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WOUND HEALING POTENTIAL OF PLANT-DERIVED GUMS, RESINS, AND OLEO-GUM-RESINS: AN EVIDENCE-BASED REVIEW

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ABSTRACT

Gums, resins, and oleo-gum-resins are natural plant products widely used in Ayurveda for wound healing, inflammation control, and infection prevention. These substances are obtained from plants such as *Sarala (Pinus roxburghii), Guggulu (Commiphora wightii), Shriveshtaka (Pinus longifolia), Rala* and *Sala (Shorea robusta),* and *Shallaki (Boswellia serrata*). Traditionally, they are applied in the form of pastes, oils, ointments, and fumigation therapies for the management of wounds.

These plant exudates help reduce pain, discharge, inflammation, and bleeding, while promoting granulation tissue formation, collagen synthesis, and strengthening of healed tissue. Modern scientific studies support these traditional uses and demonstrate that gums, resins, and oleo-gum-resins possess antimicrobial, anti-inflammatory, antioxidant, and tissue-regenerating properties. They enhance wound contraction, epithelialization, angiogenesis, and tensile strength, thereby improving both the speed and quality of healing.

This review aims to evaluate the wound-healing potential of gums, resins, and oleo-gum-resins and to scientifically validate their traditional use in Ayurvedic wound management. The findings suggest that these natural substances act through multiple mechanisms and can serve as effective and promising agents for the development of modern wound care formulations.

Keywords: Wound healing, Oleo-gum-resins, Resins, *Niryasa*, Ayurveda, Anti-inflammatory

INTRODUCTION

Gums, resins, and oleo-gum-resins are natural plant products that have long been used for their health benefits, especially in the treatment of inflammatory conditions and wounds. These substances are produced by plants as metabolic by-products and are released either naturally or due to injury to the plant bark. Oleo-gum-resins contain small amounts of essential oils, which enhance their therapeutic value. Such resinous substances are commonly obtained from plants growing in dry and arid regions and have been traditionally used in food, medicine, incense, and as protective coatings.

In the process of wound healing, several local and systemic factors such as infection, poor blood supply, tissue damage, diabetes, malnutrition, and chronic inflammation can delay or impair healing. Proper wound contraction and adequate tensile strength are essential for the formation of a healthy and stable scar. Therefore, agents that reduce inflammation, prevent infection, promote tissue repair, and support collagen formation play an important role in effective wound management.

In Ayurveda, wounds are described under the term *Vraṇa*, and their treatment (*Vraṇa Chikitsa*) has been explained in detail in classical texts, particularly by *Acharya Sushruta*. Ayurvedic wound care focuses not only on wound closure but also on wound cleansing, control of bleeding and discharge, reduction of pain and inflammation, prevention of infection, and restoration of tissue strength. For these purposes, several herbal drugs possessing *Vraṇahara* (wound-healing), *Shothahara* (anti-inflammatory), *Krimighna* (antimicrobial), and *Ropaṇa* (tissue-repairing) properties have been described. Among the various wound-healing substances used in Ayurveda, plant exudates known as *Niryasa*, which include gums, resins, and oleo-gum-resins, occupy a significant place. These substances are valued for their ability to reduce wound discharge, control infection, protect the wound surface, and promote healthy granulation tissue. Their sticky and protective nature helps maintain a favourable environment for wound healing.

Bhavaprakash Nighantu is a well-known Ayurvedic reference text that describes many drugs used for wound treatment. A focused review of *Vraṇahara dravya* reveals that many effective wound-healing drugs are resin-yielding plants classified under specific groups, particularly the *Karpuradi Varga* and *Vatadi Varga* **[33, 34]**.

The *Karpuradi Varga*, described in *Bhavaprakash Nighantu* (Adhyaya 8, p. 128) **[33]**, mainly includes aromatic and resinous substances that are especially useful in infected, foul-smelling, and

chronic wounds. Important resin-based drugs from this group include *Sarala (Pinus roxburghii Roxb.), Guggulu (Commiphora wightii Arn.), Shriveshtaka (Pinus longifolia), and Rala (resin of Shorea robusta Gaertn.).* These drugs have traditionally been used in the form of pastes, medicated oils, ointments, and fumigation, and are known to reduce pain, inflammation, bleeding, and discharge while promoting faster wound healing. In addition, the *Vatadi Varga,* described in *Bhavaprakash Nighantu* (Adhyaya 9, p. 137) **[34]**, includes important resin-yielding plants such as *Shallaki (Boswellia serrata Roxb.)* and *Sala (Shorea robusta Gaertn.).* The resins obtained from these plants are traditionally used in wounds associated with inflammation and bleeding, including *Raktapitta*-related wounds. These drugs support wound contraction, promote granulation tissue, and improve the tensile strength of healed wounds, making them important *Vraṇahara dravya*.

