

## Plants that heal wounds. A review

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### Summary

Plants have traditionally been used as a source of medicine in India by indigenous people of different ethnic groups inhabiting various terrains for the control of various ailments afflicting human and their domestic animals. Recently, focus on plant research has increased all over the world and a large body of evidence has collected to show immense potential of medicinal plants used in various traditional systems. More than 13,000 plants have been studied during last 5 years. Our review aims to compile data generated through the research activity using modern scientific approaches and innovative scientific tools in last few years. This article represent wound healing activity of various plants found and used traditionally. We have made an attempt to give an insight into different plants of potential wound healing properties which could be beneficial in therapeutic practice.

**Key words:** *wound healing, phytoconstituents, pharmacological actions*

## INTRODUCTION

The development of traditional medicinal systems incorporating plants as means of therapy can be traced back to the Middle Paleolithic age some 60,000 years ago as found from fossil studies [1]. Recently, developed countries have

turned to traditional medicinal systems that involve the use of herbal drugs and remedies [2] and according to the World Health Organization (WHO), almost 65% of the world's population has incorporated the value of plants as a methodology of medicinal agents into their primary modality of health care [3]. It is often noted that 25% of all drugs prescribed today come from plants [4, 5]. This estimate suggests that plant-derived drugs make up a significant segment of natural product-based pharmaceuticals. Over the past 20 years, our knowledge of the wound healing process has increased dramatically. Along with this knowledge the development of new, exciting technologies that accelerate normal wound healing and counter the pathophysiologic processes that lead to chronic wound formation has come. From growth factors to bioengineered skin substitutes, the future of wound healing holds great promise.

## HEALING OF WOUNDS

Wound is defined as a loss or breaking of cellular and anatomic or functional continuity of living tissues [6]. Healing of wound is a biological process that is initiated by trauma and often terminated by scar formation [7]. The process of wound healing occurs in different phases such as coagulation, epithelization, granulation, collagenation and tissue remodeling [8].

Collagen, the major component which strengthens and supports extracellular tissue, contains substantial amounts of hydroxyproline, which has been used as a biochemical marker for tissue collagen [9]. Wound contraction occurs as a myofibroblasts contract. Platelets release growth factors and other cytokines [10].

## MECHANISM OF WOUND HEALING

Wound healing is the physiological response to the tissue injury that results in the replacement of destroyed tissue by living tissue and thus restoration of tissue integrity. The mechanism of wound repair occurs by four basic processes such as inflammation, wound contraction, epithelialization and granulation tissue formation.

Inflammation starts immediately after the disruption of tissue integrity. The platelets become adherent with clotting factors and form haemostatic plug to stop bleeding from the vessels. The prostaglandins ( $PGE_1$  and  $PGE_2$ ) are released in the inflammation area and seem to be the final mediators of acute inflammation. They also can play a haemostatic role for white cells and fibroblasts. The active motile white cells migrate into the wound and start engulfing cellular debris. At the initial stages wound contraction begins slowly but becomes rapid on the day 3 or 4. The myofibroblasts present in the margin of the wound appear to constitute the machinery for the wound contraction. These are responsible for overlaying debris. The epithelialization of the wound occurs mainly by proliferation and migration of

the marginal basal cells lying close to the wound margin. The hematoma within the wound may be replaced by granulation tissue which consists of new capillaries and fibroblasts. The fibroblasts are responsible for the production of the mucopolysaccharide ground substance. The lymphatics develop new nerve fibers and also acts in the formation of scar tissue in which collagen turn over increases [11].

## PHYTOCONSTITUENTS

Various plants of wound healing property and also contain flavonoids as active constituents have been found. Tannins promote the wound healing through several cellular mechanisms, chelating of the free radicals and reactive species of oxygen, promoting contraction of the wound and increasing the formation of capillary vessels and fibroblasts [12, 13]. The process of wound healing is promoted by several natural products [14], plant products composed of active principles like triterpenes, alkaloids, flavonoids [15] and biomolecules [16].

## MEDICINAL PLANTS

Plants or chemical entities derived from plants used in the treatment and management of wounds need to be identified and formulated. For this case, a number of herbal products are being investigated at present. Various herbal products have been used in the management and treatment of wounds for years.

