International Journal of Pharmaceuticals and Health care Research (IJPHR)

IJPHR |Vol.15 | Issue 1 | Jan - Mar -2026

www.ijphr.com

DOI : https://doi.org/10.61096/ijphr.v15.iss1.2026.95-108

ISSN: 2306-6091

Review

COMPREHENSIVE REVIEW ON HERBAL TOPICAL GELS FOR THE MANAGEMENT OF VARICOSE VEINS

Kathirvel. B[1*], Dr. L.V. Vigneshwaran[2], Abinayah[3], Gunal. B[4], Ganesh. S[5], Nandhini. S[6], Lokeshawari. P[7], Jaya prakash. S[8]

RKP College of Pharmacy, Krishnagiri, Tamil Nadu -635001

* Corresponding author: Kathirvel. B
Email: kathirvel9443@gmail.com

Published on: 10.03.2026

Published by: Futuristic Publications

2026| All rights reserved.

Creative Commons Attribution 4.0 International License.

Abstract

Varicose veins represent a chronic venous disorder characterized by dilated, tortuous superficial veins resulting from venous valve dysfunction and impaired blood return. The condition affects a significant proportion of the adult population worldwide and is associated with pain, edema, inflammation, heaviness of legs, and cosmetic concerns that may progress to chronic venous insufficiency if untreated. Conventional management strategies include compression therapy, sclerotherapy, pharmacological agents, and surgical interventions; however, these approaches may be expensive, invasive, or associated with adverse effects. Increasing attention has therefore shifted toward herbal-based topical formulations, particularly gels, due to their enhanced patient compliance, localized drug delivery, minimal systemic toxicity, and improved therapeutic outcomes. Herbal topical gels incorporate plant-derived bioactive compounds possessing anti-inflammatory, venotonic, antioxidant, and microcirculatory enhancing properties that directly target pathological mechanisms involved in venous disorders. This review comprehensively discusses the scientific basis of herbal topical gels in varicose vein management, including anatomical considerations, pathophysiology, causative factors, symptomatology, commonly used medicinal plants, formulation advantages, and therapeutic potential. Emphasis is placed on phytoconstituents capable of improving vascular tone, reducing edema, and protecting endothelial integrity. The article aims to provide a consolidated scientific framework supporting the development of effective, safe, and evidence-based herbal topical therapies for chronic venous diseases.

Keywords: Varicose veins, Herbal gels, Venous insufficiency, Phytotherapy, Topical delivery, Medicinal plants.

1. INTRODUCTION

Varicose veins are among the most prevalent manifestations of chronic venous disorders, affecting nearly 20–30% of adults globally and showing higher incidence among women, elderly individuals, and populations exposed to prolonged standing occupations. The disorder is characterized by elongated, dilated, and tortuous superficial veins caused primarily by venous hypertension and valve incompetence. Although traditionally considered a cosmetic concern, varicose veins are now recognized as a progressive vascular condition capable of leading to edema, dermatitis, thrombophlebitis, and venous ulceration if left untreated. Modern lifestyles involving reduced physical activity, obesity, and occupational strain have significantly increased disease prevalence in developing countries, including India, thereby necessitating safer and more accessible treatment options (1).

The venous system of the lower limb depends heavily on efficient valve function and muscular pumping mechanisms to maintain unidirectional blood flow against gravity. Failure of these mechanisms results in blood pooling within superficial veins, producing increased hydrostatic pressure and vascular wall dilation. Persistent venous hypertension initiates inflammatory cascades, endothelial dysfunction, and extracellular matrix remodeling, contributing to progressive vein enlargement and symptom severity. Studies have demonstrated that inflammatory mediators, leukocyte activation, and oxidative stress play central roles in the deterioration of venous structure and function (2).

Conventional treatment modalities include compression stockings, pharmacological venotonics, laser therapy, and surgical vein stripping. While effective in advanced stages, these approaches often present limitations such as recurrence, high treatment costs, discomfort, or procedural risks. Long-term oral medications may also produce gastrointestinal disturbances and systemic adverse effects. Consequently, interest has grown in alternative and complementary therapies, particularly plant-based medicines that have historically been used in traditional systems such as Ayurveda, Siddha, and European phytotherapy for vascular health (3).