Ayurveda also emphasizes the use of *Niryasa* in *Dhupana karma* (therapeutic fumigation) as part of wound care. *Acharya Sushruta* has recommended *Dhupana* in painful, profusely discharging, and *Vata* dominant wounds to reduce microbial load and promote healing. This highlights the role of resinous substances in maintaining wound hygiene and preventing infection. Modern scientific studies support many of these traditional observations. This review aims to demonstrate that gums, resins, and oleo-gum-resins possess significant anti-inflammatory, antimicrobial, antioxidant, angiogenic, and collagen-promoting activities **[1, 5, 8, 18, 23, 24]**, thereby establishing their wound-healing potential and supporting their traditional use as well as their application in modern wound management.

MATERIALS AND METHODS

The present review was carried out to study the wound healing potential of gums, resins, and oleo-gum-resins used in traditional and modern medicine. Different plant exudates obtained from medicinal plants such as *Boswellia serrata, Shorea robusta, Commiphora wightii, Shriveshtaka,* and *Pinus roxburghii* were included in this study. These natural substances are commonly used in pharmaceutical and traditional systems because of their healing and protective properties. Data were obtained from published literature including peer-reviewed journals and classical Ayurvedic texts.

The information for this review was collected from previously published research articles, review papers, and classical Ayurvedic texts. Online sources such as Google Scholar and other freely available scientific websites were used to gather relevant data. During the search, common terms related to gums, resins, and wound healing were used to find suitable

studies. Articles were selected based on their relevance to wound healing activity, traditional use, and scientific evidence. Studies that included laboratory experiments, animal studies, and phytochemical analysis were considered. Special attention was given to important chemical constituents such as essential oils, and resin acids, which are responsible for healing activity. The collected information was carefully reviewed and arranged to understand how these natural substances help in wound healing through actions like reducing inflammation, preventing infection, promoting tissue repair, and improving collagen formation

Search Strategy

A detailed search of the literature was carried out to collect information on the wound healing properties of gums, resins, and oleo-gum-resins. The main source used for data collection was Google Scholar, along with other freely accessible research articles and journals. Different simple keywords related to the topic were used, such as gums, resins, wound healing, medicinal plants, and antimicrobial activity. Based on these searches, relevant articles were identified. Only articles that were available in full text and written in English were included. Studies that were not related to wound healing or had incomplete information were excluded. The selected articles were then reviewed carefully to collect useful information about their traditional uses, chemical composition, and healing effects. This helped in creating a clear understanding of the role of these natural substances in wound management.