### *Alternanthera sessilis* (L.) R.Br. ex DC. (*Amaranthaceae*)

The plant consists of chemical constituents like  $\alpha$ - and  $\beta$ -spinasterols, lupeol isolated from roots. Apart from the above, plant also contains  $\beta$ - sitosterol (fig. 1), stigmasterol (fig. 2) etc. The leaves are used in eye diseases, in cuts and wounds, antidote to snake bite and scorpion sting, in skin diseases [17].

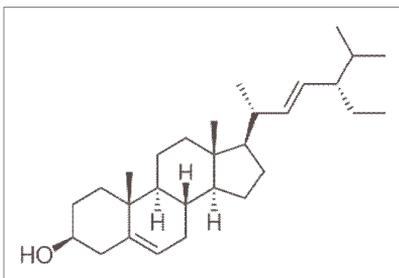


Figure 1  
Stigmasterol

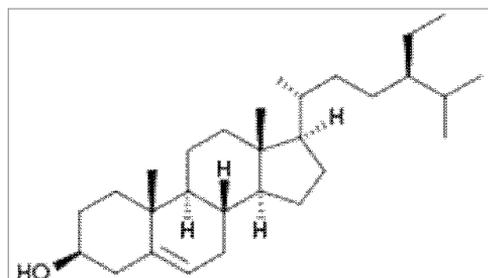


Figure 2  
 $\beta$ - sitosterol

### *Arnebia densiflora* (Nordm.) Ledeb. (*Boraginaceae*)

The roots of some genera of the Boraginaceae family are rich in naphthoquinones. Shikonin (fig. 3) (*R*-configuration) and alkannin (*S*-configuration) found in those families are enantiomers and their derivatives are potent pharmaceutical substances with a wide spectrum of biological properties, namely wound healing etc. [18].

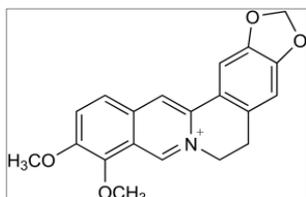


Figure 3  
Shikonin

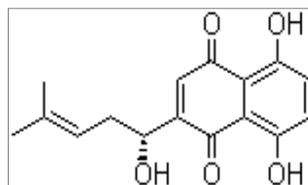


Figure 4  
Berberine

### *Berberis lyceum* Royle (*Berberidaceae*)

The root of *Berberis lyceum* contains flavonoids, alkaloids including berberine (fig. 4), tannins, saponins and triterpenoids. Triterpenoids and saponins are thought to promote the wound healing process due to their antioxidant and antimicrobial activities. Their astringent and antimicrobial properties also contribute to wound contraction and increase the rate of epithelialization [19].

### *Carallia brachiata* Merrill (*Rhizophoraceae*)

The bark is mentioned to be useful in the treatment of itching, cuts and wounds, oral ulcers, inflammation of throat and stomatitis. From the bark, new proanthocyanidins (fig. 5) were reported to possess free radical scavenging activity. A new megastigmane diglycoside (3-hydroxy-5, 6-epoxy- $\beta$ -ionol-3-O- $\beta$ -apiofuranosyl (1 $\rightarrow$ 6)- $\beta$ -glucopyranoside), two megastigmanes, condensed tannins, flavonoids and glyceroglycolipids were isolated from the leaves. The presence of alkaloid glyhroline in the leaves was also reported [20].

### *Centella asiatica* (L.) Urban (*Mackinlayaceae*)

The titrated extract of *C. asiatica* contains 3 principal ingredients – Asiaticoside (fig. 6), asiatic acid, and madecassic acid – all known to be clinically effective in

the treatment of systemic scleroderma, abnormal scar formation and keloids. This extract significantly shortens the wound-healing time, acting more specifically on the immediate process of healing [21, 22]. Asiaticoside, isolated from *C. asiatica*, is the main active constituent and exhibits significant wound-healing activity in normal and delayed-healing models [23].