Herbal medicines contain diverse phytochemicals including flavonoids, tannins, saponins, triterpenoids, and phenolic acids that exhibit anti-inflammatory, antioxidant, vasoprotective, and anti-edematous activities. These compounds act synergistically to strengthen capillary walls, reduce vascular permeability, and enhance venous tone. Scientific investigations have validated the therapeutic benefits of several medicinal plants traditionally used for circulatory disorders, providing pharmacological justification for their incorporation into modern topical formulations (4).

Topical drug delivery systems have gained considerable attention due to their ability to deliver therapeutic agents directly to affected tissues while minimizing systemic exposure. Among these systems, gels offer significant advantages such as non-greasy texture, ease of application, enhanced drug diffusion, improved patient compliance, and rapid absorption. Herbal topical gels allow localized delivery of bioactive constituents, promoting targeted action on inflamed veins and surrounding tissues. Additionally, hydrophilic gel bases improve skin hydration, facilitating deeper penetration of phytochemicals through the stratum corneum (5).

Recent pharmaceutical research emphasizes integrating traditional herbal knowledge with modern formulation science to develop standardized, stable, and clinically effective topical preparations. Advances in polymer technology, permeation enhancers, and phytochemical standardization have enabled improved bioavailability of plant-derived compounds. Such innovations have strengthened the scientific credibility of herbal gels as promising adjunct or alternative therapies for managing chronic venous disorders (6).

Another significant advantage of herbal topical therapy lies in its safety profile. Many medicinal plants used for venous disorders have long histories of topical application with minimal adverse reactions. Compared with synthetic anti-inflammatory drugs, herbal preparations often provide multi-target therapeutic effects without significant toxicity. This multi-mechanistic action is particularly valuable in varicose veins, where inflammation, oxidative stress, vascular weakness, and

microcirculatory impairment occur simultaneously (7).

Furthermore, patient preference toward natural therapies has increased due to awareness regarding chemical side effects and the growing popularity of integrative medicine. Herbal gels not only address therapeutic needs but also improve cosmetic appearance by reducing swelling and discoloration, thereby enhancing quality of life. Clinical observations indicate improved symptom relief when herbal topical therapy is combined with lifestyle modification and compression therapy (8).

Despite growing interest, comprehensive scientific reviews focusing specifically on herbal topical gels for varicose veins remain limited. Many studies evaluate individual plant extracts without integrating anatomical, pathological, and formulation perspectives. Therefore, a consolidated review is essential to bridge the gap between traditional usage, pharmacological evidence, and pharmaceutical development (9).

The present review aims to systematically examine herbal topical gels in the management of varicose veins by discussing disease mechanisms, therapeutic targets, commonly used medicinal herbs, formulation benefits, and future research directions. By compiling available experimental and clinical evidence, this article seeks to support the rational development of safe, effective, and standardized herbal gel formulations for chronic venous disorders (10).

2. Anatomy of The Venous System In Relation to Varicose Veins

The venous system of the lower limbs plays a crucial role in maintaining effective circulation by returning deoxygenated blood from peripheral tissues to the heart against gravitational forces. Understanding venous anatomy is essential for interpreting the development of varicose veins and identifying therapeutic targets for topical herbal formulations. The veins of the lower extremities are structurally and functionally adapted to regulate blood flow through a coordinated interaction between venous valves, muscular pumps, and surrounding connective tissues (11).

The venous network of the legs is broadly divided into three interconnected systems: the superficial veins, deep veins, and perforator veins. Superficial veins lie within the subcutaneous tissue and are primarily responsible for draining blood from the skin and superficial structures. The most clinically significant superficial veins include the great saphenous vein and the small saphenous vein. These vessels are frequently affected in varicose vein disease due to their anatomical position and exposure to sustained hydrostatic pressure (12).