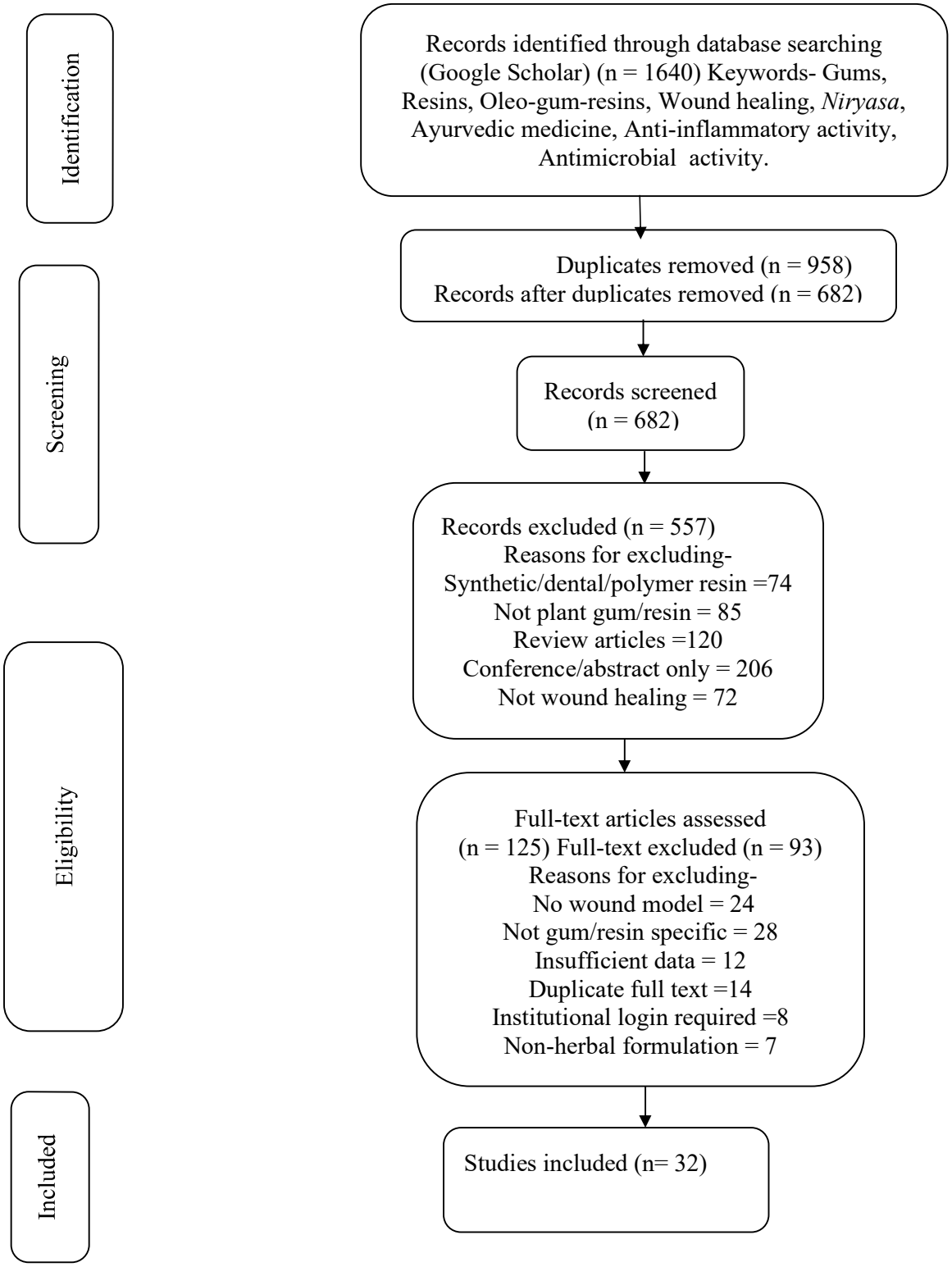


Figure 1: PRISMA flow diagram of study selection

RESULTS AND DISCUSSION

Wound healing is a highly organized biological process involving inflammation control, tissue regeneration, collagen formation, and final remodeling. For successful healing, each stage must progress in a coordinated way. If inflammation remains excessive, infection persists, or collagen production is weak, healing becomes delayed and may result in chronic wounds. This review analyzed 32 primary wound-healing studies from resin-based investigations. The evidence consistently shows that gums, resins, and oleo-gum-resins influence multiple biological pathways involved in wound repair.

Importantly, these plant exudates do not act through a single mechanism. Instead, they act in a multi-target manner, which may explain their strong traditional reputation in Ayurvedic wound care.

Karpuradi Varga Drugs and Vatadi Varga Drugs

Table 1: Resin and Oleo-Gum-Resin Drugs in Wound Healing

Drug (Common Name)	Botanical Name	Type of Resin	Wound-Healing Evidence / References
Sarala	*Pinus roxburghii Roxb.*	Oleoresin	Antioxidant, antimicrobial, supports angiogenesis and tissue repair [1]
Guggulu	*Commiphora wightii Arn.*	Gum resin	Enhances tissue regeneration, improves wound contraction, strengthens healed tissue [2]
Shriveshtaka	*Pinus longifolia*	Resin	Antimicrobial and antioxidant, reduces microbial contamination in wounds [3]
Sala	*Shorea robusta Gaertn.*	Resin (Oleo-gum-resin)	Accelerates wound contraction, promotes epithelization, increases collagen content and tensile strength [4–9]
Shallaki	*Boswellia serrata Roxb.*	Gum resin	Anti-inflammatory, antioxidant, improves wound contraction, collagen formation, non-toxic in clinical trials [10,11]