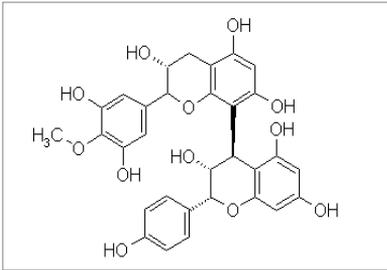


Figure 5  
Proanthocyanidins

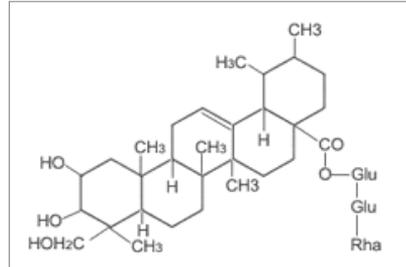


Figure 6  
Asiaticoside

### *Curcuma longa* L. (Zingiberaceae)

The part used are rhizomes containing curcumin (fig. 7) (diferuloyl methane), turmeric oil or turmerol and 1, 7-bis, 6- hepta-diene-3, 5-dione. *Curcuma longa* also contains protein, fats, vitamins (A, B, C etc.) all of which have an important role in wound healing and regeneration. Turmeric has been used for treating the wounds in the rats [24].

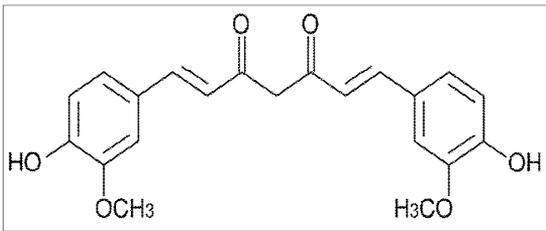


Figure 7  
Curcumin

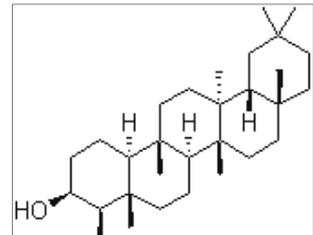


Figure 8  
Epifriedelinol

### *Elephantopus scaber* L. (Asteraceae)

The whole plant is macerated and applied on the wound surface to promote wound healing. Phytochemically the plant has been reported to contain sesquiterpene lactones deoxyelephantopin, isodeoxyelephantopin and scabertopin. It also contains epifriedelinol (fig. 8), lupeol and stigmasterol [25].

### *Embelia ribes* Burm. (*Myrsinaceae*)

Leaf pastes of this species are used to cure cut wounds and leprosy. Fruits contain a quinone derivative embelin (fig. 9) (3-undecyl 2,5-dihydroxy, 1,4-benzoquinone), an alkaloid christembine and a volatile oil vilangin(fig. 10); its chemical constituent is 2,5-dihydroxy-4-undecyl-3, 6-benzoquinone [26].

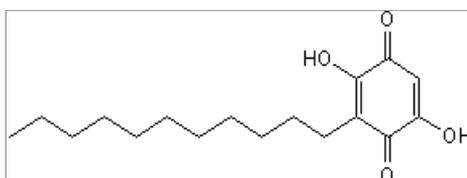


Figure 9  
Embelin

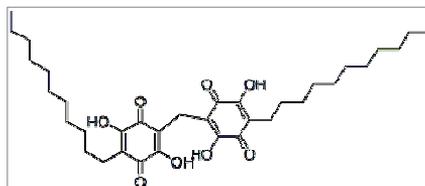


Figure 10  
Vilangin

### *Hibiscus rosa sinensis* L. (*Malvaceae*)

It is used as an herb in Ayurvedic or alternative medicine in India to treat colds, wound healing, and damaged and/or inflamed tissue as well as to rejuvenate the skin. The phytochemical analysis of the flower extract both by qualitative and thin layer chromatography showed the absence of active constituents such as polyphenols, triterpenoids (fig. 11), tannins, saponins, flavonoids, alkaloids, and carboxylic acids [27].

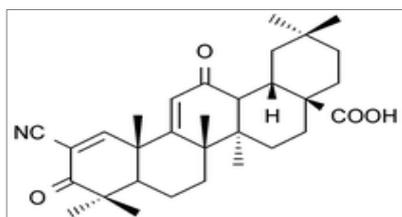


Figure 11  
Triterpenoids

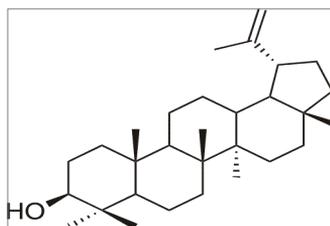


Figure 12  
Lupeol

### *Jasminum auriculatum* Vahl. (*Oleaceae*)

The alcohol free defatted extract of *J. auriculatum* leaves has been reported to contain lupeol (fig. 12) and jasminol [28]. Juice of leaves of *J. auriculatum* has been shown to be beneficial in wound healing. When applied in the form of jelly, locally

on linear uniform excised wound in rats, the juice is found to promote wound healing [29, 30].