The deep venous system lies beneath the muscular fascia and accompanies major arteries such as the femoral, popliteal, and tibial veins. Approximately 85–90% of venous return from the lower limb occurs through deep veins, making them essential for efficient circulation. Deep veins possess thicker walls and are supported by surrounding muscles, which assist in propelling blood upward during movement. Dysfunction in the superficial system often results from overload when deep venous efficiency declines (13).

Perforator veins serve as communication channels between superficial and deep venous systems. They contain one-way valves that ensure blood flows from superficial veins into deep veins. Failure of perforator valve competence allows reverse blood flow, increasing pressure within superficial veins and contributing to vein dilation and tortuosity. Anatomical studies demonstrate that incompetent perforators are strongly associated with chronic venous hypertension and progression of varicosities (14).

Venous valves are bicuspid folds of endothelium reinforced with connective tissue that prevent retrograde blood flow. These valves are distributed at regular intervals, particularly in distal portions of the leg where gravitational pressure is highest. Proper valve closure depends on intact connective tissue structure and coordinated muscle contraction. Degeneration or stretching of valve leaflets leads to reflux, which represents the primary anatomical abnormality underlying varicose vein formation (15).

The calf muscle pump, often referred to as the “peripheral heart,” plays a vital role in venous circulation. During walking or muscle contraction, compression of deep veins forces blood upward while valves prevent backward flow. Sedentary lifestyles, prolonged standing,

or muscle weakness impair this mechanism, resulting in venous pooling. Persistent venous stasis increases pressure transmitted to superficial veins, eventually causing structural changes (16).

The venous wall itself consists of three layers: the tunica intima, tunica media, and tunica adventitia. Compared with arteries, veins contain less smooth muscle and elastic tissue, making them more susceptible to dilation. Structural proteins such as collagen and elastin maintain venous integrity; however, enzymatic degradation and inflammatory processes weaken these components in chronic venous disease. Histological examinations reveal reduced elastin content and altered collagen ratios in varicose veins (17).

Microcirculation surrounding venous structures also contributes significantly to disease progression. Increased venous pressure causes capillary leakage, leading to edema and tissue hypoxia. Accumulation of metabolic waste products and inflammatory mediators further damages vascular endothelium. This microvascular dysfunction explains symptoms such as heaviness, itching, and skin discoloration commonly observed in patients (18).

Lymphatic drainage works in close association with venous circulation. When venous pressure rises, lymphatic overload occurs, resulting in fluid accumulation within interstitial tissues. Chronic edema subsequently leads to fibrosis and skin changes such as lipodermatosclerosis. Restoration of microcirculation and reduction of inflammation are therefore important therapeutic goals addressed by many herbal preparations used in topical gels (19).

Anatomical variations among individuals also influence susceptibility to varicose veins. Differences in valve distribution, vein diameter, and connective tissue strength may predispose certain individuals to venous insufficiency. Genetic factors affecting collagen synthesis and vascular elasticity have been reported, suggesting that anatomical vulnerability interacts with environmental and lifestyle factors (20).

A clear understanding of venous anatomy highlights why localized treatment approaches, including herbal topical gels, can be effective. By targeting superficial veins and surrounding tissues directly, topical formulations may improve microcirculation, reduce inflammation, and enhance venous tone without systemic exposure. Thus, anatomical knowledge forms the structural foundation for rational therapeutic intervention in varicose vein management.

3. PATHOPHYSIOLOGY OF VARICOSE VEINS

Varicose veins develop as a consequence of complex hemodynamic, structural, biochemical, and inflammatory alterations within the venous system. The condition primarily arises from chronic venous hypertension caused by valvular incompetence, impaired venous return, and prolonged gravitational stress on lower limb veins. Understanding the underlying pathophysiological mechanisms is essential for designing effective therapeutic strategies, including herbal topical gels that target inflammation, oxidative stress, and vascular weakness (21).

The initiating event in most cases is venous valve dysfunction. Normally, venous valves ensure unidirectional blood flow toward the heart; however, structural damage or dilation of the venous wall prevents complete valve closure. This results in retrograde blood flow, known as venous reflux, which increases hydrostatic pressure in superficial veins. Persistent reflux gradually stretches the vein wall, leading to elongation, tortuosity, and visible varicosities (22).

