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Review Article

A Review on Wound Healing Potential of *Berberis aristata*, *Symplocos racemosa*, and *Rubia cordifolia*

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ABSTRACT

The healing process of wounds is a complicated physiological process, which includes hemostasis, inflammation, proliferation, and tissue remodeling. The use of plants in traditional medicine to facilitate and hasten this process has a long history because of their varying phytochemical composition. The review identifies the three medicinal plants *Berberis aristata*, *Symplocos racemosa*, and *Rubia cordifolia* as having the potential of wound healing. *Berberis aristata* is highly alkaloid containing (berberine) and exhibits excellent antimicrobial and anti-inflammatory properties, which are essential in the early stages of wound healing. *Symplocos racemosa* is rich in flavonoids, tannins, and triterpenoids, which are known to have an antioxidant effect, hemostatic effect, and tend to strengthen the tissues, which will later be useful in the wound maturation process. *Rubia cordifolia* richly contains anthraquinones and flavonoids which have the following effects; antioxidant, antimicrobial and collagen promoting properties, and improves tissue regeneration and scarring. Together these plants synergistically affect the various phases of healing, and therefore poly herbal preparations could be more effective than their single-plant counterparts. Although there is promising evidence provided by preclinical tests, additional standardized research and properly designed clinical trials are necessary to prove their ability to be used as a therapeutic option in the modern wound management.

INTRODUCTION

1.1 Introduction to skin

The skin is the largest organ of the body, counting for further than 10 of body mass, and the bone that enables the body to interact utmost privately with

its terrain. The skin consists of four layers the stratum corneum (nonviable epidermis), the remaining layers of the epidermis (feasible epidermis), dermis, and subcutaneous. There are also several associated accessories hair follicles, sweat tubes, apocrine glands, and nails. numerous of the functions of the skin can be classified as

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essential to survival of the body bulk of mammals and humans in a fairly hostile terrain. In a general environment, these functions may be classified as defensive, maintaining homeostasis, or seeing. The significance of the defensive and homeostatic part of the skin is illustrated in one environment by its hedge property. This allows the survival of humans in a terrain of variable temperature; water content (moisture and bathing); and the presence of environmental troubles, similar as chemicals, bacteria, allergens, fungi, and radiation. In an alternate environment, the skin is a major organ for maintaining the homeostasis of the body,

especially in terms of its composition, heat regulation, blood pressure control, and excretory places. It has been argued that the rudimentary metabolic rate of creatures differing in size should be gauged to the face area of the body to maintain a constant temperature through the skin's thermoregulatory control. Third, the skin is a major sensitive organ in terms of seeing environmental influences, similar as heat, pressure, pain, allergen, and microorganism entry. Eventually, the skin is an organ that's in a continual state of rejuvenescence and form.[1]

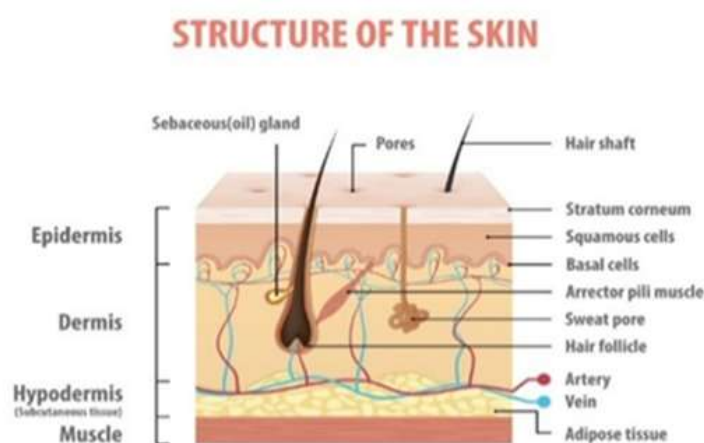


Figure:1 Structure of Skin

1.2 Introduction to Wound Healing:

The term wounds can be described as a break in continuity of the skin which depresses the normal structural and functional integrity of the skin.[2] Wounds are bodily traumas that influence a breach or rupture of the skin. Wounds need to be healed properly to restore anatomic flow and dysfunctional pathology of the skin. The process of healing is dynamic and it starts once an injury is caused and strives to help reinstate the structure and functions of the damaged tissues. The wound healing process relies on a series of continuous interactions between cells and local matrix and occurs in three overlapping stages; inflammation (0-3 days), cell proliferation (3-12 days), and remodeling (3-6 months). The healing process

