

## Wound Healing Medicinal Plants: A Review

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**Article History:**

*Received: 23 November 2012*

*Accepted: 9 December 2012*

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### ABSTRACT

Medicinal plants have been long since claimed to be useful for wound healing in the traditional system of medicine. A review of scientifically proven wound healing medicinal highlighting the wound healing potential of plants and the parts analysed is presented. The review covers reports on wound healing studies on medicinal plants during the period 2000-2012. Such reviews may provide lead to researchers for the development of new wound healing formulations for human use.

**Keywords:** Wound healing plants, review, phytoconstituents.

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### INTRODUCTION

In India, medicines based on herbal origin have been the basis of treatment and cure for various diseases [46]. A large number of plants are used by folklore traditions in India for treatment of cuts, wounds and burns. More than 80% of the world's population depends upon traditional medicines for various skin diseases [32]. Recently, the traditional use of plants for wound healing has received much attention from the scientific community. Herbal drugs are prescribed widely because of their effectiveness, low side effects and relatively low cost [356]. Therefore investigation on active principles from traditional medicinal plants has become more important [328]. The world health organization [372] has also recommended the evaluation of the effectiveness of plants in treatments where we lack safe modern drugs [361]. Approximately one-third of all traditional medicines in use are for the treatment of wounds and skin disorders.

Wounds are physical injuries that result in an opening or break of the skin. Wound healing process holds several steps which involve coagulation, inflammation, formation of granulation tissue, matrix formation, remodeling of connective tissue, collagenization and acquisition of wound strength [346]. Proper healing of wounds is essential for the restoration of disrupted anatomical continuity and disturbed functional status of the skin [40]. A drug which aids in wound healing, with minimal side effects and is economical is the one which is always looked for. Four distinct stages are involved in wound healing, namely- inflammatory stage, debridement stage, proliferation stage and maturation (remodeling stage). The inflammatory stage is directed at preventing further loss of blood by platelet accumulation at the site leading to coagulation those results to the formation of thrombus. The debridement stage occurs from the third to the sixth day after injury and involves the appearance of neutrophils to clear contaminating organisms. The proliferation or repair stage is characterized by endothelial budding in the nearby blood vessels forming new capillaries that penetrate and nourish the injured tissue. The maturation stage commences from tenth day to several months depending on wound severity during which the number of capillaries decreases and wound changes from pink or white [351].

Research on wound healing agents is one of the developing areas in modern biomedical sciences. Many of the synthetic drugs currently used for the treatment of wounds are not only expensive but also pose problems such as allergy, drug resistance etc and this situation has forced scientists to seek alternative drugs [286]. A substantial number of drugs are developed from plants, minerals and animals and are described in the Ayurveda for their wound healing properties under the term Vranaropaka [44]. Plant metabolites play a vital role in wound healing. There are recent reports on wound healing efficacy of the redox-active grape seed proanthocyanidins [295], the chitosans [279] and chitins [53], polysaccharides [350] and [39], the terpenoidal compounds oleanolic acid [97] and lupeol [102].

Of the wound healing Ayurvedic drugs, 70% are of plant origin, 20% of mineral origin, and the remaining 10% are of animal origin [47]. Some of the commonly available drugs used in the healing of wounds are ibuprofen, colchicine, corticosteroids, aspirin, heparin, warfarin and the vasoconstrictors, nicotine, cocaine and adrenaline [92]. It is also reported that haemorrhheologics, pentoxifylline (*Trental*), methyl xanthenes, retinoids, phenytoin and prostaglandins have the potential of improving the healing of wounds [348]. Nitrofurazone ointment is used as a standard drug for comparing the wound healing potential of a plant extract in the animal models.

A large number of plants are used by tribals and folklore in many countries for the treatment of wounds and burns. In Indian traditional medicine, the species of the following genera are commonly used to treat wound and related injuries; *Abutilon*, *Achyranthes*, *Acorus*, *Aegle*, *Aerva*, *Aloe*, *Azadirachta*, *Bambusa*, *Bidens*, *Boerhaavia*, *Butea*, *Caesalpinia*, *Calotropis*, *Carissa*, *Cassia*, *Cucumis*, *Curcuma*, *Cynodon*, *Datura*, *Dodonaea*, *Eclipta*, *Euphorbia*, *Ficus*, *Hyptis*, *Lantana*, *Leucas*, *Morinda*, *Ocimum*, *Opuntia*, *Pavetta*, *Pergularia*, *Plumbago*, *Pongamia*, *Sida*, *Smilax*, *Terminalia*, *Tridax*, *Vitex* and *Zizyphus*[111]. These natural agents induce healing and regeneration of the lost tissue by multiple mechanisms. These phytomedicines are not only cheap and affordable but are also safe. The presence of various life-sustaining constituents in plants has urged scientists to examine these plants with a view to determine potential wound healing properties.

Kumar et al [149] and Biswas and Mukherjee [47] have reported that about 163 species of plants were used as wound healing plants in Indian systems of medicine such as Ayurveda, Siddha, Unani and folk medicine. Of these, *Aloe vera*, *Azadirachta indica*, *Berberis aristata*, *Carica papaya*, *Celosia argentea*, *Centella asiatica*, *Cinnamomum zeylanicum*, *Curcuma longa*, *Cynodon dactylon*, *Euphorbia nerifolia*, *Ficus bengalensis*, *Ficus racemosa*, *Glycyrrhiza glabra*, *Nelumbo nucifera*, *Ocimum sanctum*, *Phyllanthus emblica*, *Plumbago zeylanica*, *Pterocarpus santalinus*, *Rubia cordifolia*, *Symplocos racemosa*, *Terminalia arjuna* and *Terminalia chebula* were widely used by most of the tribal communities in India.

