids, and steroids from the neem tree have been proven to possess anti-inflammatory, anticarcinogenic, anti-ulcer, antioxidant, immunomodulatory, antifungal, antibacterial, antiviral, antimalarial, antimutagenic, and antihyperglycemic properties^[65,66]. Active compounds such as nimbidin, nimbin, and nimbidol present in neem, which have anti-inflammatory, antimicrobial activities that help in accelerating the wound healing process. Neem also consists of a large amount of amino acids, vitamins, and minerals that play a major role in the proliferation phase of the wound healing process^[67,68,69]. This prevents secondary infections by microorganisms in any wound or lesion. According to clinical studies, neem inhibits inflammation as effectively as cortisone acetate, which further accelerates wound healing^[70]. Neem (*A. indica*) oil is found to have a significant effect in healing chronic wounds and in the management of non-healing wounds when applied topically. It helps in angiogenesis and increases DNA content. Neem and Haridra (*C. longa*) can be used in combination to treat diabetic chronic wounds in a more effective way, both have a great effect in leprotic, venous, and decubitus ulcers too^[71].

4.5 Turmeric



Figure 6 : Turmeric

Synonym – curcumin, curcuma, curcuma aromatic.

Turmeric is a spice that originates from the root of *Curcuma longa*. It is a member of the ginger family, Zingiberaceae. In Ayurveda, turmeric has been utilized for its therapeutic properties for various treatments and via various routes of administration such as topical, oral, and by inhalation^[72]. Turmeric is used as herbal medicine

for centuries in the treatment of various ailments. Curcumin has been reported of consisting significant wound healing properties along with anti-infective, anti-oxidant, anti-inflammatory, anti-mutagenic, anti-carcinogenic and anti-coagulant effects. It acts on different stages of wound healing process to fasten the process. Curcumin also has capacity to enhance granulation tissue formation, collagen deposition, tissue remodeling and wound contraction^[73]. Curcumin accelerates the management of wound contraction by producing growth factors involved in the healing process^[74]. In vitro, curcumin acts on wound healing in a dose dependent manner. It may be stimulatory at low doses and inhibitory at higher doses. It was reported that, curcumin facilitates fibrinolysis and cellular movement in wound healing by altering urokinase plasminogen activator expression^[75]. The following properties of turmeric aids in wound healing: • Antibiotic activity: It inhibits bacterial infection of wound by bacteria such as *E. coli*, *Staphylococcus* and *Bacillus*. • Anti-inflammatory activity: It acts to relieve inflammation. • Analgesic activity: Decreases pain. • Helps in the synthesis of new skin cells and wound closure.^[76].

4.6 Bael (Stone apple)



Figure 7 : Bael (Stone apple)s

Synonym – Bengal quince , golden apple .

Bael (*Aegle marmelos*, family: Rutaceae) is a slender, aromatic, medium sized tree with 6.0-7.5 m height and 90-120 cm girth and found as a wild tree in the entire deciduous forests of India. The leaves of Bael are applied topically for wound healing^[77]. The Indian subcontinental inhabitants have used *Aegle marmelos* for over 5000 years. It is an indigenous plant. In Ayurveda and in various folk medicines, its leaves, bark, roots, fruits, and seeds are extensively used to treat various diseases. According to scientific reports, fruits of bael possesses wide range of therapeutic effects like free radical scavenging, antioxidant, inhibition of lipid peroxidation, anti-diabetic, cardioprotective and radioprotective effects validating many of the ethnomedicinal uses^[78,79]. Leaf extracts of *Aegle marmelos*, possesses good antioxidant power and it acts as an antigenotoxicant to heal wounds^[80,81]. The active components of the root extract of *Aegle marmelos* accelerates wound healing and gives breaking strength to the healed wound^[77]. Fruit pulp of *Aegle marmelos* shows wound healing effects as it increases collagen determinants and decreases inflammation^[82].

4.7 Panax ginseng



Figure 8 : Panax Ginseng

Synonym - Ginseng , Chinese ginseng .

Panax ginseng is one of the most popular medicinal plants consumed in China, Japan, Korea, and Eastern Siberia to improve thinking, concentration, and memory. It is also claimed to support immunity and physical stamina and to reduce fatigue^[83]. *Panax ginseng* is thus used to treat depression, anxiety, and chronic fatigue syndrome^[84]. *Panax ginseng* has been demonstrated to induce vasodilation , control blood lipids , reduce inflammation , and confer antioxidant, anticancer, antibacterial , antiallergic , antiaging, and immunomodulating activities. *Panax ginseng* contains many bioactive substances, among which a class of saponins (termed ginsenosides by Asian researchers and panaxosides by Russian researchers) represent the most potent active constituents of *Panax ginseng*^[85].

The root extracts of *Panax ginseng* have been shown to protect skin in C57BL mice from acute UVB irradiation^[86] and significantly improve healing after laser burn injury and excisional wounding . Studies demonstrate *Panax ginseng* extracts enhance keratinocyte migration , as well as stimulate proliferation and increase collagen synthesis in human dermal fibroblasts *in vitro*. In addition, Choi demonstrated that the ginsenoside Rb2, isolated from *Panax ginseng*, induces the formation of the epidermis in raft culture via increased expression of epidermal growth factor and its receptor, fibronectin and its receptor, and keratin 5/14 and collagenase I^[87], all of which have critical roles in wound healing.

4.8 German chamomile (*Chamomilla recutita*)



Figure 9 : German chamomile

Synonym – Chamomile, German chamomile, Hungarian chamomile.