begins as a reaction to injury and is used to restore the functionality and strength of injured tissues. It entails platelet aggregation and blood clotting, fibrin conformation, an inflammatory reaction to wound, alteration in the ground substances, angiogenesis and re epithelialization. A wound is said to be healed properly when collagen forms and becomes stronger to repair the affected area. The process of healing is best achieved by limiting the further destruction of the tissues, keeping the blood circulation and oxygenation up, proper nutrition and a wet environment conducive to repair. All these factors combine to repair the damaged structure and functionality of the site. [3]

1.2.1 Classification of Wounds:[4]

The cause, depth and healing response of wounds allow broad classification. They can be classified mostly into acute and chronic with a number of subcategories.

Acute wounds: Acute wounds are the result of an abrupt injury and tend to follow the normal course of healing which eventually restores the structure and function of the wound. This can be surgical incisions and accidental sharp object cuts.

Closed wounds: In such injuries, blood comes out of broken vessels but it is retained in the tissues, so it manifests itself in the form of bruises or hematomas instead of open discontinuity of the skin.

Open wounds: These are those that have an external break to the skin and external bleeding. These may be characterized into:

- **Cut wounds:** Straight sharp wounds that are inflicted using scalpels or knives, and usually involve the destruction of a small amount of tissue.
- **Laceration or tears:** Abnormal injuries that are usually related to blunt force resulting in an extreme disturbance of tissues.
- **Puncture wounds:** Slender and deep cuts caused by sharp objects such as needles or nails and in most cases, the wound is highly susceptible to infection. Abrasions Superficial scrapes, which develop as a result of rubbing against rough surfaces and removes the epidermis, leaving the nerve endings exposed.
- **Penetrating wounds:** Injuries inflicted by sharp objects e.g. knives that could form entry and exit points.

- **Gunshot wounds:** Bullets or projectiles cause them and the effects of these wounds can be complicated patterns of tissue damage based on the speed and direction.
- **Chronic wounds:** Chronic wounds do not manifest the chronological pattern of normal healing and are usually retained in a state of persistent inflammation. They are long-term care patients and are usually observed in diabetic foot ulcers, venous leg ulcers and pressure sores.

1.2.2 Phases of Wound Healing:

The process of wound healing is dynamic and complex and involves the interaction of different types of cells, signaling molecules, and structural elements of the body to regain tissue integrity. The mechanism of repair happens in four overlapping but separate phases: hemostasis, inflammation, proliferation and remodeling.^[5] The stages are very crucial and any hitch or disruption in any of the stages can severely hinder or slow down the recovery.

1. **Hemostasis:** Hemostasis is the initial response to injury and is aimed at controlling the bleeding in as short a time possible and establishing a temporary protective barrier. Several seconds after tissue damage, blood vessels narrow, platelets clump together and a fibrin clot is developed. The clot is not only used to prevent the further loss of blood, but it also acts as a scaffold to the further coming cells and also provides signals that attract inflammatory mediators to the wound site.
2. **Inflammatory phase:** Inflammatory stage is initiated soon after the formation of clots. There are migrations of immune cells into the wound bed, where neutrophils enter first to rid the wound bed of pathogens and other cellular

debris by phagocytosis. Macrophages, which are evolved out of the circulating monocytes, in turn take over the position. These cells secrete inflammatory and growth factors that interact in the control of inflammation and activate fibroblasts and endothelial cells to repair tissues.