1. *Sala (Shorea robusta Gaertn.)*

Shorea robusta, commonly known as Sal tree, is widely distributed in India, Nepal, and Bhutan. It is an important oleoresin-producing plant, and its resin has been used in traditional medicine for many years. In Ayurveda, it is commonly used for treating wounds, burns, skin diseases, pain, diarrhoea, and dysentery. Its application in wound care is mainly due to its *Vrana Ropana* (healing) and *Shodhana* (cleansing) properties. Modern scientific studies have confirmed its strong wound healing potential. Different extracts of *Shorea robusta* oleoresin, such as essential oil, methanol extract, petroleum ether extract, and benzene-insoluble methanol extract, have been studied using excision and incision wound models in animals. These studies showed that all extracts significantly improved wound healing **[4–9]**.

In excision wound models, the resin extracts helped in faster wound contraction and quicker formation of new skin (epithelization). In incision wound models, they increased tensile strength, which

indicates better collagen formation and stronger healed tissue. Among all extracts, petroleum ether and benzene-insoluble methanol extracts showed the best results.

Another study using 70% alcoholic extract also demonstrated increased wound contraction and improved tissue strength. The healing effect is mainly due to the presence of triterpenoids and phenolic compounds, which help reduce inflammation, promote collagen synthesis, and support tissue regeneration. Overall, *Shorea robusta* can be considered a highly effective natural wound-healing agent with strong support from both traditional use and modern scientific evidence.

2. *Shallaki (Boswellia serrata)*

Boswellia serrata, commonly known as *Shallaki* or *Salai guggul*, is an oleo-gum-resin obtained by tapping the bark of the tree. It has been widely used in *Ayurveda* for managing inflammation, joint pain, wounds, and various chronic conditions. Its wound healing properties are mainly due to its strong anti-inflammatory action. The main active compounds present in *Boswellia serrata* are boswellic acids. These compounds work by inhibiting inflammatory pathways, especially the 5-lipoxygenase enzyme, which reduces swelling and inflammation at the wound site.

Experimental studies have evaluated the wound healing activity of *Boswellia serrata* using cream formulations containing 5%, 10%, and 15% extracts. Among these, the 15% formulation showed the best results. It significantly increased wound contraction, reduced healing time, and improved collagen formation.

The resin also promotes fibroblast activity, which helps in the production of collagen and new tissue. Additionally, it supports angiogenesis (formation of new blood vessels), which is essential for supplying nutrients and oxygen to the healing tissue. Another important advantage is its safety profile. Clinical studies have shown that *Boswellia serrata* is non-toxic and safe for topical use. Thus, due to its anti-inflammatory, antioxidant, and tissue-regenerating properties, *Boswellia serrata* is a very promising natural drug for wound healing and is widely used in herbal formulations **[10, 11]**.

3. *Sarala (Pinus roxburghii)*

Pinus roxburghii, commonly known as Chir pine, is a resin-producing plant widely found in Himalayan regions. Its oleoresin has been traditionally used for treating wounds, infections, and inflammatory conditions. The resin contains important compounds such as α-pinene and β-pinene, which are responsible for its medicinal properties. Traditionally, it is applied to wounds to reduce swelling, prevent infection, and promote healing.

Scientific studies have shown that *Pinus roxburghii* has strong antimicrobial activity against common wound-causing microorganisms. This helps in preventing infection and keeping the wound clean. It also has antioxidant properties, which protect the wound from oxidative damage and support faster healing. In addition, the resin promotes angiogenesis, which helps in the formation of new blood vessels. This improves blood supply to the wound area and accelerates tissue repair. It also supports cellular proliferation, which is necessary for the formation of new skin. The anti-inflammatory effect of the resin helps in reducing pain and swelling, making the healing process more comfortable **[1]**. Overall, *Pinus roxburghii* plays an important role in wound healing by combining antimicrobial, antioxidant, and tissue-repairing actions, making it a useful natural remedy.

4. *Guggulu (Commiphora wightii)*

Guggulu is a well-known gum resin obtained from the plant *Commiphora wightii*. It has been used in Ayurveda for centuries for treating inflammation, skin diseases, obesity, and metabolic disorders. It is also widely used in wound healing. The main active compounds present in *guggulu* are guggulsterones, which have strong anti-inflammatory and antioxidant properties. These compounds help in reducing inflammation at the wound site and protect tissues from damage. Experimental studies have shown that *guggulu* improves wound healing by increasing wound contraction, enhancing collagen synthesis, and improving tensile strength of the healed tissue. It also promotes tissue regeneration and reduces the overall healing time. The antimicrobial activity of *guggulu* helps in preventing infection, which is an important factor in proper wound healing. Additionally, it helps in regulating inflammatory pathways and supports fibroblast activity, which plays a key role in collagen formation and tissue repair **[2]**.