### *Lycopodium serratum* (Lycopodiaceae)

The plant is reported to contain alkaloids like serrtezomines A-C, lycoposerramine-A, Lycoposerramine F-O, quinolizine (fig. 13) or pyridine and alpha-pyridone (fig. 14) type alkaloids which are the potent inhibitors of acetylcholineesterase and triterpenoids. The tribal groups of Western Ghats of Chikamagalur region use this plant for treating wounds. The whole plant is ground in hot water and the thick paste is thus obtained and applied externally to sores, cuts, wounds and burns [31].

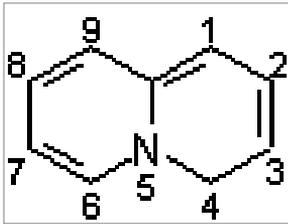


Figure 13  
Quinolizine

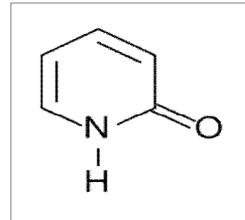


Figure 14  
Alpha-pyridone

## SAFETY AND EFFICACY OF PLANT MATERIAL

No system of medicine is entirely safe. Some of the risks are inherent in the medication prescribed; however, the experience of the practitioner also plays an important role.

The evidence of efficacy is derived from randomized, controlled trials, a methodology that has not been used in Ayurvedic or other traditional systems of medicine. I argue that other clinical parameters such as patient satisfaction, improvement of well-being, improved or faster healing, as well as the number of wounds that attain healing are a part of the objective that is efficacy.

## MECHANISM OF ACTION OF WOUND HEALING PLANTS

Plants with mechanism of action are given in table 1.

Table 1.

## Plants with mechanism of action

No.	Plant name	Part used	Mechanism of action	Ref.
	<i>Ageratum conyzoides</i> Linn. (Asteraceae)	roots	by antioxidant and antimicrobial activities	32
	<i>Aloe vera</i> (Liliaceae)	gel	by enhancing keratinocyte multiplication and migration, expression of proliferation related factors, and epidermis formation.	33
	<i>Alternanthera sessilis</i> (Linn.) R. Br. ex DC (Amaranthaceae)	leaves	by increasing collagen content and degree of collagen cross-linkage within the wound they may also promote cell division , growth of bone, cartilage and other connective tissues	17
	<i>Arnebia densiflora</i> (Nordm.) Ledeb. (Boraginaceae)	roots	an increase in the synthesis of collagen, fibronectin, and transforming growth factor- $\beta$ 1, which enhance healing of wounds	18
	<i>Aspilia africana</i> C. D. Adams (Compositae)	leaves	by arresting wound bleeding, inhibiting the growth of microbial wound contaminants	34
	<i>Berberis lyceum</i> Royle (Berberidaceae)	roots	by astringent and antimicrobial properties	19
	<i>Catharanthus roseus</i> L. (Apocyanaceae)	flowers	by increasing wound contraction and tensile strength, augmented hydroxyproline content	35
	<i>Calendula officinalis</i> L. (Asteraceae)	flowers	by stimulating the proliferation and, to a higher extent, the migration of fibroblasts.	36
	<i>Carapa guianensis</i> L. (Meliaceae)	leaves	by increasing rate of wound contraction, skin breaking strength and hydroxyproline content	37
	<i>Elephantopus scaber</i> Linn. (Asteraceae)	leaf	by increasing cellular proliferation, formation of granulation tissue, synthesis of collagen and by increase in the rate of wound contraction	25
	<i>Euphorbia nerifolia</i> Linn. (Euphorbiaceae)	latex	due to its epithelial proliferative action	38
	<i>Hevea brasiliensis</i> Müll. Arg. (Euphorbiaceae)	latex	by increasing vascular permeability and angiogenesis	39
	<i>Hibiscus rosa sinensis</i> L. (Malvaceae)	flowers	by enhancing wound contraction, shortened epithelialization period, increased tensile strength	27