There are very few reviews of recent literature on wound healing studies on medicinal plants. Few plants and plant products with promising wound healing efficacy have been highlighted by Rajinder Raina et al [263]. A review on wound healing herbs of the Pacific is also reported [335]. A systematic review of *in vitro* and *in vivo* experiments adopted in the various models designed to establish the wound healing efficacy of plants, the extraction techniques and the evaluation protocol followed has been reported by Rupesh Thakur et.al [279]. Raju Kasarla et al have reported an annual review on wound healing plants analysed in 2011 [264]. The present review is on scientifically proven wound healing medicinal plants. It is an exhaustive review of wound healing studies on medicinal plant extracts that has been done for the period from 2000 till date. Investigations on the wound healing potential of 306 medicinal plants have been reviewed.

The review exemplifies that among a number of plant families, plants of the *Asteraceae*, *Leguminosae* and *Labiatae* have been largely investigated for their wound healing efficacy followed by the plants of the *Euphorbiaceae*. Chart-1 depicts the trend. Notable also is the fact that a majority of the scientific reports on wound healing efficacy of medicinal plants is by Indian authors and constitutes 222 of the 383 reports during the review period. Chart-2 depicts this.

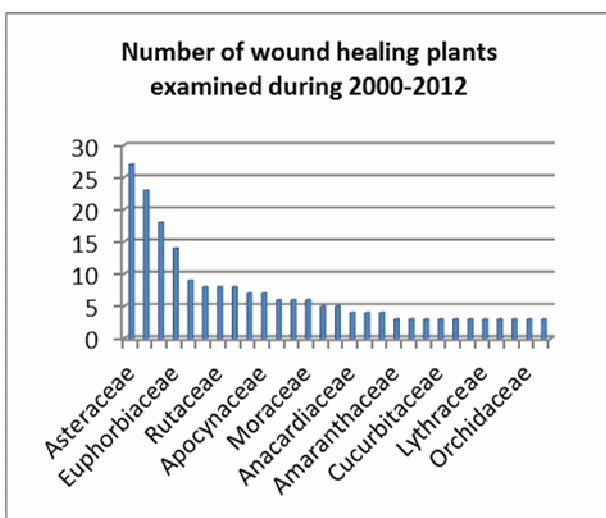


Chart-1



Chart-2

The most dominant families comprising plants with wound healing potential are *Asteraceae* (27 species), *Fabaceae* (23 species), *Lamiaceae* (17 species), *Euphorbiaceae* (14 species), *Malvaceae* (9 species). Table 1-5 represent the plants of the foresaid families. The plant families *Rubiaceae*, *Rutaceae*, *Verbenaceae*, *Apocynaceae*,

*Acanthaceae, Bignoniaceae, Boraginaceae, Moraceae, Asclepiadaceae, Combretaceae, Anacardiaceae* and *Ranunculaceae* and *Zingiberaceae* have been also explored.

Table-1: Asteraceae or Compositae family of plants reported during the period 2000-2012

S.No	Plant name	Parts analysed for wound healing efficacy	Reference [Reference Number]
1	<i>Achillea biebersteinii</i> Afan	Aerial part	Akkol et al [12]
2	<i>Achillea kellalensis</i> Bioss & Hauskn	Flower	Pirbalouti et al [251]
3	<i>Achillea millefolium</i> Linn	Leaves	Nirmala et al [219]
4	<i>Ageratum conyzoides</i>	Leaves+Honey	Mustafa et al [201]
		Leaves	Oladejo et al [226]
		Root	Sachin et al [283]
		Leaves	Dash et al [57] Abdullah et al [3]
5	<i>Aspilia africana</i> C.D. Adams	Leaves	Attama et al [31]
6	<i>Bidens pilosa</i> Linn	Leaves	Hassan et al [103]
7	<i>Blumea lacera</i> (Burn.f)DC	Plant	Sandhya et al [289]
8	<i>Calendula officinalis</i> Linn	Flower	Parente et al [239]
			Preethi et al [258]
9	<i>Centaurea iberica</i> Trev ex Spreng	Aerial part	Koca et al [140]
10	<i>Centaurea sadleriana</i> Janka	Aerial part	Csupor et al [56]
11	<i>Centratherum anthelminticum</i> (L.) Kuntz	Seeds	Sahoo et al [285]
12	<i>Chromolaena odorata</i> Linn	Leaves	Anyasor et al [27]
			Mahmood et al [169]
13	<i>Echinacea pallida</i> (Nutt)	Root	Zili Zhai et al [385]
14	<i>Elephantopus scaber</i> Linn	Leaves and Aerial part	Singh et al [323]
15	<i>Flaveria trinervia</i> (Speng) C.Mohr	Leaves	Umadevi et al [363]
16	<i>Gynura procumbens</i> (Lour.) Merr	Leaves	Zahra et al [384]
17	<i>Matricaria chamomilla</i>	Plant	Jarrahi et al [117]
18	<i>Siegesbeckia pubescens</i> Mak.	Plant	Wang et al [375]
19	<i>Sphaeranthus indicus</i> Linn	Aerial part	Sadaf et al [284]
		Flower head	Jha et al [120]
			Jha et al [121]
20	<i>Stevia rebaudiana</i> Bert	Leaves	Kuntal das et al [155]
21	<i>Tagetes erecta</i> Linn	Leaves	Ghosh et al [86]
			Kiranmai et al [138]
			Kiranmai et al [139]
			Chatterjee et al [50]
22	<i>Tridax procumbens</i> Linn.	Leaves	Yaduvhashi et al [379]
			Shirish S. Pingale [312]
23	<i>Vernonia amygdalina</i> Delile	Leaves	Momoh et al [188]
24	<i>Vernonia arborea</i> Hk	Leaves	Manjunatha et al [175]
25	<i>Vernonia arborea</i> Buch. Ham	Bark	Pradhan et al [257]
26	<i>Vernonia scopioides</i> Schreb	Plant	Sandhya et al [289]
		Leaves	Leite et al [162]
27	<i>Wedelia trilobata</i> Linn	Leaves	Balekar et al [34]