3. **Proliferative phase:** The characteristic of this phase is the development of granulation tissue, which is composed of fibroblasts, new blood vessels and the elements of extracellular matrix. Collagen is produced by fibroblasts and it gives the structure strength, whereas angiogenesis is facilitated by endothelial cells to deliver oxygen and nutrients. At the same

time, keratinocytes migrate from the wound edges to re-epithelialize the surface, sealing the wound and restoring barrier function

4. **Remodelling (maturation) stage:** The last stage that can last months to years is aimed at strengthening and restructuring the repaired tissue. The collagen fibres are re-aligned and cross-linked which builds-up tensile strength progressively. Myofibroblasts will play a role in wound contracting which will result in a smaller scar size and better appearance. Regenerated tissue seldom reaches the strength of normal skin, but this step is essential in the process of functional stability in the long term.^[6]

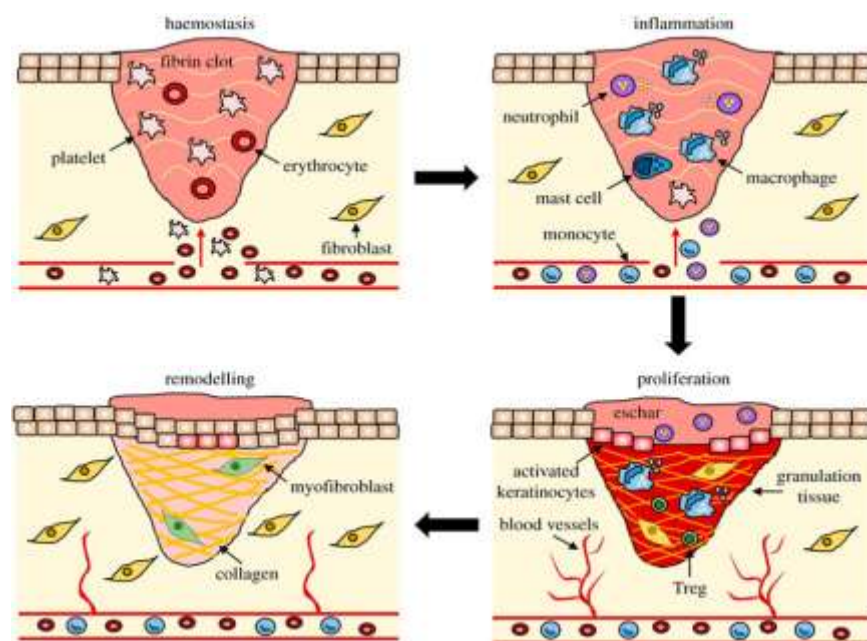


Figure:2 Wound Healing Phases

2. Detailed Plant Studies

2.1 Berberis aristata (Daruharidra)

2.1.1 Taxonomical Classification of B.aristata[7]

Taxonomical rank	Taxon
Kingdom	Plantae
Division	Phanerogamea

Sub-division	Angiospermea
Class	Dicotyledonae
Sub class	Polypetalae
Group	Thalamiflorae
Order	Ranunculales
Family	Berberidaceae
Genus	Berberis
Species	aristata
Common name	Daruharidra

2.1.2 Vernacular names of B.aristata[8][9]



Hindi	Daruhaldi, Chitra, Chotra, Kashmal, Kashmar
English	Indian beriberi
Gujarati	Daruhaladar
Malayalam	Maradarisina, Maramanjil
Marathi	Daruhalad
Tamil	Mullukala, Usikkala, Garamenjal
Sanskrit	Katamkateri, Darvi, pitadaru, Pnachmpacha suvarnavarna

2.1.3 Botanical description:



Figure:2 *Berberis aristata* (Daruharidra)

Leaves: The leaves occur in tufts 5 to 8, phyllotaxy is verticillate, the leaf is simple, spiny, lanceolate, toothed, leathery, sessile, acuminate with reticulate pinnate venation, length of the leaf 4.9 cm. and breadth 1.8 cm. dark green on the dorsal surface and pale green on the ventral surface.

Flower: stalked, yellow, complete, hermaphrodite, cyclic, actinomorphic, perigynous, the average diameter of a fully opened flower is 12.5 mm; inflorescence, a simple corymbose raceme, 11 or 16 flowers in a cluster.