No.	Plant name	Part used	Mechanism of action	Ref.
	<i>Hippophae rhamnoides</i> L. ( <i>Elaeagnaceae</i> )	seed oil	possesses antioxidant properties as evidenced by significant increase in reduced glutathione (GSH) level and reduced production of reactive oxygen species (ROS) in wound granulation tissue	40
	<i>Hypericum perforatum</i> L. ( <i>Clusiaceae = Guttiferaceae</i> )	aerial parts	may be a result of the fibroblast migration and stimulation of collagen synthesis	41
	<i>Leucas hirta</i> (Roth) Spreng., ( <i>Labiataeae</i> )	leaves	by increasing rate of wound contraction, reduction in the epithelialization. Increase in collagen deposition. Breaking strength and hydroxyproline in granulation tissue	42
	<i>Mimosa tenuiflora</i> (Willd.) Poirrett ( <i>Mimosaceae</i> )	bark	by stimulating mitochondrial activity and proliferation of dermal fibroblasts.	43
	<i>Morinda citrifolia</i> Linn. ( <i>Rubiaceae</i> )	leaves	by astringent and antimicrobial property, which seems to be responsible for wound contraction and increased rate of epithelialization	44
	<i>Pterocarpus santalinus</i> Linn. ( <i>Fabaceae</i> )	stem	by stimulating a growth factor or factors signal cascade system	45
	<i>Radix paeoniae</i> ( <i>Paeonaceae</i> )	root	by decreasing the surface area of the wound and increasing the tensile strength	46
	<i>Radix Rehmanniae</i> (RR) ( <i>Scrophulariaceae</i> )	herb	by better developed scars and epithelialization as well as good formation of capillaries with enhanced VEGF expression.	47
	<i>Rheum officinale</i> Baill ( <i>Polygonaceae</i> )	roots	by accelerating healing of cutaneous wounds which is related to TGF- $\beta$ 1/ Smad signaling pathway and improves reorganization of the regenerating tissue.	48
	<i>Terminalia bellirica</i> Roxb. ( <i>Combretaceae</i> )	fruits	by cellular mechanism; chelating of the free radicals and reactive species of oxygen. Promoting contraction of the wound and increasing the formation of capillary vessels and fibroblasts	49
	<i>Vanda roxburghii</i> R. Br. ( <i>Orchidaceae</i> )	leaves	by increasing the migration of epithelial cells	50

## PLANTS THAT HEAL WOUND

Plants which have been used in management and treatment of wounds over the years are given in table 2.

Table 2.

## Plants that heal wound

No.	Plant name	Extract used	Model studied	Ref.
	<i>Acalypha indica</i> Linn. ( <i>Euphorbiaceae</i> )	whole plant ethanolic extract	excision and incision	51
	<i>Aegle marmelos</i> Corr. ( <i>Rutaceae</i> )	methanolic extract of plant	excision and incision	52
	<i>Allamanda cathartica</i> Linn. ( <i>Apocyanaceae</i> )	aqueous extract	excision and incision	53
	<i>Alternanthera sessilis</i> (Linn.) R.Br.ex DC ( <i>Amaranthaceae</i> )	chloroform extract of leaves	incision and excision	17
	<i>Alternanthera brasiliana</i> Kuntz ( <i>Amaranthaceae</i> )	methanolic extract of leaves	excision and incision	54
	<i>Anogeissus latifolia</i> (Roxb. ex DC ) Wall, ex Guill & Pern ( <i>Combretaceae</i> )	ethanolic extract of bark	excision and incision	55
	<i>Aristolochia bracteolata</i> Lam. ( <i>Aristolochiaceae</i> )	ethanol extract	excision, incision and dead space	56
	<i>Areca catechu</i> L. ( <i>Areceaceae</i> )	betel nut extract	excision, incision and dead space	57
	<i>Argemone mexicana</i> Linn. ( <i>Papaveraceae</i> )	ethanolic extract	excision, incision and dead space wounds	58
	<i>Arnebia densiflora</i> (Nordm.) Ledeb. ( <i>Boraginaceae</i> )	the extract of the roots in olive oil	incision and excision	18
	<i>Azadirachta indica</i> ( <i>Meliaceae</i> )	pure neem oil and neem ointment	incised and gap wounds in bovine calves	59
	<i>Berberis lyceum</i> Royle ( <i>Berberidaceae</i> )	aqueous and methanolic extract of root	excision, incision and dead space	19
	<i>Bryophyllum pinnatum</i> (Lam.) ( <i>Crassulaceae</i> )	leaf, alcoholic and water extracts	excision, incision and dead space	60
	<i>Butea monosperma</i> (Lam.) Kuntze ( <i>Papilionaceae</i> )	alcoholic bark extract	excision	61
	<i>Calotropis gigantea</i> L. ( <i>Asclepiadaceae</i> )	latex	excision and incision	62
	<i>Canthium parviflorum</i> Lam. ( <i>Rubiaceae</i> )	aqueous and ethanolic extract	excision	63
	<i>Carallia brachiata</i> Merrill ( <i>Rhizophoraceae</i> )	petroleum, ethyl acetate and methanol extract of bark	excision and incision	20
	<i>Cassia fistula</i> Linn. ( <i>Leguminosae</i> )	alcoholic leaf extract	excision	64