Table-2: *Fabaceae* or *Leguminosae* family of plants reported during the period 2000-2012

S.No	Plant name	Parts analysed for wound healing efficacy	Reference [Reference Number]
1	<i>Butea monosperma</i> Lam	Stem bark	Sumitra et al [338] Gavimath et al [83] Muralidhar et al [195]
		Flower	Sharma et al [303]
2	<i>Cassia fistula</i> Linn	Leaves	Senthil Kumar et al [298]
3	<i>Cassia tora</i> (L.) Roxb	Leaves	Jayasutha et al [119]
4	<i>Centrosema pubescens</i> Benth	Leaves	Ekpo et al [69]
5	<i>Clitoria ternatea</i> Linn	Seed and Root	Solanki et al [329]
6	<i>Colutea cilicica</i> Bioss and Balansa	Fruits and Leaves	Suntar et al [343]
7	<i>Crotalaria verrucosa</i> Linn	Plant	Kumari et al [154]
8	<i>Delonix regia</i> (Boj. Ex Hook.) Raf	Flower	Khan et al [133]
9	<i>Desmodium gangeticum</i> L.(DC)	Aerial part	Jain et al [112]
10	<i>Desmodium gyrans</i> (Linn.F)	Leaves	Kalirajan et al [124]
11	<i>Glycyrrhiza glabra</i> Linn	Root	Alsayed et al [22]
12	<i>Indigofera asphalathoides</i> Vahl. exDC	Drug powder	Saritha et al [291]
13	<i>Mimosa pudica</i> Linn.	Leaves	Singh et al [323]
		Root	Kokane et al [143] Paul et al [248]
		Leaves	Venkateshwarlu [369]
14	<i>Prosopis cineraria</i> (L.) Druce	Bark	Nagori et al [204]
15	<i>Pseudarthria viscida</i> Linn	Whole plant	Vijaya Baskaran et al [372]
16	<i>Pterocarpus marsupium</i> Roxburgh	Wood	Singhal et al [325]
17	<i>Pterocarpus santalinus</i> Linn.f	Wood	Biswas et al [45]
18	<i>Pueraria tuberosa</i> (Roxb Ex. Wild) DC	Tubers	Kambhoja et al [126]
19	<i>Senna alata</i> Linn	Leaves	Midawa et al [183]
20	<i>Sesbania grandiflora</i> Linn	Flower	Sheikh et al [306] Karthikeyan et al [130]
		Seed	Mohamad et al [185]
22	<i>Tephrosia purpurea</i> Linn	Aerial part	Lodhi et al [164]
		Root	Chaudhari et al [51]
23	<i>Trigonella foenum graecum</i> Linn	Leaves	Abdullah et al [3]
		Seed+Honey	Mustafa et al [202]

Table-3: *Lamiaceae* or *Labiatae* family of plants reported during the period 2000-2012

S.No	Plant name	Parts analysed for wound healing efficacy	Reference [Reference Number]
1	<i>Coleus amboinicus</i> Lour.	Leaves	Vijaya kumar [373]
2	<i>Coleus aromaticus</i> Benth	Leaves	Soni et al [330]
3	<i>Hyptis suaveolens</i> Linn	Leaves	Shenoy et al [307] Shirwaikar et al [315]
		Leaves	Nithya et al [221]
4	<i>Leonotis nepetaefolia</i> R.Br	Leaves	Manjunatha et al [174]
5	<i>Leucas hirta</i> B.Heyne ex Roth	Leaves	Manjunatha et al [174]
6	<i>Ocimum basilicum</i> Linn	Leaves	Solanki et al [328]
7	<i>Ocimum gratissimum</i> Linn	Leaves	Momoh et al [189]
8	<i>Ocimum kilimandscharicum</i> Guerke	Leaves	Paschapur et al [241]
9	<i>Ocimum sanctum</i> Linn	Leaves	Udupa et al [360]

			Shetty et al [310]
			Goel et al [87]
			Asha et al [28]
10	<i>Ocimum suave</i> Wild	Leaves	Hassan et al [103]
11	<i>Rosmarinus officinalis</i> Linn	Essential oil	Abu-Al-Basal et al [6]
12	<i>Salvia cryptantha</i> Montbr. and Aucher	Plant	Suntar et al [334]
13	<i>Salvia cyanescens</i> Boiss	Plant	Suntar et al [334]
14	<i>Salvia hypoleuca</i> Benth	Leaves and Fruits	Estakhr et al [72]
15	<i>Salvia splendens</i> Sellow J.A.Schultes	Leaves	Narayan et al [206]
16	<i>Stachys lavandulifolia</i> Vahl	Flowers	Pirbalouti et al [250]
17	<i>Teucrium polium</i> Linn	Flower Honey	Alizadeh et al [20]