Due to its multiple beneficial effects, *guggulu* is considered an effective natural agent for wound management and is commonly used in both traditional and modern formulations.

5. *Shriveshtaka (Pinus longifolia Roxb.)*

Shriveshtaka, commonly known as benzoin resin, is obtained from Styrax species and has been traditionally used for wound care. It contains important compounds such as benzoic acid, cinnamic acid, and vanillin. Traditionally, it is used for cleaning wounds, preventing infection, and promoting healing. It acts as a natural antiseptic and helps in maintaining a clean wound environment. Scientific studies support its antimicrobial activity, which helps in reducing bacterial contamination in wounds. This prevents infection and supports faster healing. It also has antioxidant properties,

which protect tissues from oxidative stress and damage. This helps in better tissue repair and regeneration.

Another important function of benzoin resin is that it forms a protective layer over the wound, acting like a natural dressing. This protects the wound from external factors and supports faster epithelization. Due to its combined antimicrobial, antioxidant, and protective actions, benzoin resin is highly useful in wound management **[3]**.

Strength of Available Evidence

Most available studies were conducted in controlled animal models, particularly excision and burn wounds. These models allow measurement of wound contraction, epithelialization time, hydroxyproline content, collagen deposition, and tensile strength. A smaller number of studies evaluated diabetic wound models, which are more challenging due to impaired blood supply and metabolic imbalance. Only limited clinical trials were identified. The overall distribution of evidence is summarized below:

Table 2: Distribution of Included Studies

Study Type	Evidence Strength	Key Observation
Excision wound (animal)	Strong	Faster wound closure & collagen increase
Burn wound (animal)	Strong	Reduced inflammation & improved epithelialization
Diabetic wound models	Moderate	Improved healing but fewer studies
Clinical studies	Limited	Promising results in burns & chronic ulcers
In vitro studies	Supportive	Increased fibroblast proliferation

This distribution suggests strong experimental validation but highlights the need for more human-based research.

Anti-Inflammatory and Infection Control Effects

Inflammation is necessary at the beginning of healing; however, prolonged inflammation damages tissue and delays repair. Several studies demonstrated that *Boswellia, Commiphora*, and *Pine* species significantly reduced inflammatory cell infiltration and improved tissue structure **[19, 24, 27, 30]**. Reduction in inflammatory markers was also observed in diabetic wound models. In addition, antimicrobial activity was reported in multiple studies. Oleo-gum-resins showed stronger antimicrobial effects due to their volatile oil components. This dual action controlling inflammation and preventing infection is critical for faster progression into the repair phase.

Stimulation of Tissue Regeneration

During the proliferative phase, fibroblasts migrate into the wound and produce collagen. Angiogenesis (formation of new blood vessels) provides oxygen and nutrients to support repair. Many studies reported: **[18, 23, 30]**

Increased fibroblast activity leads to enhanced angiogenesis, which further improves granulation tissue formation. *Commiphora* species showed strong fibroblast stimulation in both animal and in vitro models **[23, 27]**. Pistacia resins demonstrated dose-dependent angiogenic effects. These findings suggest that resin-based preparations actively stimulate tissue regeneration rather than merely protecting the wound surface. The multi-stage contribution of these substances is summarized below:

Table 3: Stage-Wise Biological Action

Healing Stage	Biological Function	Effect of Resins
Inflammatory phase	Immune response	Reduce excessive inflammation
Proliferation phase	Tissue formation	Increase fibroblast activity
Angiogenesis	Blood vessel growth	Improve vascularization
Collagen phase	Structural repair	Enhance collagen deposition
Remodeling phase	Strengthening	Improve tensile strength

This stage-wise influence supports the idea that resins act as multi-functional healing agents

Collagen Deposition and Mechanical Strength

Collagen determines the strength and stability of healed tissue. Increased hydroxyproline levels and better collagen fiber alignment were consistently reported in resin-treated groups **[8, 24, 18]**. *Shorea robusta* and *Boswellia serrata* showed particularly strong effects on collagen deposition and tensile strength. Even in diabetic wound models, *Boswellia* extract improved collagen formation, which is clinically important because diabetic wounds are known for poor collagen quality. Thus, these plant exudates not only accelerate healing but also improve the quality and durability of the scar.