Elevated venous pressure produces mechanical stress on endothelial cells lining the veins. Endothelial dysfunction alters vascular permeability and promotes expression of adhesion molecules that attract leukocytes. Activated leukocytes release inflammatory mediators, proteolytic enzymes, and reactive oxygen species, initiating chronic inflammation within venous tissues. This inflammatory cascade plays a central role in disease progression rather than being merely a secondary response (23).

Inflammation contributes to remodeling of the extracellular matrix. Matrix metalloproteinases (MMPs), enzymes responsible for degrading structural proteins, become overexpressed in varicose veins. Increased MMP activity leads to breakdown of collagen and elastin fibers,

weakening venous walls and reducing elasticity. As a result, veins lose their ability to resist pressure and continue to dilate progressively (24).

Smooth muscle cell dysfunction also contributes significantly to pathological changes. In healthy veins, smooth muscle contraction helps maintain vascular tone. Chronic venous hypertension alters cellular signaling pathways, causing abnormal proliferation and reduced contractility of smooth muscle cells. This imbalance further reduces venous strength and promotes structural deformity (25).

Another important mechanism involves oxidative stress. Accumulation of reactive oxygen species damages endothelial cells and lipids within the vascular wall. Oxidative injury amplifies inflammatory responses and accelerates tissue degeneration. Antioxidant deficiency has been widely observed in patients with chronic venous disease, supporting the therapeutic relevance of plant-derived antioxidants commonly present in herbal formulations (26).

Microcirculatory impairment represents a downstream consequence of venous hypertension. Increased pressure in capillaries leads to leakage of plasma proteins and fluid into surrounding tissues, producing edema. Fibrin deposition around capillaries interferes with oxygen diffusion, resulting in tissue hypoxia. Hypoxic conditions stimulate further inflammation and contribute to skin changes such as pigmentation and ulcer formation (27).

Leukocyte trapping within microvessels further aggravates tissue injury. Activated white blood cells release cytokines and free radicals that damage surrounding tissues, perpetuating a cycle of inflammation and vascular dysfunction. This explains why patients frequently experience pain, heaviness, itching, and burning sensations in affected limbs (28).

Hormonal influences, particularly progesterone and estrogen, also affect venous wall integrity. These hormones may reduce vascular tone and contribute to valve relaxation, explaining the higher prevalence of varicose veins among women and during pregnancy. Hormonal effects combined with mechanical pressure from the growing uterus exacerbate venous congestion (29).

Recent studies suggest that genetic predisposition influences susceptibility through alterations in connective tissue metabolism and inflammatory responses. Variations in genes regulating collagen synthesis and vascular remodeling may weaken vein walls, making certain individuals more vulnerable even under normal physiological stress (30).

The multifactorial nature of varicose vein pathophysiology highlights the need for multi-target therapeutic approaches. Herbal topical gels are particularly promising because phytoconstituents often exhibit combined anti-inflammatory, antioxidant, venotonic, and microcirculatory protective activities. By addressing several pathological pathways simultaneously, herbal formulations may slow disease progression and relieve symptoms effectively.

4. CAUSES AND SYMPTOMS OF VARICOSE VEINS

Varicose veins arise from a combination of genetic, physiological, occupational, and lifestyle-related factors that collectively impair venous circulation. The development of this condition is rarely attributed to a single cause; rather, it results from multiple interacting mechanisms that increase venous pressure and weaken vascular structures over time. Identification of causative factors is essential for both prevention and therapeutic management, including the rational use of herbal topical gels aimed at symptom relief and vascular protection (31).

One of the most significant risk factors is prolonged standing or sitting. Occupations such as teaching, nursing, factory work, and retail employment require extended periods of immobility, which reduces the effectiveness of the calf muscle pump. Reduced muscular contraction limits venous return, allowing blood to pool in the lower limbs and increasing hydrostatic pressure within superficial veins (32).