Calyx: Calyx is yellow in colour, polysepalous, with 6 sepals (3 small, 3 large), yellow, actinomorphic caducous, 4 to 5 mm long. The corolla consists of six distinct yellow petals which are symmetrical and each has a length of approximately 45 mm. Androecium are polyandrous with 6 stamens which are adnate, 5 to

6 mm long and gynoecium 1, 4 to 5 mm long, short style and broad stigma.

Fruits: Fruits are globose to ovoid, usually covered with bloom as in plums. The length of the fruits is 7 mm, diameter is 4 mm, weight is 227 mg, 237 microlitres of volume. The colour of the fruit is aconite violet. Seeds: The number of seeds is 2 to 5, with different colours including yellow to pink, with each seed weighing 25 mg, and having a volume of 29 microlitres.^[11]

2.1.4 Geographical Description:

Indian barberry *Berberis aristata*, the native of Nepal, is prevalent in South and Southeast Asia, including India, Sri Lanka, and Bhutan.^[12] The species thrives in the Sub-Himalayan region in India with an altitude between 1000 and 3000 meters. The Nilgiri Hills of southern India (1000-2400 meters) and other states, such as Jammu and Kashmir, Himachal Pradesh, Madhya Pradesh, Tamil Nadu, Uttar Pradesh, Uttarakhand and Sikkim, are also reported to have it. The plant will be able to flourish in favourable habitats up to an altitude of 3500 meters.^[13]

2.1.5 Phytochemical constituents of Daruharidra:^[14]

Berberis aristata has an abundance of bioactive compounds including alkaloids, flavonoids, and phenolic acids among other secondary compounds. It contains some of the important phytochemical constituents as listed below.

Berberine: Berberine is the main and most famous alkaloid used in *Berberis aristata*. It takes care of the yellow colour of the roots of the plant. Berberine is a widely researched drug due to its multiple pharmacological effects, such as antimicrobial, anti-inflammatory, antioxidant, and antidiabetic effects.

Palmatine: Palmatine is another valuable alkaloid, which happens in *Berberis aristata*. It has a very similar chemical structure to that of berberine, and shows a number of similar pharmacological activities.

Isoquinoline: Isoquinoline alkaloids include jatrorrhizine and magnoflorine, along with a number of other isoquinole-based alkaloids, found in *Berberis aristata* in addition to berberine and palmatine.

Flavonoids: *Berberis aristata* also has different flavonoid molecules such as quercetin, kaempferol, and their glycosides. Flavonoids possess antioxidant as well as anti-inflammatory effects and contribute to therapeutic potential of the plant.

Phenolic Acids: Gallic acid, ferulic acid, and caffeic acid are phenolic acids that have been discovered in *Berberis aristata*. These are antioxidant and anti-inflammatory compounds that help in increasing the antioxidant potential of the plant as a whole.

Tannins: *Berberis aristata* has got tannins, which are stringent polyphenol compounds. Tannins are known to possess the power to be antioxidants as well as antimicrobials.

2.1.6 Pharmacological properties of Daruharidra (*Berberis aristata*):

Anti-inflammatory Activity: The plant possesses highly effective anti-inflammatory activities especially those of berberine. Because of these properties it finds application in treatment of inflammatory diseases such as arthritis and inflammatory bowel disease and arthritis.^[15]

Antimicrobial Action: *Berberis aristata* contains an alkaloid known as Berberine which has been known to act as a broad-spectrum antibacterial

agent. It has proven that it is effective in a large variety of bacteria, fungi, viruses and parasites.

Hepatoprotective Activity: Traditional uses of *Berberis aristata* involve enhancing liver function. Its extracts have hepatoprotective effects, which help the liver to be protected against toxin-induced, oxidative stress-induced, and inflammatory damage. It can be beneficial in the therapy of liver disorders and as an adjuvant in liver detoxification as a result of it.^[16]

Antidiabetic Action: *Berberis aristata*, has exhibit antidiabetic properties. It aids in the management of blood sugar levels through enhancement of insulin sensitivity, uptake of glucose into cells and reduces production of glucose in the liver. It could have a positive effect on the treatment of type 2 diabetes and complications thereof.^[17]

Gastrointestinal Effects: *Berberis aristata* exhibits anti-secretory and anti-diarrheal action, which is why it is applicable in such processes as diarrhoea and gastroenteritis. It has also been discovered to possess positive potentials in the treatment of gastric ulcers.