No.	Plant name	Extract used	Model studied	Ref.
	<i>Cecropia peltata</i> L. ( <i>Cecropiaceae</i> )	aqueous and ethanolic extract of leaves	excision	65
	<i>Celosia argentea</i> Linn. ( <i>Amaranthaceae</i> )	alcoholic extract	burn wound	66
	<i>Centella asiatica</i> L. ( <i>Umbelliferae</i> )	ethanolic extract	incision, excision, and dead space	21, 22
	<i>Cinnamomum zeylanicum</i> Blume ( <i>Lauracea</i> )	ethanol extract of bark	excision, incision and dead space	67
	<i>Cocos nucifera</i> Linn. ( <i>Arecaceae</i> )	oil	burn	68
	<i>Coronopus didymous</i> ( <i>Brassicaceae</i> )	ethanol and aqueous extracts of whole plant	incision	69
	<i>Cyperus rotundus</i> Linn. ( <i>Cyperaceae</i> )	extract of tuber	excision, incision and dead space	70
	<i>Datura alba</i> (Bernh.) Rumph. ex Nees ( <i>Solanaccae</i> )	alcoholic leaf extract	burn rat wound	71
	<i>Dendrophthoe falcata</i> (L.f) Ettingsh ( <i>Loranthaceae</i> )	ethanolic extract of aerial parts	excision and incision	72
	<i>Desmodium triquetrum</i> ( <i>Leguminosae</i> )	ethanolic leaf extract	excision, incision and dead space	73
	<i>Elephantopus scaber</i> Linn. ( <i>Asteraceae</i> )	aqueous ethanol	excision, incision and dead space	25
	<i>Embelia ribes</i> Burm ( <i>Myrsinaceae</i> )	ethanol extract of the leaves	excision, incision and dead space	26
	<i>Eucalyptus globulus</i> ( <i>Myrtaceae</i> )	ethanolic extract of leaf	excision, incision and dead space	74
	<i>Euphorbia nerifolia</i> Linn. ( <i>Euphorbiaceae</i> )	aqueous extract of latex	excision	38
	<i>Flaveria trinerva</i> ( <i>Asteraceae</i> )	methanol extract	excision and incision	75
	<i>Gmelina arborea</i> Roxb. ( <i>Verbenaceae</i> )	alcoholic extract of leaf	excision, incision and dead space	76
	<i>Heliotropium indicum</i> ( <i>Boraginaceae</i> )	whole plant ethanolic extract	excision and incision	51
	<i>Hemigraphis colorata</i> (Blume) H.G. Hallier ( <i>Acanthaceae</i> )	crude leaf paste	excision	77
	<i>Hibiscus rosa sinensis</i> L. ( <i>Malvaceae</i> )	ethanol extract of flower	excision, incision and dead space models	27
	<i>Hippophae rhamnoides</i> L. ( <i>Elaeagnaceae</i> )	aqueous extract of leaf	excision	78