Age is another major contributing factor. With advancing age, venous walls gradually lose elasticity due to degeneration of collagen and elastin fibers. Valve leaflets may also weaken, reducing their ability to prevent backflow. These structural changes explain the increasing prevalence of varicose veins among older populations (33).

Genetic predisposition plays an important role in disease susceptibility. Individuals with a family history of venous disorders are more likely to develop varicose veins due to inherited abnormalities in connective tissue composition and vascular integrity. Studies indicate that hereditary weakness of vein walls significantly increases the risk of valve incompetence (34).

Hormonal influences contribute strongly, particularly among women. Pregnancy, menopause, and hormonal therapies alter vascular tone and increase blood volume. Elevated progesterone levels relax smooth muscle in venous walls, promoting dilation. During pregnancy, mechanical pressure from the enlarged uterus further obstructs venous return from the lower limbs (35).

Obesity is closely associated with chronic venous disease. Excess body weight increases intra-abdominal pressure, which impedes venous flow and elevates pressure within leg veins. Additionally, obesity is linked with systemic inflammation that may worsen endothelial dysfunction and vascular damage (36).

Lack of physical activity is another modifiable risk factor. Regular walking and exercise stimulate the calf muscle pump and improve circulation, whereas sedentary behavior encourages venous stasis. Modern lifestyles characterized by prolonged screen time have contributed significantly to increased disease incidence (37).

Previous deep vein thrombosis (DVT) or venous injury can also lead to secondary varicose veins. Damage to deep venous valves results in chronic venous hypertension, forcing blood into superficial veins. This compensatory overload causes progressive dilation and visible varicosities (38).

5. Symptoms of Varicose Veins

Clinical manifestations vary depending on disease severity and duration. Early stages may present primarily with cosmetic concerns, while advanced stages involve significant discomfort and complications.

The most common symptom is a sensation of heaviness or aching in the legs, particularly after prolonged standing. This discomfort typically improves with leg elevation or rest, reflecting the role of venous congestion in symptom development (39).

Swelling of the ankles and lower legs is frequently observed due to fluid leakage from capillaries under elevated venous pressure. Persistent edema may worsen by evening and reduce overnight. Patients often report tightness or fatigue in affected limbs (40).

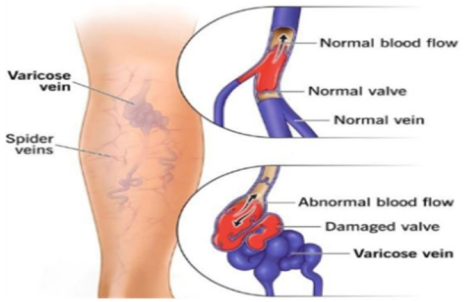

Fig.1: **Varicose vein**

6. Herbs Used for Varicose Veins in Topical Gel Applications

Herbal medicine has long been employed in traditional systems for the treatment of circulatory disorders, particularly conditions associated with venous insufficiency and inflammation. Modern pharmacological research has validated the venotonic, anti-inflammatory, antioxidant, and microcirculatory-enhancing properties of numerous medicinal plants. Incorporating these plant extracts into topical gel formulations enables localized therapeutic action, improved patient compliance, and reduced systemic adverse effects. This section discusses major herbs scientifically recognized for managing varicose veins when formulated as topical gels (41).

6.1 Aesculus hippocastanum (Horse Chestnut)

Botanical name: Aesculus hippocastanum.

Family: Sapindaceae or soapberry family.

Parts used: Ripe chestnut and bark.

Benefits: It reduces leg swelling, pain, heaviness, and inflammation by improving venous tone, sealing capillaries, and enhancing blood flow.

Chemical constituents: Triterpene saponins(escin), Flavonoids, Coumarins, and tannins across its seeds, bark, flowers, and leaves.

Mode of Action: Improve vascular resistance, reduced pathologically induced capillary wall permeability, antringent.