Chamomile (*C. recutita*) studied the effect of nanofibrous membranes of electrospun poly caprolactone/polystyrene (PCL/PS) as chamomile-containing active wound dressings. Therapy qualities *C. recutita* (L.) Rauschert, a member of the Asteraceae family, is present because of specific phenolics and flavonoids, apigenin, quercetin, patuletin, luteolin, and their glucosides. Apigenin is the rarest flavonoid in chamomile flora and has a remarkable effect on the wound healing process. Studies of antibacterial and antifungal *in vitro* demonstrated nanofibers' efficacy against microorganisms, Bacteria *S. aureus*, and *C. Albicans* (fungi) with inhibitory zones approximately 7.6 mm in diameter. MTT assay demonstrated the adhesion of *in vitro* cells and the viability of mesenchymal stem cells on the nanofibers. The nanofibers, according to authors with 15 percent chamomile extract, up to 99 ± 60.5 percent of the wound could be cured after 14 day post-treatment periods which were confirmed using a rat wound model. This wound examination showed the accretion of reepithelization and collagen in the dermis tissue, and also the absence of necrosis^[88].

4.9 Burdock (*Arctium lappa*)



Figure 10 : Burdock (*Arctium lappa*)

Synonym – Greater burdock, edible burdock.

This, generally referred to as burdock, is a commonly grown perennial weed. *Arctium lappa* is used in the treatment of sore throats and skin pathologies such as boils, rashes, and acne in North America, Europe, and

Asia. In a clinical trial, the antioxidant, antimicrobial, anti-inflammatory, anti-diabetic, antiviral, anti-cancer, and hepatoprotective effects of *Arctium lappa* were detected. It has been shown that *Arctium lappa* root extract greatly enhances dermal ECM metabolism, affects glycosaminoglycan turnover and decreases visible in vivo wrinkles in human skin. *Arctium lappa* has also been reported to control cell adhesion and gene expression in canine dermal fibroblasts, influencing the Wnt/ β -catenin signaling pathway, known to be a key wound cure regulator. In a pilot study of one medical drug, namely, *Arctium lappa*, burns and wounds topical ointment (B&W), discomfort and healing of human first and second-degree burns was found to be handled more efficiently than the control procedure^[89]

4.10 *Calendula officinalis*



Figure 11: *Calendula officinalis*

Synonym – Marigold , ruddles , scotch marigold.

Calendula officinalis, commonly known as pot marigold, is a very widely distributed plant used for the treatment of a variety of skin conditions, such as wounds, burns, and dermatitis^[90,91]. A range of pharmacological activities are ascribed to *Calendula officinalis*, including anti-inflammatory, antioxidant, antibacterial, antiviral, antifungal, and anticancer activities^[92]. However, the exact mechanisms involved in its activities on the wound healing remain unknown. Studies using cultures of human and murine fibroblasts demonstrated that extracts of *Calendula officinalis* stimulate fibroblast migration and proliferation in a PI3K-dependent manner^[93,94]. Extracts from the flower of *Calendula officinalis* stimulate granulation tissue formation by altering the expression of connective tissue growth factor (CTGF) and α -smooth muscle actin (α -SMA) in excisional wounds of BALB/c mice *in vivo*^[95]. *Calendula officinalis* is also reported to enhance angiogenesis *in vivo*, demonstrated using the chicken chorioallantoic membrane (CAM) assay and a cutaneous wound healing model in rats^[96].

Table 2 - Scientifically evident plants used for wound healing activity

Botanical Name Family	Parts/ phytoconstituents used	Wound Healing Model used	Ref.
<i>Aloe barbadensis</i> miller (Liliaceae)	Leaves	Excision	⁹⁷
<i>Ocimum tenuiflorum</i> (Lamiaceae)	Leaves	Excision	⁹⁸
<i>Eucalyptus</i> (Myrtaceae)	Leaves	Excision, Incision, Dead space	⁹⁹
<i>Azadirachta indica</i> (Meliaceae)	Stem Bark , leaves	Excision , Incision	¹⁰⁰
<i>Curcuma longa</i> (Zingiberaceae)	Rhizome, curcumin	Excision	¹⁰¹
Bael (stone apple) Rutaceae	Roots extrats	Fruit extracts of bael have demonstrated protective effects on pancreatic tissues of diabetic rats	¹⁰²
<i>Panax gingseng</i> (Araliaceae)	Leaves ,roots , whole plant	laser burn and excision wounds models in mice Cell migration and wound healing assays	¹⁰³
German chamomile (Asteraceae)	Flavonoids, apigenin, quercetin, Patuletin, luteolin.	chamomile ameliorates hyperglycemia and diabetic complications by suppressing blood sugar levels, increasing liver glycogen storage and inhibition of sorbitol in the human erythrocytes.	¹⁰⁴
Burdock (<i>Arctium lappa</i>)	Leaves , whole plants	Human burn wounds Canine dermal fibroblast adhesion assay	¹⁰⁵
<i>Calendula officinalis</i>	Flower	Excision wound model in BALB/c mice Punch wound model in rats	¹⁰⁶

V. Conclusion

Wound healing from the ancient times remain the challenging clinical issue for effective wound healing treatment. It also involves various phases like Hemostasis, Inflammation, Proliferation, Remodeling etc. The goal of wound care is to enhance healing process and reduce the risk factors. The review covers the medicinal plants that are used for wound healing potential which could be beneficial in therapeutic practice and development of new healing drugs for human use.

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