Effects on wound Healing: Wound healing effects of *Berberis aristata* are also implemented. Male adult goat under which wound healing activity was tested was the focus of a study based on clinical observation, healing and change rate of histo morphological features. As a wound dressing, aqueous and alcoholic extract were applied on the open wounds and the findings are valuable in wound healing.^[18]

2.2 *Symplocos racemosa* (Lodhra):

2.2.1 Taxonomical classification of *S.racemosa*:^[19]

Taxonomical rank	Taxon
Kingdom	Plantae



Division	Magnoliophyta
Class	Magnoliopsida
Order	Ericales
Family	Symplocaceae
Genus	Symplocos
Species	Racemosa

2.2.2 Vernacular Names of *S.racemosa*:^[20]

Sanskrit	Rodhra, Paittki Lodhra, Sabara Lodhra, Tirita
Gujarati	Lodhaz
English	Symplocos Bark
Hindi	Lodha
Malayalam	Pachotti
Marathi	Lodha, Lodhra
Tamil	Vellilathi, Vellilothram

2.2.3 Botanical Description:



Figure:3 *Symplocos racemosa* (Manjistha)

Penchant: It is an evergreen tree, now and then in form of a bramble, whose branchlets are smooth or vaguely covered with hairy scales.

Bark: The outer bark has a dull, buff tone with fine longitudinal cracks and occasional fissures, while the inner bark appears whitish-buff. The leaves and the bark both are used in dyeing.

Leaves: The leaves are dark green with the upper surface, and are of various shapes orbicular, elliptic-oval or lanceolate with sizes of about 5-12.5 cm. They are leathery in texture, smooth above, and sparsely hairy along the midrib underneath. The veins are not very clear and the petiole is developed.

Flowers: The flowers are sessile or almost so, white, which turn yellow with age, and fragrant. They are carried in the short axillary compound racemes. The corolla is far much longer than the calyx. The number of stamen is high, usually approximately 100. The ovary is three-celled.

Fruit and Stem: The stem is quite long, rather rounded, hollow, 0.5 inches long. They are leathery in texture, smooth above, and sparsely hairy along the midrib underneath.

Uses: A yellow colour is extracted primarily by the use of the bark, but leaves also provide colour. It is a dye which is traditionally applied to silk, commonly along with turmeric and *Plecosperrum spinosum* (also called Gumbengfong locally). One of the ingredients of Abir, the coloured powder used during the Holi festival, is also made of the plant. It is also used in calico printing and leather dyeing.^[21]

2.2.4 Geographical Distribution:

The Himalayan districts of north and east India are the common areas of *Symplocos racemosa*. The Symplocaceae family has 300-500 species, which have a place with the class *Symplocos*. India harbors approximately 68 species.^[22] The very tall 6 to 8.5 metres *Symplocos racemosa* Roxb. is so abundant in the plains and lower hills of India,^[23] that it is common everywhere. It rises to 1400m in Himalayas, and also in Bengal, Assam, and Chota Nagpur. *Symplocos* a genus of plant, flowering, approximately 250 species native to Asia, America and Australia.^[24]

2.2.5 Phytochemical constituents:

Symplocos racemosa was pure source of phytochemicals which include flavonoids, phenols, tannins, saponins and Glycosides.^[25] It contains several flavonoid glucosides like

symplocoside, symposide, leucopelargonidine-3 glucoside, ellagic acid, rhamnetin, 3-digalactoside, triterpenoids like 19 α -hydroxy acetic acid 3, 28-O-bis- β -glucopyranosides, betulin, linoleic acid, β -sitosterol and α -amyrin and alkaloids like loturine, loturidine, colloturine and harmine are seen as chief bio actives from the plant. Most of the flavonoids and its respective compounds have been isolated from aerial parts of the plant while glycosides of different extracted from the polar fractions of the bark of the plant.^[26] It also contains Flavanol glucoside which contains active constituents like Symplocoside, Symposide, Leucopelargonid in 3-Glucoside, Ellagic Acid, Rhamnetin 3 Galactoside. Triterpenoids: 19 A Hydroxyarjunoli c Acid-3, 28-O Bis-B Glucopyranosid es, 19 A Hydroxyasiatic Acid-3, Betulin, Oleanolic Acid, B- Sitosterol & A-Amyrin.^{[27][28]}