Table-4: *Euphorbiaceae* family of plants reported during the period 2000-2012

S.No	Plant name	Parts analysed for wound healing efficacy	Reference [Reference Number]
1	<i>Acalypha fruticosa</i> Forssk	Aerial part	Gopalakrishnan et al [90]
2	<i>Acalypha indica</i> Linn	Plant	Reddy et al [274]
3	<i>Acalypha langinia</i>	Plant	Gutierrez et al [99]
4	<i>Baliospermum montanum</i> (Wild) Muell	Root	Kumar et al [150]
5	<i>Bridelia ferruginea</i> Benth	Bark	Udegbunam et al [358]
6	<i>Croton bonplandianum</i> Baill	Leaves	Divya et al [65]
7	<i>Emblca officinalis</i> Gaerth	Fruit	Agrawal et al [8]
8	<i>Euphorbia heterophylla</i> Linn	Leaves	Omale James et al [228]
9	<i>Euphorbia hirta</i> Linn	Whole plant	Jaiprakash et al [113]
10	<i>Hevea brasiliensis</i> Mull.Arg	Latex	Mendonca et al [182]
11	<i>Jatropha curcas</i> Linn	Bark	Shetty et al [311]
		Leaves	Esimone et al [71]
		Stem Bark	Sachdeva et al [282]
12	<i>Pedilanthus tithymaloides</i> Linn	Leaves	Sriwiroch et al [331]
13	<i>Plectranthus tenuiflorus</i> (Vetke)	Leaves	Khorshid et al [135]
14	<i>Tragia involucrata</i> Linn	Root	Perumal samy et al [249]

Table-5: *Malvaceae* family of plants reported during the period 2000-2012

S.No	Plant name	Parts analysed for wound healing efficacy	Reference [Reference Number]
1	<i>Abutilon indicum</i> Linn	Leaves	Suresh et al [345]
2	<i>Gossypium arboreum</i> Linn	Leaves	Annan et al [24]
3	<i>Gossypium herbaceum</i> Linn	Leaves	Velmurugan et al [367]
4	<i>Hipiscus-rosa sinensis</i> Linn	Flower	Shivananda Nayak et al [318]
5	<i>Malva sylvestris</i> Linn	Flower	Pirbalouti et al [254]
			Pirbalouti et al [253]
			Pirbalouti et al [250]
6	<i>Pterospermum acerifolium</i> Wild	Flower	Senapati et al [297]
7	<i>Sida acuta</i> Burm.f	Plant	Akilandeswari et al [11]
8	<i>Sida spinosa</i> Linn	Leaves	Krishnan et al [147]
9	<i>Thespesia populnea</i> Linn	Fruit	Nagappa et al [203]

**Other families of plants investigated for wound healing efficacy****Rubiaceae**

*Anthocephalus cadamba* (Roxb) Bisser [362], *Hamelia patens* Jacq [89], *Ixora coccinea* Linn [296], *Morinda citrifolia* Linn [269, 211], *Mussaenda frondosa* Linn [246], *Nauclea latifolia* Smith [359], *Pentas lanceolata* (Forssk.) [212], *Rubia cordifolia* Linn [129].

**Rutaceae**

*Aegele marmelos* Linn [326], *Aegle marmelos* Linn [118, 302, 327], *Citrus reticulata* Linn [289], *Citrus sinensis* Linn [289], *Glycosmis arborea* (Roxb.) DC [321], *Limonia acidissima* Linn [109], *Murraya koenigii* Linn [243], *Toddalia asiatica* Linn [128].

**Verbanaceae**

*Clerodendrum infortunatum* Linn [91], *Clerodendrum serratum* (Linn) [370], *Clerodendron splendens* G. Don [84], *Lantana camara* Linn [2, 214], *Lantana wightiana* Wall Ex. Gamble [275], *Tectona grandis* L.f [192], *Verbena officinalis* Linn [290], *Viex negundo* Linn [349].

**Apocynaceae**

*Allamanda cathartica* Linn [214], *Carissa spinarum* Linn [276], *Catharanthus roseus* Linn [207,319], *Hemidesmus indicus* R.Br. [80], *Ichnocarpus frutescens* R. Br. [238], *Saba florida* Benth [229], *Wrightia arborea* (Dennst) Mabb [160], *Wrightia tinctoria* (Roxb) R. Br. [64].

**Acanthaceae**

*Adhatoda vasica* Linn [374,333], *Andrographis peniculata* (Burm.f) Wall [186], *Barleria cuspidata* Heyne ex Nees [180], *Blepharis maderaspatensis* Linn [262], *Crossandra infundibuliformis* Linn [337], *Hemigraphis colorata* (Blume) H.G.Hallier [336], *Strobilanthes crispus* Linn [18].

**Bignoniaceae**

*Arrabidaea chica* Verlot [122], *Kigelia pinnata* (Jacq.) DC [304], *Pyrostegia venusta* (Ker gawl) Miers [259], *Spathodea campanulata* P.Beauv [225], *Stereospermum colais* (Buch-Ham.ex Dillwyn) Mabb [41], *Tecomaria capensis* (Thunb.) Lindl [287].

**Boraginaceae**

*Arnebia densiflora* (Nordm.) Ledeb [15,144], *Arnebia euchroma* Rolye. (Johnst) [252, 254], *Cordia dichotoma* Forst.f [157], *Cordia macleodii* Hook.f & Thoms [43], *Echium amoenum* Fish and C.A.Mey [74], *Heliotropium indicum* Linn [30, 58, 67, 275].