No.	Plant name	Extract used	Model studied	Ref.
	<i>Hippophae rhamnoides</i> L. ( <i>Elaeagnaceae</i> )	seed oil	burn wounds	40
	<i>Hypericum hookerianum</i> ( <i>Hypericaceae</i> )	methanolic extracts of leaf	incision and excision	79
	<i>Hypericum mysorense</i> Wight and Arn. ( <i>Hypericaceae</i> )	methanol extract of leaf	excision and incision	80
	<i>Hypericum patulatum</i> Thumb ( <i>Hypericaceae</i> )	methanolic extract of leaf	excision and incision	81
	<i>Hyptis suaveolens</i> (L.) ( <i>Lamiaceae</i> )	ethanolic extract of leaf	excision, incision and dead space	82
	<i>Indigofera enneaphylla</i> Linn. ( <i>Fabaceae</i> )	alcoholic extract of aerial parts	excision and incision	83
	<i>Ixora coccinea</i> Linn. ( <i>Rubiaceae</i> )	alcoholic extract of flowers	dead space	84
	<i>Lantana camara</i> Linn. ( <i>Verbenaceae</i> )	leaf juice and hydroalcoholic extract	excision	85
	<i>Laurus nobilis</i> Linn. ( <i>Lauraceae</i> )	aqueous extracts	excision and incision	53
	<i>Lawsonia alba</i> Lam. ( <i>Lythraceae</i> )	difference extracts of leaf	excision and incision	86
	<i>Leucas hirta</i> (Roth) Spreng., ( <i>Labiatae</i> )	aqueous and methanolic leaf extracts	excision, incision and dead space	42
	<i>Leucas lavandulaefolia</i> Rees. ( <i>Labiatae</i> )	methanol extract	excision and incision	87
	<i>Lycopodium serratum</i> ( <i>Lycopodiaceae</i> )	70% ethanolic extract	excision	31
	<i>Moringa oleifera</i> Lam. ( <i>Moringaceae</i> )	ethyl acetate extract of dried leaf	excision, incision and dead space	88, 89
	<i>Nelumbo nucifera</i> ( <i>Nymphaeaceae</i> )	methanol extract of rhizomes	excision, incision and dead space	90
	<i>Ocimum sanctum</i> Linn. ( <i>Labiaceae</i> )	ethanolic extract of leaves	excision, incision and dead space	91
	<i>Oxalis corniculata</i> ( <i>Oxalidaceae</i> )	alcohol and petroleum ether extracts of whole plant	excision, incision and dead space	92
	<i>Pentas lanceolata</i> ( <i>Rubiaceae</i> )	ethanolic extract of flowers	excision	93
	<i>Phyllanthus emblica</i> Linn. ( <i>Euphorbiaceae</i> )	plant extract	excision	94