Comparative Effectiveness: Gums vs Resins vs Oleo-Gum-Resins

Although often grouped together, these substances differ in biological strength. Gums primarily provide moisture retention and a protective layer. Resins contain active phytochemicals that reduce inflammation and stimulate collagen. Oleo-gum-resins combine resin acids with volatile oils, producing broader biological effects.

Table 4: Comparative Healing Properties

Feature	Gums	Resins	Oleo-Gum-Resins
Protective barrier	Strong	Moderate	Strong
Anti-inflammatory	Mild	Moderate	Strong
Antimicrobial	Limited	Present	Strong
Collagen stimulation	Supportive	Strong	Strong
Overall healing capacity	Supportive	Active	Multi-target & strongest

This explains why oleo-gum-resins often show superior outcomes across different wound models.

Plant-Wise Therapeutic study

Different plants demonstrate different strengths.

Boswellia serrata shows strong anti-inflammatory and diabetic wound benefits **[19, 24, 27, 30]**. *Shorea robusta* strongly improves collagen and tensile strength. *Commiphora* species stimulate fibroblast proliferation and antimicrobial activity **[1, 20, 23, 27]**. *Pine* species demonstrate strong burn healing and angiogenesis **[5, 6, 18]**.

Table 5: Plant-Wise Comparative Strength

Plant	Main Strength	Evidence Level
Boswellia serrata	**Anti-inflammatory & diabetic healing**	**Strong**
Shorea robusta	**Collagen & tensile strength**	**Strong**
Commiphora wightii	**Fibroblast & antimicrobial**	**Strong**
Pinus roxburghii Roxb.	**Burn healing & angiogenesis**	**Strong**
Pinus longifolia	**Antimicrobial support**	**Moderate**

This comparative view helps identify plants with higher translational potential.

Evidence Gaps

While results are encouraging, most studies focus on acute wounds. Fewer studies address diabetic or chronic ulcers. This highlights an important research gap for future investigation.

Table 6: Evidence by Wound Type

Wound Type	Evidence Strength
Acute wounds	**Strong**
Burn wounds	**Strong**
Diabetic wounds	**Moderate**
Chronic ulcers	**Limited but promising**

Table 7: Overall Interpretation of Resin-Based Wound Healing

Key Aspect	Interpretation
Mode of Action	**Acts through multiple biological pathways rather than a single mechanism**
Inflammation Control	**Reduces excessive inflammation and prevents delay in healing**
Infection Control	**Decreases microbial load and lowers infection risk**
Tissue Regeneration	**Enhances fibroblast activity, angiogenesis, and granulation tissue formation**
Collagen Formation	**Improves collagen synthesis and increases tensile strength**
Healing Speed	**Accelerates wound contraction and epithelialization**
Healing Quality	**Produces stronger and more stable healed tissue**
Comparative Strength	**Oleo-gum-resins show the broadest and most effective healing profile**

CONCLUSION

The present review shows that plant-derived gums, resins, and oleo-gum-resins have strong wound healing ability, supported by both Ayurvedic knowledge and modern scientific studies. These natural substances help in healing wounds through multiple actions such as reducing inflammation,

preventing infection, protecting tissues from damage, promoting new blood vessel formation, and improving collagen production. As a result, they help in faster wound closure and formation of stronger healed tissue. Among the studied drugs, *Boswellia serrata* and *Shorea robusta* showed strong effects in reducing inflammation and improving tissue strength, while *Commiphora wightii* and Pinus species were more effective in controlling infection and supporting tissue repair. Oleo-gum-resins showed the best overall effect because they contain both active resin compounds and essential oils, which act together on different stages of wound healing.

Overall, this study supports the *Ayurvedic* concept of *Niryasa* as effective wound healing substances (*Vraṇahara dravya*). These natural products have good potential to be used in modern formulations such as ointments, gels, and wound dressings. However, more clinical studies in humans are needed to confirm their effectiveness and to promote their use in modern healthcare.

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REFERENCES

[1] Gebrehiwot M, Asres K, Bisrat D, Mazumder A, Lindemann P, Bucar F. Evaluation of the wound healing property of Commiphora guidottii Chiov. Ex Guid. J Ethnopharmacol. 2015;15:282.