**Moraceae**

*Artocarpus heterophyllus* Lam [95], *Ficus asperifolia* Mid [24], *Ficus bengalensis* Linn [82, 197, 199], *Ficus deltoidea* Linn [1], *Ficus racemosa* Linn [146, 268], *Ficus religiosa* Linn [200, 215, 277].

**Combretaceae**

*Anogeissus acuminata* Wall [105], *Terminalia avicennioides* Guill & Perr [176], *Terminalia bellirica* Roxb [55], *Terminalia coriacea* (Roxb.) Wight & Arn [134], *Terminalia chebula* Retz [54].

**Asclepiadaceae**

*Calotropis gigantean* Linn [61,205,245,313,344], *Calotropis procera* (Ait.) R. Br. [265], *Gymnema sylvestere* R.Br [139,171], *Wattakaka volubilis* (L.f) Stapf [29].

**Anacardiaceae**

*Buchanania lanzan* Spreng [52], *Pistacia lentiscus* Linn [66], *Pistacia atlantica* Desf [356], *Pistacia khinjuk* Linn [356].

**Zingiberaceae**

*Boesenbergia rotunda* (Linn) Mansf.A [167], *Curcuma aromatica* Salisb [148], *Curcuma longa* Linn [351], *Kaempferia galanga* Linn [300].



**Ranunculaceae**

*Naravelia zeylanica* DC [309], *Nigella sativa* Linn [292], *Ranunculus constantinopolitanus* (DC.) [13], *Ranunculus pedatus* Waldst. & Kit [13].

Plants with wound healing potential from other families have been enumerated in table 6. In the animal models, the plant material has been applied on the wound as a paste or juice from fresh parts or as a powder of fresh or dry plant parts. In some studies an oral administration of plant paste was done. The most frequently used extraction methods are soxhlet extraction, maceration, percolation and steam distillation. Wistar albino rats were used and excision wound model was mostly adopted for the efficacy studies.

Table -6: Wound healing plants reported during the period 2000-2012

S.No	Plant name	Family	Parts analysed for wound healing efficacy	Reference [Reference Number]
1	<i>Achyranthes aspera</i> Linn	<i>Amaranthaceae</i>	Leaves	Ghosh et al [85] Baura et al [37]
2	<i>Acorus calamus</i> Linn	<i>Araceae</i>	Leaves	Nilesh Jain et al [218]
3	<i>Allium cepa</i> Linn	<i>Liliaceae</i>	Bulbs	Shenoy et al [308]
4	<i>Aloe arbore</i> Scens	<i>Aloeaceae</i>	Leaves	Yimei Jia et al [381]
5	<i>Aloe ferox</i> Miller	<i>Xanthorrhoeaceae</i>	Leaves	Yimei Jia et al [381]
6	<i>Aloe littoralis</i> Baker	<i>Asphodelaceae</i>	Leaves	Hajhashemi et al [100]
7	<i>Aloe barbadensis</i> Linn	<i>Liliaceae</i>	Leaves Whole plant	Subramanian et al [334] Oryan et al [231]
8	<i>Alternanthera brasiliana</i> Kuntz	<i>Amaranthaceae</i>	Leaves	Barua et al [38]
9	<i>Alternanthera sessilis</i> (Linn) R.Br. ex DC	<i>Amaranthaceae</i>	Leaves	Jalalpure et al [114]
10	<i>Ammannia baccifera</i> Linn	<i>Lythraceae</i>	Plant	Rajasekaran et al [262]
11	<i>Anagallis arvensis</i> Linn	<i>Primulaceae</i>	Plant	Lopez et al [165]
12	<i>Anagallis foemina</i> Mill	<i>Myrsinaceae</i>	Plant	Lopez et al [165]
13	<i>Annona muricata</i> Linn	<i>Annonaceae</i>	Stem bark	Paarakh et al [233]
14	<i>Anredera diffusa</i> (Moq.)	<i>Basellaceae</i>	Plant	Moura-Letts et al [191]
15	<i>Argemone mexicana</i> Linn	<i>Papaveraceae</i>	Leaves	Dash et al [59]
16	<i>Argyrea nervosa</i> (Burm.f) Bojer	<i>Convolvulaceae</i>	Leaves	Singhal et al [324]
17	<i>Aristolochia bracteolata</i> Lam	<i>Aristolochiaceae</i>	Leaves	Shirwaikar et al [314]
18	<i>Aristolochia bracteata</i> Linn	<i>Aristolochiaceae</i>	Leaves	Jayasutha et al [119]
19	<i>Arisaema leschenaultii</i> Blume	<i>Araceae</i>	Tubers	Suruse et al [347]
20	<i>Asparagus racemosus</i> Wild	<i>Liliaceae</i>	Root	Kodancha et al [141]
21	<i>Astilbe thunbergii</i> (Siebold & Zucc.)	<i>Saxifragaceae</i>	Rhizomes	Kimura et al [136]
22	<i>Avena sativa</i> Linn	<i>Poaceae</i>	Whole plant	Akkol et al [16]
23	<i>Bauhinia purpurea</i> Linn	<i>Caesalpiniaceae</i>	Leaves	Ananth et al [23]
24	<i>Berberis aristata</i> Linn	<i>Berberidaceae</i>	Plant	Sandhya et al [289]
25	<i>Beta vulgaris</i> Linn	<i>Chenopodiaceae</i>	Root	Ibrahim et al [108]
26	<i>Blechnum orientale</i> Linn	<i>Blechnaceae</i>	Leaves	Lai et al [159]
28	<i>Bombax malabaricum</i> DC	<i>Bombacaceae</i>	Bark	Chandrika et al [49]
29	<i>Borassus flabellifer</i> Linn	<i>Arecaceae</i>	Fruit	Keerthi et al [131]
30	<i>Brassica juncea</i> Linn	<i>Brassicaceae</i>	Leaves	Malan et al [170]
31	<i>Bulbine frutescens</i> Wild	<i>Xanthorrhoeaceae</i>	Plant	Pather et al [242]
32	<i>Bulbine natalensis</i> Baker	<i>Xanthorrhoeaceae</i>	Plant	Pather et al [242]
33	<i>Capparis zeylanica</i> Linn.	<i>Capparaceae</i>	Whole plant Root	Padhan et al [234] Chandan das et al [48]