Fig.2: Horse Chestnut

Aesculus Hippocastanum is one of the most extensively studied medicinal plants for chronic venous insufficiency. Its primary active constituent, aescin (escin), is a triterpenoid saponin known for venotonic and anti-edematous effects. Aescin reduces capillary permeability, enhances venous tone, and inhibits inflammatory mediators responsible for vascular damage (42).

Topical preparations containing horse chestnut extract have demonstrated reduction in leg swelling, pain, and heaviness. The mechanism involves stabilization of lysosomal membranes and inhibition of hyaluronidase activity, thereby preserving vascular integrity. Clinical studies confirm its efficacy in reducing symptoms associated with varicose veins and chronic venous insufficiency (43).

6.2 CENTELLA ASIATICA (GOTU KOLA)

Botanical name: Centella asiatica

Family: Umbelliferae or Apiaceae

Part used: whole plant

Benefits: kola can be used externally and internally. It accelerates the healing time in wounds and ulcers, and stimulant

Chemical constituents: Triterpenoids, flavonoids, madecassoside asiaticacid, and asiaticoside

Mode of action: Anti-inflammatory, diuretic, laxative, antiseptic, stimulant, heals wounds and cers, improves memory, sluggish digestion, leprosy, skin eruptions, varicose veins, improves capillary permeability, and fever.

Fig.3: **Gotu kola**

Gotu Kola is widely used in Ayurvedic and traditional Chinese medicine for wound healing and vascular strengthening. Its bioactive compounds—asiaticoside, madecassoside, and triterpenoids—stimulate collagen synthesis and improve connective tissue metabolism (44).

Topical gels containing Centella extract enhance microcirculation, reduce edema, and improve venous wall elasticity. Clinical evidence suggests that it promotes venous tone and decreases capillary filtration rate, making it particularly beneficial in early-stage varicose veins (45).

6.3 HAMAMELIS VIRGINIANA (WITCH HAZEL)

Botanical name: Hamamelis virginiana

Family: Hamamelidaceae or witch hazel

Part used: Bark

Benefits: Used in venous laxity (Ligamentous laxity) and also used as an astringent, styptic, for wounds and local inflammations.

Chemical constituents: Tannins, flavonoids, and polyphenols. Mode of action: Astringent, styptic, mucous membrane irritation, passive hemorrhages, venous laxity, congestion, bleeding hemorrhoids, varicosities, heal wounds and local inflammations.

Fig.4: **Witch hazel**

Witch Hazel contains tannins and flavonoids with strong astringent and anti-inflammatory properties. These compounds constrict dilated blood vessels and reduce local inflammation (46).

When incorporated into gels, witch hazel extract provides symptomatic relief from itching, swelling, and discomfort. Its astringent action tightens superficial tissues and supports weakened venous walls. Topical use is well tolerated and widely accepted in dermatological preparations (47).

6.4 VITIS VINIFERA (GRAPE SEED EXTRACT)

Botanical name: Vitis Vinifera L.

Family: vitaceae

Part used: Seeds, Leaves,

Chemical constituents: Carbohydrates, Organic Acid, Polyphenolic compounds, Tannis, Volatile.

Fig.5: **Vitis vinifera**

Vitis vinifera seeds are rich in proanthocyanidins, powerful antioxidants that protect vascular endothelium from oxidative stress. These polyphenols strengthen capillaries and improve venous tone (48).

Grape seed extract in gel formulations enhances microvascular resistance and reduces capillary fragility. Studies indicate significant reduction in edema and improvement in symptoms of chronic venous insufficiency following topical or oral administration (49).

6.5 RUSCUS ACULEATUS (BUTCHER'S BROOM)

Botanical name: Ruscus aculeatus

Family: Asparagaceae, Liliaceae (Lily).

Part used: leaves, Root and rhizome of the plant.

Benefits: It has anti-inflammatory, antihemorragic, and vasoconstrictive properties. When applied externally, it causes venous constriction and decreases inflammation.

Chemicalconstituents:teroidalsaponins, lavonoids, saponins, zruscogenin, and steroidal glycosides. Mode of action:Anti-inflammatory, vasoconstrictor, antihemorrhagic.