No.	Plant name	Extract used	Model studied	Ref.
	<i>Plagiochasma appendiculatum</i> Lehm. et Lind. ( <i>Aytoniaceae</i> )	alcohol and ethanolic extract	excision and incision	95
	<i>Polyscias scutellaria</i> (Burm. f.) Fosberg. ( <i>Araliaceae</i> )	leaf saponin extract	excision, incision and dead space	96
	<i>Punica granatum</i> L. ( <i>Punicaceae</i> )	methanolic extract of peels	excision	97
	<i>Quercus infectoria</i> Oliver ( <i>Fagaceae</i> )	crude aqueous extract of galls	excision, incision and dead space	98
	<i>Rafflesia hasseltii</i> ( <i>Rafflesiaceae</i> )	methanol extract of flower	induced wounds	99
	<i>Sphaeranthus indicus</i> Linn. ( <i>Asteraceae</i> )	ethanolic extract of aerial parts	excision	100
	<i>Tephrosia purpurea</i> (Linn.) Pers. ( <i>Leguminosae</i> )	ethanolic extract	excision, incision and dead space	101
	<i>Terminalia arjuna</i> (Roxb.) W&A. ( <i>Combretaceae</i> )	50% ethanolic extract of bark and tannins	excision and incision	102
	<i>Terminalia bellirica</i> Roxb. ( <i>Combretaceae</i> )	ethanol extract of fruits	excision and incision wounds	49
	<i>Terminalia chebula</i> Retz. ( <i>Combretaceae</i> )	alcoholic extract of leaf	incision and <i>in vitro</i>	103
	<i>Thespesia populnea</i> Soland ex Correa ( <i>Malvaceae</i> )	aqueous extract of fruit	incision and excision	104
	<i>Toddalia asiatica</i> (Linn.) Lam. ( <i>Rutaceae</i> )	ethanol, petroleum ether, chloroform, acetone extracts	excision and incision	105
	<i>Tragia involucrate</i> L. ( <i>Euphorbiaceae</i> )	methanol extract	excision	106
	<i>Tridax procumbens</i> Linn. ( <i>Compositae</i> )	whole plant, aqueous extract,	dead space	107, 108
	<i>Trigonella foenum-graecum</i> Linn. ( <i>Fabaceae</i> )	aqueous extract of seed	excision, incision and dead space	109
	<i>Vanda roxburghii</i> R. Br. ( <i>Orchidaceae</i> )	extract of whole plant	excision	50
	<i>Vernonia arborea</i> HK ( <i>Asteraceae</i> )	aqueous and methanol leaf extracts	excision, incision and dead space	110
	<i>Vanda roxburghii</i> R. Br. ( <i>Orchidaceae</i> )	crude aqueous extract of plant	excision, incision and dead space	111
	<i>Wedelia calendulacea</i> (L.) Less. ( <i>Asteraceae</i> )	aqueous extract	incision and excision	112

## DISCUSSION

The search for “natural remedies” for a common disorder such as wounds has drawn attention to herbals. From ancient times, herbals have been routinely used to treat wounds and in many cultures their use in traditional medicine has persisted to present times. While it is possible that some time-tested herbal remedies are indeed effective, it seems to be often the case that the patient knows more about this form of medicine than the physician. In spite of the various challenges encountered in the medicinal plant-based drug discovery, natural products isolated from plants will still remain an essential component in the search of new medicines. Proper utilization of these resources and tools in bioprospecting will certainly help in discovering novel lead molecules from plants by employing modern drug discovery techniques and the coordinated efforts of various disciplines.

## CONCLUSION

Wound healing is a fundamental response to tissue injury that results in restoration of tissue integrity. This is mainly achieved by the synthesis of the connective tissue matrix. Collagen is a major protein of the extracellular matrix and is the major component that ultimately contributes to wound strength. Utilization of plants for medicinal purposes in India has been documented long back in ancient literature because they are essential to human survival. The consumption, management and valuation of wild plants are central aspects of traditional knowledge in many human populations. Thus, plants gathering the diffusion and conservation of knowledge within the community are traditional practices that have contribution to the subsistence of many cultures. Plants and their extracts have immense potential for the management and treatment of wounds. Therefore, it is important to study and examine all options available with which wound management may be improved. However, there is a need for scientific validation, standardization and safety evaluation of plants of the traditional medicine before these could be recommended for healing of the wounds. This review is an approach towards the herbal plants having wound healing potentials involving the observation, description, and experimental investigation of indigenous drugs and their biological activities. It is based on botany, chemistry, biochemistry, pharmacology, and many other disciplines that contribute to the discovery of natural products of biological activity.

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### Streszczenie

Ludność z grup etnicznych zamieszkujących różne rejony Indii tradycyjnie używa roślin do leczenia wielu dolegliwości u ludzi i zwierząt domowych. Ostatnio na świecie odnotowuje się zwiększone zainteresowanie lekami pochodzenia roślinnego. Zebrano wiele dowodów na ogromne możliwości roślin leczniczych używanych tradycyjnie w wielu społecznościach. W ciągu ostatnich pięciu lat przestudowano ponad 13 000 gatunków. Nasz przegląd to próba porównania danych uzyskanych w trakcie badań w ciągu ostatnich kilku lat przy użyciu nowoczesnego podejścia i innowacyjnych narzędzi badawczych. Artykuł dotyczy roślin używanych tradycyjnie na gojenie ran. Podjęto próbę przeglądu roślin o właściwościach gojących, które mogłyby być z powodzeniem stosowane w praktyce leczniczej.

**Słowa kluczowe:** gojenie ran, składniki roślinne, działanie lecznicze