34	<i>Carapa guianensis</i> Linn	<i>Meliaceae</i>	Leaves	Nayak et al [209]
35	<i>Carica Candamarcensis</i> Hook. F.	<i>Caricaceae</i>	Fruit	Gomes et al [88]
36	<i>Carica papaya</i> Linn	<i>Caricaceae</i>	Leaves Fruit Latex Epicarps Root	Mohmood et al [168] Nayak et al [208] Gurung et al [96] Anuar et al [25] Tiwari et al [354]
37	<i>Caryocar coriaceum</i> Wittm	<i>Caryocaraceae</i>	Root	De Oliveira et al [60]
38	<i>Cassia occidentalis</i> Linn	<i>Caesalpiaceae</i>	Leaves	Sheeba et al [305]
39	<i>Cecropia peltata</i> Linn	<i>Cecropiaceae</i>	Leaves	Shivananda Nayak [316]
40	<i>Centella asiatica</i> Linn	<i>Apiaceae</i>	Leaves Plant	Tiwari et al [355] Ruszymah et al [280]
41	<i>Cinnamomum zeylanicum</i> Linn	<i>Lauraceae</i>	Whole plant	Farahpour et al [73]
42	<i>Cissus quadrangularis</i> Linn	<i>Vitaceae</i>	Plant	Mohanty et al [187]
43	<i>Cissus multistriata</i>	<i>Vitaceae</i>	Leaves	Omale James et al [230]
44	<i>Cleoma viscosa</i> Linn	<i>Capparaceae</i>	Leaves and Whole plant	Panduraju et al [237]
45	<i>Cleome ruidosperma</i> DC	<i>Capparaceae</i>	Root	Mondal et al [190]
46	<i>Coccinia indica</i> (W.A)	<i>Cucurbitaceae</i>	Fruit	Bambal et al [35]
47	<i>Cocculus hirsutus</i> Linn	<i>Menispermaceae</i>	Leaves	Kalirajan et al [125] Nilani et al [217]
48	<i>Cocculus pendulus</i> (J.R & Forst) Diels	<i>Menispermaceae</i>	Leaves	Rabari et al [261]
49	<i>Coronopus didymus</i> Linn	<i>Brassicaceae</i>	Whole plant	Prabhakar et al [255]
50	<i>Crinum zeylanicum</i> Linn.	<i>Amaryllidaceae</i>	Whole plant	Yahaya et al [380]
51	<i>Cuminum cyminum</i> Linn	<i>Umbelliferae</i>	Seed	Patil et al [244]
52	<i>Curculigo orchiooides</i> Gaertn	<i>Amaryllidaceae</i>	Root tubers Root	Agrahari et al [9] Anurag singh et al [26]
53	<i>Cynodon dactylon</i> Linn	<i>Poaceae</i>	Leaves Whole plant	Saroja et al [293] Thakare et al [351]
54	<i>Cyperus rotundus</i> Linn	<i>Cyperaceae</i>	Tubers	Puratchikody et al [260]
55	<i>Datura alba</i> Nees	<i>Solanaceae</i>	Leaves	Shanmuga Priya et al [301]
56	<i>Dendrophthoe falcate</i> (L.f) Ettingsh	<i>Loranthaceae</i>	Aerial part	Pattanayak et al [247]
57	<i>Dissotis theifolia</i> (G.Don) Hook.f	<i>Melastomataceae</i>	Stem	Odimegwu et al [223]
58	<i>Dodonea viscosa</i> Linn	<i>Sapindaceae</i>	Whole plant Leaves	Ramya et al [266] Joshi et al [123]
59	<i>Eichornia crassipes</i> (Mart)Solms	<i>Pontederiaceae</i>	Leaves	Ali et al [19]
60	<i>Elaeis guineensis</i> Jacq	<i>Arecaceae</i>	Leaves	Sasidharan et al [294]
61	<i>Embelica ribes</i> Burm	<i>Myrsinaceae</i>	Leaves	Kumara swamy et al [153]
62	<i>Equisetum arvense</i> Linn	<i>Equisetaceae</i>	Leaves	Ozay et al [232]
63	<i>Eriolaena hookeriana</i> Wt.&Arn	<i>Sterculiaceae</i>	Root	Kumar et al [151]
64	<i>Eucheuma cottonii</i>	<i>Areschouggiaceae</i>	Seaweed	Fard et al [75]
65	<i>Eugenia jambolana</i> Lam	<i>Myrtaceae</i>	Bark	Palanimuthu et al [235]
66	<i>Evolvulus numularius</i> Linn	<i>Convolvulaceae</i>	Plant	Sandhya et al [289]
67	<i>Fagonia schweinfurthii</i> Hadidi	<i>Zygophyllaceae</i>	Whole plant	Alqasoumi et al [21]
68	<i>Flabellaria Paniculata</i> Cav.	<i>Malpigbiaceae</i>	Leaves	Abo et al [5] Olugbuyiro et al [227]
69	<i>Gentiana lutea</i> Linn	<i>Gentianaceae</i>	Rhizomes	Mathew et al [178]
70	<i>Ginkgo biloba</i> Linn	<i>Ginkgoaceae</i>	Leaves	Abdullah et al [3] Bairy et al [33]