Fig.6: Butcher's Broom

Butcher's Broom contains steroidal saponins such as ruscogenin, which exert vasoconstrictive and anti-inflammatory actions. The herb enhances venous return by stimulating alpha-adrenergic receptors on vascular smooth muscle (50).

Topical gels incorporating butcher's broom extract have shown efficacy in reducing leg heaviness, swelling, and venous dilation. It also decreases capillary permeability and improves lymphatic drainage (51).

6.6 CALENDULA OFFICINALIS (MARIGOLD)

Botanical name: Calendula officinalis

Family: Asteraceae

Part used: Flowers prior to fully opening

Benefits: Act as antiseptic, anti-inflammatory, it also supports creation of normal connective tissue structure and wound healing

Chemical constituents: Triterpenoid saponins, flavonoids, carotenoids, and phenolic acids.

Mode of action: Antiseptic, anti-inflammatory, choleretic, demulcent, vulnerary, immune stimulant, antiviral, support creation of normal connective tissues structures, wound healing, burns, boils, rashes, formulations of granulations tissues.

Fig.7: **Calendula**

Calendula possesses anti-inflammatory, antioxidant, and wound-healing properties attributed to flavonoids and triterpenoids. It is traditionally used for skin conditions and minor vascular injuries (52).

In varicose vein management, calendula-based gels help reduce inflammation, soothe irritated skin, and promote tissue repair. Its inclusion is particularly beneficial in patients with associated dermatitis or early ulceration (53).

6.7 ALOE VERA

Botanical name: Aloe barbadensis Miller

Family: Asphodelaceae

Part used: Leaf

Chemical constituents: Polysaccharides, Anthraquinones, Glycoproteins

Mode of action: Venous stasis, Inflammation, Edema, Pain

Fig.8: **Aloe vera**

Aloe Vera gel contains polysaccharides, vitamins, and phenolic compounds that exhibit anti-inflammatory and moisturizing effects. Aloe enhances skin penetration of co-administered herbal extracts in gel formulations (54).

Topical application provides cooling relief, reduces inflammation, and supports microcirculation. Its hydrating effect also improves skin elasticity over affected veins (55).

6.8 GINKGO BILOBA

Botanical name: Ginkgo biloba

Family: Ginkgoaceae

Part used: Dried leaves, Seeds

Benefits: Improves peripheral blood circulation, Strengthens blood vessel walls, Reduces capillary fragility, Decreases swelling and leg heaviness, Acts as a venotonic agent, Antioxidant protection to vascular tissues and May reduce pain and cramping in legs.

Chemical constituents: Flavonoids, Terpenoids, Proanthocyanidins, Organic acids

Mode of action: Varicose veins occur due to weakened vein walls and poor venous return.

Fig.9: **Ginko Biloba**

Ginko biloba leaves contain flavonoids and terpenoids that improve blood flow and exhibit antioxidant activity. Though commonly used orally, topical incorporation may enhance local microcirculation (56).

Ginkgo extract helps reduce oxidative damage and supports endothelial function, contributing to improved venous tone and reduced swelling (57).

6.9 MELILOTUS OFFICINALIS (SWEET CLOVER)

Botanical name: Melilotus officinalis

Family: Fabaceae (Leguminosae)

Part used: Dried flowering tops, Leaves and stems (aerial parts)

Benefits: Reduces leg swelling (edema),Improves venous return,Decreases heaviness and pain in legs,Strengthens capillaries, Anti-inflammatory action, Mild anticoagulant effect Useful in chronic venous insufficiency

Chemical constituents: Coumarins, Flavonoids, Tannins, Saponins and Volatile oil Mode of action: Varicose veins result from weakened venous walls and impaired lymphatic drainage.

Fig.10: **Melilotus officinalis**

Melilotus Officinalis contains coumarins and flavonoids that promote lymphatic drainage and reduce edema. It is particularly effective in conditions associated with fluid retention (58).

In topical gels, sweet clover extract reduces swelling and improves venous-lymphatic circulation, aiding symptom management in chronic venous disease (59).