[2] Althurwi HN, Salkini MA, Soliman GA, Ansari MN, Ibnouf EO, Abdel-Kader MS. Wound healing potential of Commiphora myrrha stems essential oil and chloroform extract. BMC Complement Med Ther. 2022;9(9):254.

[3] Mallik AM, Goupale DG, Dhongade HD, Nayak SN. Evaluation of Boswellia serrata oleo-gum resin for wound healing activity. Der Pharm Lett. 2015.

[4] Nikolic M, Andjic M, Bradic J, Kocovic A, Tomovic M, Samanovic AM, Jakovljevic V, Veselinovic M, Capo I, Krstonosic V, Kladar N. Topical application of siberian pine essential oil formulations enhance diabetic wound healing. Pharmaceutics. 2023 Oct 9;15(10):2437.

[5] Sonia K, Vijaya R, Janani V, Mohandoss K. Development and evaluation of boswellia-loaded solid lipid nanoparticle films for transdermal delivery in carrageenan-induced arthritis model in rats. Int J App Pharm. 2025;17(6):499-511.

[6] Bulut O, Sorucu A, Dümbek TM, Avcı Z. Experimental study on the healing effect of pine resin on skin wounds in rats. Journal of Applied Biological Sciences. 2024 Oct 1;18(3):309-17.

[7] Sahasrabudhe PB, Dhondge RD, Panse N. Raal ointment compared with 1% silver sulfadiazine cream for the treatment of second degree burns. Indian Journal of Burns. 2014 Jan 1;22(1):37-42.

[8] Datta HS, Mitra SK, Patwardhan B. Wound healing activity of topical application forms based on ayurveda. Evidence-based Complementary and Alternative Medicine. 2011;2011(1):134378.

[9] Tümen İ, Akkol EK, Taştan H, Süntar I, Kurtca M. Research on the antioxidant, wound healing, and anti-inflammatory activities and the phytochemical composition of maritime pine (Pinus pinaster Ait). Journal of ethnopharmacology. 2018 Jan 30;211:235-46.

[10] Sarup P, Pahuja S, Malik J. Chemistry, biological activities, and uses of oleo-gum resin of Commiphora wightii. InGums, Resins and Latexes of Plant Origin: Chemistry, Biological Activities and Uses 2022 Jul 21 (pp. 447-478). Cham: Springer International Publishing.

[11] Romero AG, Rodriguez AP, Kozuszko SN, Nagano K, Felice CJ, Katase N. Skin wound healing part II: from traditional cataplasm to advanced wound dressings. Frontiers in Soft Matter. 2025;5:1681598.

[12] Park JY, Lee YK, Lee DS, Yoo JE, Shin MS, Yamabe N, Kim SN, Lee S, Kim KH, Lee HJ, Roh SS. Abietic acid isolated from pine resin (Resina Pini) enhances angiogenesis in HUVECs and accelerates cutaneous wound healing in mice. Journal of ethnopharmacology. 2017 May 5;203:279-87.

[13] Karl B, Alkhatib Y, Beekmann U, Bellmann T, Blume G, Steiniger F, *et al*. Development and characterization of bacterial nanocellulose loaded with Boswellia serrata extract nanoemulsions as natural dressing. Int J Pharm. 2021;587:119635.

[14] Roșca OJ, Coneac GH, Racoviceanu R, Nistor A, Olariu IV, Cotan AM, *et al*. Optimizing burn wound healing: role of pH and rheological behavior in plant-derived topical formulations. Pharmaceutics. 2025;17(7):853.

[15] Mukherjee H, Ojha D, Bharitkar YP, Ghosh S, Mondal S, Kaity S, Dutta S, Samanta A, Chatterjee TK, Chakrabarti S, Mondal NB. Evaluation of the wound healing activity of Shorea robusta, an Indian ethnomedicine, and its

isolated constituent (s) in topical formulation. Journal of ethnopharmacology. 2013 Aug 26;149(1):335-43.

[16] Yadav K, Sodhi RK, Sithta A, Sharma R, Venkatesan K, Ahmed R, Sirag N, Elfadil H, Elodemi M, Mohamed JM. Albumin-Stabilized Shorea robusta Resin Nanoparticles Embedded in a Nanogel for Improved Controlled Release and Diabetic Wound Healing. Journal of Pharmaceutical Innovation. 2026 Apr;21(2):109.