2.2.6 Pharmacological properties:

Lodhra has astringent, hemostatic, quieting, febrifuge, constipative, wound healing, disease anticipation specialist, anthelmintic, Unfriendly to angiogenic, antibacterial, suppurative, lipoxigenase moreover, urease inhibitory exercises.^[29]

Anti-bacterial Property: Antibacterial property helps the diabetic patient to fight against infections caused over skin, urinary tract etc. Its antibacterial property is helpful in prevention of complications. Ethanolic extract of *S. racemosa* Roxb shows good antibacterial activity as compared to petroleum ether, but it has poor antibacterial activity against gram negative microorganism like *P. aeruginosa* and *E. Coli*.^[30] Methanolic extracts of the leaves, roots, and stem bark of *S. cochinchinensis*, along with their fractions obtained through partitioning with petroleum ether, dichloromethane, and ethyl acetate, were evaluated for their antimicrobial activity. All crude extracts and fractions showed a

broad spectrum of antibacterial activity that was enhanced on fractionation.^[31]

Anti-oxidant activity: Antioxidant property helps in person to avoid many ailments and keep body tissues healthy. It scavenges the harmful free radicles that are either accumulated in the body or produces during abnormalities in metabolism. Thus it helps in protection of vital cell against metabolic disorder and complications of diabetes. The methanol extract of Lodhra leaves showed very good scavenging activity on 2,2-diphenyl-picrylhydrazyl (DPPH), hydroxyl, nitric oxide radicals, as well as high reducing power. The extract also showed strong suppressive effect on lipid per-oxidation.^[32]

Neuro-supportive role: Lodhra extract are having nervine tonic and good healing properties that may be utilized in diabetic wound healing as well as nervine damage. It may play a preventive role over neuropathy complications as well as body tissue damage complications. Locoracemosides A, B and C from n butanol soluble extract from bark of *S. racemosa* showing in vitro inhibitory activity against α chymotrypsin.^[33]

Anticancer Activity: The test with chloroform, butanol and ethyl acetate bark extracts has cytotoxic activity determined by using the XTT salt based on cytotoxicity assay against one leukaemia and one cervical cancer cell line. It was also reported butanol extract have highest cytotoxicity activity against hela cell line.^[34]

Hepatoprotective Activity: The evaluated study with ethanolic extract of bark on carbon tetrachloride can induce hepatic damage in rats. Ethanolic extracts demonstrated a dose-dependent ability to restore serum enzyme levels, bilirubin, albumin, total protein, and antioxidant activity. It is an effective method for inducing hepatic



damage and has a potential clinical application for the treatment of liver diseases.^[35]

Wound Healing Effects: *Symplocos racemosa* or *Lodhra* have been tested with other combined drug forms for healing the wounds and it was found to be effective in animal models. It is also used in plasters and applied on wounds for promoting maturation of wounds.^[36] The most advantage is powdered formation of bark *lodhra* is used for heals wounds.^[37]

2.3 *Rubia cordifolia* (Manjistha):

2.3.1 Taxonomical classification of *R.cordifolia*:^[38]

Taxonomical rank	Taxon
Kingdom	Plantae
Class	Dicotyledoneae
Subclass	Sympetalae
Family	Rubiaceae
Genus	<i>Rubia</i>
Species	<i>Cordifolia</i>

2.3.2 Vernacular names of *R.cordifolia*:^[39]

English	Indian madder
Sanskrit	Aruna, Viksa, Yojanvalli
Hindi	Manjith
Gujarati	Manjitha
Tamil	Mancitti
Malayalam	Manjithi

2.3.3 Botanical Description:



Figure:4 *Rubia cordifolia* (Manjistha)

Rubia cordifolia (Manjistha) is a perennial, herbaceous climbing herb.^[38] It is a perennial herb that can spread up to 1.5 or 2 meters by climbing or scrambling.