71	<i>Grewia tiliaefolia</i> Vahl	<i>Tiliaceae</i>	Stem bark	Khadeer Ahamed et al [132]
72	<i>Gymnosporia emerginata</i> Wild	<i>Cleastraceae</i>	plant	Hemamalini et al [105]
73	<i>Hippophae rhamnoides</i> Linn	<i>Elaeagnaceae</i>	Seed oil	Upadhyay et al [364]
			Leaves	Upadhyay et al [365]
74	<i>Hiptage benghalensis</i> Linn	<i>Malpighiaceae</i>	Root	Gandhimathi et al [79]
75	<i>Holoptelea integrifolia</i> (Roxb)	<i>Urticaceae</i>	Leaves	Reddy et al [273]
76	<i>Hypericum patulum</i> Linn	<i>Hypericaceae</i>	Leaves	Mukherjee et al [194]
77	<i>Hypericum perforatum</i> Linn	<i>Hypericaceae</i>	Aerial part	Hemmati et al [106]
				Suntar et al [343]
78	<i>Ipomoea batatas</i> (L.) Lam	<i>Convolvulaceae</i>	Tubers and peel	Panda et al [236]
79	<i>Jasminum grandiflorum</i> Linn	<i>Oleaceae</i>	Leaves	Mishra et al [184]
80	<i>Jasminum sambac</i> Linn	<i>Oleaceae</i>	Leaves	Sabharwal et al [281]
81	<i>Juglans nigra</i> Linn	<i>Juglandaceae</i>	Leaves	Jain et al [110]
82	<i>Kalanchoe pinnata</i> Lam	<i>Crassulaceae</i>	Leaves	Shivananda Nayak et al [317]
83	<i>Laurus nobilis</i> Linn	<i>Lauraceae</i>	Leaves	Nayak et al [214]
84	<i>Lawsonia ulba</i> Linn	<i>Lythraceae</i>	Leaves	Nithya et al [220]
85	<i>Lawsonia inermis</i> Linn	<i>Lythraceae</i>	Leaves	Sakarkar et al [288]
				Nayak et al [213]
				Muhammad et al [193]
86	<i>Litsea glutinosa</i> (Lour) C.B.Rob	<i>Lauraceae</i>	Whole plant	Devi et al [62]
87	<i>Luffa cylindrica</i> Linn	<i>Curcubitaceae</i>	Whole plant	Abirami et al [4]
88	<i>Lycopodium serratum</i> Thunb P.E	<i>Lycopodiaceae</i>	Leaves	Manjunatha et al [173]
89	<i>Martynia Annu</i> Linn	<i>Martyniaceae</i>	Leaves	Lodhi et al [163]
90	<i>Melia azedarach</i> Linn	<i>Meliaceae</i>	Leaves	Vidya et al [371]
91	<i>Memecylon edule</i> Roxb	<i>Melastomataceae</i>	Leaves	Nualkaew et al [222]
92	<i>Michelia champaca</i> Linn	<i>Magnoliaceae</i>	Plant	Dwajani et al [68]
			Flowers	Shanbhag et al [299]
93	<i>Mimosa tenuiflora</i> (Wild) Poiret	<i>Mimosaceae</i>	Bark	Janina Zipper et al [116]
94	<i>Mimusops elengi</i> Linn	<i>Sapotaceae</i>	Stem bark	Gupta et al [94]
95	<i>Moringa oleifera</i> Lam	<i>Moringaceae</i>	Bark	Lambole vijay et al [161]
			Leaves and Seed	Hukkeri et al [107]
96	<i>Musa sapientum</i> Linn var. <i>paradisiaca</i>	<i>Musaceae</i>	Fruit	Agarwal et al [7]
97	<i>Myristica andamanica</i> Hook.f	<i>Myristicaceae</i>	Leaves	Kantha.D.Arunachalam et al [127]
98	<i>Napoleona imperialis</i> P.Beauv	<i>Lecythidaceae</i>	Leaves	Esimone et al [70]
99	<i>Nyctanthes arbor-trisitis</i> Linn.	<i>Oleaceae</i>	Leaves	Bharti et al [42]
100	<i>Oncidium flexuosum</i> C.Loddiges	<i>Orchidaceae</i>	Leaves	Fernada et al [76]
101	<i>Opuntia ficus-indica</i> Linn	<i>Cactaceae</i>	Stems	Park et al [240]
			Cladodes	Galati et al [78]
102	<i>Oxalis corniculata</i> Linn	<i>Oxalidaceae</i>	Whole plant	Taranalli et al [350]
103	<i>Piper hayneanum</i> C.DC	<i>Piperaceae</i>	Leaves, roots and stems	Bastos et al [36]
104	<i>Pisonia grandis</i> R.Br	<i>Nyctaginaceae</i>	Leaves	Prabu et al [256]
105	<i>Plagiochasma appendiculatum</i> Lehm	<i>Aytoniaceae</i>	Plant	Singh et al [322]
106	<i>Plagiochila beddomei</i> Steph	<i>Plagiochilaceae</i>	Thallus	Manoj et al [177]
107	<i>Plantago major</i> Linn	<i>Plantaginaceae</i>	Leaves	Mohmood et al [166]
108	<i>Plumbago zeylanica</i> Linn	<i>Plumbaginaceae</i>	Plant	Reddy et al [274]