[17] Wani TA, Chandrashekara HH, Kumar D, Prasad R, Gopal A, Sardar KK, Tandan SK, Kumar D. Wound healing activity of ethanolic extract of Shorea robusta Gaertn. f. resin. Indian journal of experimental biology. 2012 Apr 1;50(4):277.

[18] Chakote A, Duragkar N. Formulation and Validation of Tinea Pedis Cream using extract of *Madhuca indica*, Curcuma longa and Shorea robusta. Research Journal of Pharmacy and Technology. 2025 Mar 1;18(3):1101-7.

[19] Moussaieff A, Mechoulam R. Boswellia resin: from religious ceremonies to medical uses; a review of in-vitro, in-vivo and clinical trials. Journal of Pharmacy and Pharmacology. 2009 Oct;61(10):1281-93.

[20] Malayeri A, Abdevand ZZ, Rashedi M, Hamedi SS, Basir Z, Golfakhrabadi F. Determination of effectiveness of topical product of Commiphora mukul oleo gum resin on dermal wound healing. Int J Low Extrem Wounds. 2025;24(4):975–84.

[21] Zhang P, Li Y, Xiaoming X, Shang D, Wei X, Zhigang L, *et al*. Wound healing potential of standardized extract of Boswellia serrata on experimental diabetic foot ulcer via inhibition of inflammatory and apoptotic markers. Planta Med. 2019;85(8):657–69.

[22] Yaseen Khan M, Ali SA, Pundarikakshudu K. Wound healing activity of extracts derived from Shorea robusta resin. Pharm Biol. 2016;54(3):542–8.

[23] Wani TA, Chandrashekara HH, Kumar D, Prasad R, Gopal A, Sardar KK, *et al*. Wound healing activity of ethanolic extract of Shorea robusta resin. Indian J Exp Biol. 2012;50(4):277–82.

[24] Mestry M, Rane M, Bajaj A. Commiphora mukul and quercetin loaded liposphere gel: Potential treatment for psoriasis. Indian J

Pharm Educ Res. 2020 Jul 1;54(3):654-67.

[25] Kumar, S., Mukthar, H. M., & Singh, R. (2013). Evaluation of the wound healing activity of Shorea robusta, an Indian ethnomedicine, and its isolated constituent(s) in topical formulation. Journal of Ethnopharmacology, 149(2), 487-498.DOI: 10.1016/j.jep.2013.06.024

[26] Sabra SA. Natural compounds for wound healing: An integrated bioactive prospective. Trends in pharmacology and drug delivery учредители: Science Park Publisher. 2025;1:1-20.

[27] Vaziri M, Dehkordi AH, Tali SS, Ebrahimi N. Effects of Boswellia gel and hydrocolloid dressing on healing of pressure ulcers. J Herb Med. 2021;29:100461.

[28] Choi YJ, Jung JI, Bae J, Lee JK, Kim EJ. Evaluating the anti-osteoarthritis potential of standardized Boswellia serrata gum resin extract in alleviating knee joint pathology and inflammation in osteoarthritis-induced models. International Journal of Molecular Sciences. 2024 Mar 12;25(6):3218.

[29] Kalakar N, Jain K, Shrivastava A, Mahale S. Comparative antibacterial activity of aqueous and ethanol extracts of commiphora Wightii and commiphora mukul. Cuestiones De Fisioterapia. 2025 Feb 20;54(4):5295-8.

[30] Garg I, Singh N, Sharma I, Dhingra J, Kumar K. Anti-inflammatory and wound healing potential of Commiphora wightii ointment in Wistar rats. Curr Drug Ther. 2025;20(2):218–28.

[31] Alberts A, Lungescu IA, Niculescu AG, Grumezescu AM. Natural products for improving soft tissue healing: Mechanisms, innovations, and clinical potential. Pharmaceutics. 2025 Jun 8;17(6):758.

[32] Al-Saban A, Maad AH, Al-Sham AS, Saad HM. Antimicrobial and antioxidant properties of Boswellia sacra resin: extraction, evaluation, and formulation into a topical cream for dermatological applications. Frontiers in Medicine. 2025 Aug 25;12:1664265.

[33] Bhavamishra. Bhavaprakash Nighantu. Karpuradi Varga, Adhyaya 8, p. 128.

[34] Bhavamishra. Bhavaprakash Nighantu. Vatadi Varga, Adhyaya 9, p. 137.