Stem: The stem is covered with stiff hairs and spines, has a four-angled shape, and branches widely in a spreading pattern. They can be smooth or shiny. In cross-section, the stem is circular and smooth with pyramidal hairs on the surface and a sclerenchymatous hypodermis at the corners. The cortex, which is chlorenchymatous, aids in photosynthesis. The periderm has 4 to 11 layers of compact; rectangular cells, followed by 8 to 12 layers of flattened parenchyma. The central xylem contains small vessels and parenchyma, while secondary xylem includes various tissues and larger vessels at the periphery.^[40]

Leaves: Rough, evergreen, arranged in whorl of four per node, oval to cordate shape, 4 to 8 cm long, 2 to 3 cm width; the lower leaves are larger than the upper ones, with each leaf displaying five to seven prominent veins. Lower leaves are larger, with a slightly cordate base and minute white prickles. The leaf structure includes a cuticle, pyramidal hairs, compact palisade cells, multilayered spongy cells, and collenchymatous layers in the midrib. Vascular bundles are collateral, closed, and consistent in number.^[41]

Flowers: The plant bears small flowers that range in colour from greenish-white to red, arranged in smooth terminal clusters. They are five-petaled and release a pleasant fragrance. It blooms and bears fruits between August and October.^[42]

Fruits: The plant produces round berries measuring 4 to 6 mm in diameter, which are smooth, shiny, and fleshy. They are green when unripe and turn red to black upon ripening.

Root: About 1 meter long, 12 mm thick, and brownish-red in colour, the root is smooth, cylindrical, and long. In cross-section, the root displays 5–7 outer layers of cork tissue, sometimes containing tannins. The phellogen is indistinct, while the secondary cortical cells are polygonal, thin-walled, and exhibit a reddish coloration. Mostly made up of tracheids and vessels, the secondary xylem dish. There are many and evenly distributed vessels. Secondary phloem forms a wide zone of reddish colour consists of thin-walled, sieve elements and phloem parenchyma but phloem fibres are absent. The Cambium is unique and does not have medullary rays. The entire root is red in colour indicates that anthraquinones are present.^[43]

2.3.4 Geographical Distribution:

This species is commonly found at elevations of around 8,000 feet in the hilly regions of India, particularly throughout the Himalayan range extending from the northwestern frontier to the eastern Himalayas. Its distribution also reaches Sri Lanka, the Malay region, tropical Africa, China, Japan, and Java. It can be found in Nepal, Sri Lanka, Iran, Afghanistan, and India (Dehradun, Kashmir, Nagpur, and Malvan). The plant propagates naturally through seeds and can also be cultivated using stem cuttings. There are four varieties of Manjistha: chola, yojani, konchi, and sinhala.^[44] It is distributed in the Himalayas from Kashmir eastwards and Nilgiris and other hilly districts of India.^[45]

2.3.5 Phytochemical constituents of *Rubia cordifolia*:

Different classes of bioactive compounds such as anthraquinones and their glycosides, naphthoquinones, terpenes, hexapeptides, carboxylic acids, iridoids, and saccharides are reported from various parts of Manjistha.^[46]

Anthraquinones such as:

Rubiadin: A significant anthraquinone glycoside with anti-inflammatory and antioxidant properties in Manjistha.

Lucidin: The anthraquinone aglycone Lucidin has antibacterial and anti-cancer properties.

Purpurin: An anthraquinone glycoside that has anti-inflammatory and antioxidant properties.

Glycosides such as:

Rubianin: A glycoside of rubiadin with anti-inflammatory and antioxidant properties.

Lucidin-3-O-β-D-glucoside: An antibacterial and anti-cancer glycoside of lucidin.

Rubiaflavin: An anti-inflammatory and antioxidant glycoside.

Additional Bioactive Substances

Flavonoids: Anti-inflammatory and antioxidant properties include quercetin, kaempferol, and their glycosides.

Phenolic acids: Anti-inflammatory and antioxidant qualities, include gallic acid, ellagic acid, and ferulic acid.