			Root	Kodati et al [142]
109	<i>Polygonum barbatum</i> Linn	<i>Polygonaceae</i>	Whole plant	Kinger et al [137]
110	<i>Pothos scandens</i> Linn	<i>Araceae</i>	Leaves	Haneefa et al [101]
111	<i>Portulaca oleracea</i> Linn	<i>Portulacaceae</i>	Aerial part	Rashed et al [270]
112	<i>Prosopis juliflora</i> DC	<i>Mimosaceae</i>	Leaves	Mathias et al [179]
113	<i>Prosthechea michuacana</i> (Lex.) W.E.Higgins	<i>Orchidaceae</i>	Bulbs & aerial parts	Gutierrez et al [98]
114	<i>Psidium guajava</i> Linn	<i>Myrtaceae</i>	Leaves	Gupta et al [93]
115	<i>Punica granatum</i> Linn	<i>Punicaceae</i>	Peel	Murthy et al [196]
			Flower	Pirbalouti et al [251]
			Peel and Leaves	Soni et al [330]
			Peel	Hayouni et al [104]
116	<i>Quercus infectoria</i> Olivier	<i>Fagaceae</i>	Galls	Jalalpure et al [115]
				Umachigi et al [361]
117	<i>Quercus persica</i> Jaub and Spach	<i>Fagaceae</i>	Fruit	Akram et al [17]
118	<i>Radix paeoniae</i> Rubra	<i>Paeonaceae</i>	Root	Malviya et al [172]
119	<i>Rafflesia hasseltii</i> Suringar	<i>Rafflesiaceae</i>	Flower	Abdulla et al [2]
120	<i>Rheum officinale</i> Linn	<i>Polygonaceae</i>	Root	Tian Tang et al [353]
121	<i>Rhizophora mangle</i> Linn	<i>Rhizophoraceae</i>	Bark	Fernandez et al [77]
122	<i>Rhizopus arrhizus</i> Fisher	<i>Mucoraceae</i>	Plant	Sandhya et al [289]
123	<i>Rubus sanctus</i> Schreber	<i>Rosaceae</i>	Aerial part	Suntar et al [340]
124	<i>Sambucus ebulus</i> Linn	<i>Caprifoliaceae</i>	Leaves	Suntar et al [342]
125	<i>Sesamum indicum</i> Linn	<i>Pedaliaceae</i>	Seed and oil	Kotade Kiran et al [145]
126	<i>Shorea robusta</i> Gaertn.f.(sal)	<i>Dipterocarpaceae</i>	Resin	Wani et al [376]
127	<i>Simmondsia chinensis</i> (Link) C. K. Schneid.	<i>Simmondsiaceae</i>	Liquid wax	Ranzato et al [267]
128	<i>Solanum xanthocarpum</i> Schrad & Wendl	<i>Solanaceae</i>	Fruits	Kumar et al [152]
			Leaves	Dewangan et al [63]
129	<i>Tamarix aphylla</i> (L.) karst	<i>Tamaricaceae</i>	Leaves	Yusufoglu et al [382]
130	<i>Tinospora cordifolia</i> Willd	<i>Menispermaceae</i>	Root	Nema et al [216]
131	<i>Tribulus terrestris</i> Linn	<i>Zygophyllaceae</i>	Leaves	Wesley et al [377]
132	<i>Trichosanthes dioica</i> Roxb	<i>Cucurbitaceae</i>	Fruits	Shivhare et al [320]
133	<i>Typha domingensis</i> Pers	<i>Typhaceae</i>	Flowers	Akkol et al [14]
134	<i>Verbascum mucronatum</i> Lam	<i>Scrophulariaceae</i>	Leaves, flowers and whole aerial parts	Akdemir et al [10]
135	<i>Verbascum Thapsus</i> Linn	<i>Scrophulariaceae</i>	Flower	Mehdinezhad et al [181]
136	<i>Viscum articulatum</i> Brm	<i>Loranthaceae</i>	Whole plant	Garg et al [81]
137	<i>Vitis vitigenia</i> Linn	<i>Vitaceae</i>	Leaves	Murti et al [198]
138	<i>Ziziphus nummularia</i> Linn	<i>Rhamnaceae</i>	Leaves	Yusufoglu et al [383]
139	<i>Zizyphus oenoplia</i> Mill	<i>Rhamnaceae</i>	Leaves	Kuppast et al [157]

## CONCLUSION

Many Ayurvedic herbal plants have a very important role in the process of wound healing. Plants are more potent healers because they promote the repair mechanisms in a natural way. The healing process can be physically monitored by assessing the rate of contraction of the wound, period of epithelization, tensile strength, histopathology, and weight of granuloma in different wound models. The demand of herbal drugs is increasing day by day in the developed as well as developing countries because they are safer and well tolerated as compared to the allopathic drugs. In this review covering a twelve year period we have summarized 306 wound healing plants belonging to a variety of plant families. The most dominant families with wound healing plants were *Asteraceae* (27 species), *Fabaceae* (23 species), *Lamiaceae* (17 species), *Euphorbiaceae* (14 species) and *Malvaceae* (9 species). The most frequently used extraction methods are soxhlet extraction, maceration, percolation and steam distillation.

Mostly the excision wound model has been adopted, for the efficacy studies. In a majority of the plants reviewed, the leaf extracts have been analysed for wound healing potential. The plants have long been used both orally and topically for healing of wounds and burns in the folk medicine by the tribal communities of various countries. This review may provide lead to researchers in formulating wound healing agents.

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