Terpenoids: Anti-inflammatory and antibacterial properties include oleanolic acid, ursolic acid, and β-sitosterol.

These bioactive compounds contribute to the medicinal and cosmetic properties of Manjistha, including its antioxidant, anti-inflammatory, antimicrobial, and wound-healing activities.^[47]

2.3.6 Pharmacological Properties of *Rubia cordifolia*:



Anti-inflammatory activity: Manjistha exhibits strong anti-inflammatory properties, making it useful in managing conditions like arthritis and skin-related inflammations. This action is primarily due to its inhibition of pro-inflammatory enzymes and cytokines.^[48]

Antidiabetic activity: Alcoholic extract of *Rubia cordifolia* has antidiabetic property and this activity has been demonstrated by study conducted on alloxan treated rat model. It was found that alcoholic extract significantly lowered down the blood glucose level.^[49]

Anti-oxidant property: The antioxidant activity of Manjistha extract, particularly its ability to protect against lipid peroxidation and maintain reduced glutathione (GSH) levels in rat liver homogenates, was evaluated in comparison with vitamin E and para-benzoquinone (PBQ). In the roots of *R. cordifolia*, hydroxyanthraquinones were identified as the major phenolic compounds responsible for antioxidant activity, with both the alcoholic extract and its constituent rubiadin showing notable antioxidant effects.^[50]

Anti-microbial activity: Research has explored the antibacterial potential of *R. cordifolia* root extract against a range of pathogenic microorganisms. Both daucosterol and sitosterol have antimicrobial properties. It has been observed that rubiacordone shows significant antibacterial action against gram-positive bacteria.^[51]

Anti- acne property: A gel formulation containing anthraquinone-rich *R. cordifolia* demonstrated anti-acne effectiveness against *Propionibacterium acne*, *Staphylococcus epidermidis*, and *Malassezia furfur* when compared to clindamycin gel.^[52]

Wound Healing property: The root extract of *R. cordifolia* has been reported to possess effective

wound-healing properties in experimental models. Ethanolic extract and the hydrogel formulation of roots were found to be effective in the functional recovery and healing of wounds and also lead to histo-pathological alterations.^[53] Manjistha has ability to enhance collagen formation aids in the healing of the skin tissues, making it effective in reducing the appearance of stretch marks. Its Ropana -sothahar properties further support wound healing and reduce swelling or oedema caused by itching.^[54] Topical applications of Manjistha promote faster healing of wounds and ulcers, due to its antimicrobial and anti-inflammatory actions.^[55]

DISCUSSION AND CONCLUSION:

The process of wound healing is complicated, and the plants, discussed in this paper: *Berberis aristata*, *Rubia cordifolia*, and *Symplocos racemosa* seem to complement each other with regard to supporting various phases of wound healing. *Berberis aristata* has the greatest value in the initial stages of treatment. The major compound it contains, berberine, is used in combating infections and inflammation to provide a cleaner wound environment in which the patient can start repairing itself. *Rubia cordifolia* is introduced in the proliferative stage. Such substances as alizarin and purpurin can be considered as antioxidants and stimulate the development of new blood vessels. This does not only enhance oxygen supply but also enhances fibroblast growth and collagen deposition which are imperative to tissue regeneration. *Symplocos racemosa* plays an important role during the last stage of the remodeling. It enhances the activity of fibroblasts and promotes tightening and strengthening of the wound that is essential in maintaining tissue integrity in the long term with bioactive molecules like symplocoside and betulinic acid. These plants appear to span the



entire range of wound healing processes when placed together: berberis aristata cleans and protects the wound, Rubia cordifolia develops new tissue, and Symplocos racemosa makes sure that it is properly developed. This is an indication that a poly herbal treatment might have a better benefit than any single plant because in many cases such as in diabetic wound the healing is slow. It is worth noting though that a majority of the studies that have been conducted have been conducted in animals or in vitro with very little data available about humans themselves. Before these traditional plants can become dependable contemporary treatments, standardization of extracts, the safe, and effective doses as well as well-designed clinical trials are required. Their efficacy in wound care can be further improved by studying new delivery vehicles, including gels, hydrogels, or nanocarriers.

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