6.10 CURCUMA LONGA (TURMERIC)

Botanical name: curcuma longa

Family: Zingiberaceae

Part used: Rhizomes

Benefits: Act as a anti-inflammatory, Anti-Coagulant (Inhibit platlet aggregation) and increases wound healing.

Chemical constituents: curcuminoids, volatile oil.

Fig.11: **Turmeric**

Turmeric contains a potent anti-inflammatory and antioxidant compound. Curcumin inhibits inflammatory cytokines and oxidative stress pathways implicated in venous wall damage (60).

Incorporation into herbal gels provides localized anti-inflammatory action and may slow progression of vascular degeneration when used consistently.

7. MECHANISMS OF ACTION OF HERBAL EXTRACTS IN TOPICAL GELS

The therapeutic efficacy of herbal topical gels is primarily mediated through:

- **Venotonic activity** – strengthening venous walls and improving elasticity.
- **Anti-inflammatory action** – inhibiting cytokines and leukocyte activation.
- **Antioxidant protection** – neutralizing free radicals damaging vascular tissue.
- **Anti-edematous effect** – reducing capillary permeability and fluid accumulation.
- **Improved microcirculation** – enhancing blood and lymphatic flow.

8. ADVANTAGES OF HERBAL TOPICAL GELS IN THE MANAGEMENT OF VARICOSE VEINS

Topical gel formulations containing herbal

extracts have emerged as promising therapeutic options for managing varicose veins due to their localized action, improved patient compliance, and favorable safety profile. Compared with oral medications and invasive procedures, herbal gels offer a non-invasive and patient-friendly approach that directly targets affected tissues. Advances in pharmaceutical formulation technology have further enhanced the therapeutic efficiency of topical herbal delivery systems (61).

One of the primary advantages of herbal topical gels is **localized drug delivery**. When applied to the skin surface, active phytoconstituents penetrate the epidermal layers and reach superficial veins and surrounding tissues. This targeted delivery allows higher local drug concentration while minimizing systemic absorption and associated adverse effects. Such localized action is particularly beneficial in venous disorders where pathology is confined mainly to superficial vascular structures (62).

Another important benefit is **reduced systemic toxicity**. Oral venotonic drugs may cause gastrointestinal irritation, headache, or drug interactions during long-term therapy. Herbal gels bypass hepatic first-pass metabolism and limit systemic exposure, thereby improving safety for prolonged use. Many plant extracts used in topical formulations have long histories of traditional application with minimal adverse reactions (63).

Improved patient compliance is also a significant advantage. Gel formulations are non-greasy, easily spreadable, and rapidly absorbed without staining clothing. Their cooling and soothing effect provides immediate symptomatic relief from burning, heaviness, and itching sensations commonly associated with varicose veins. These sensory benefits encourage regular application and adherence to therapy (64).

Topical gels additionally provide **enhanced drug release and penetration**. Hydrophilic polymer bases such as carbopol and hydroxypropyl methylcellulose maintain hydration of the stratum corneum, increasing permeability and facilitating diffusion of phytochemicals. Inclusion of natural penetration enhancers like essential oils or aloe vera further improves bioavailability of herbal constituents (65).

Herbal gels exhibit **multi-mechanistic therapeutic action**. Unlike single-target synthetic drugs, plant extracts contain multiple bioactive compounds that simultaneously exert anti-inflammatory, antioxidant, venotonic, and anti-edematous effects. This synergistic activity addresses various aspects of varicose vein pathophysiology, including endothelial dysfunction, oxidative stress, and microcirculatory impairment (66).

Another advantage is **cosmetic acceptability and skin protection**. Many herbal ingredients possess moisturizing and dermatoprotective properties that improve skin texture and elasticity. Regular application may reduce dryness, pigmentation, and irritation associated with chronic venous insufficiency, thereby enhancing both therapeutic and cosmetic outcomes (67).

From a pharmaceutical perspective, gels demonstrate **formulation stability and ease of manufacturing**. They allow uniform distribution of plant extracts and provide controlled drug release. Modern standardization techniques ensure consistent phytochemical content, improving reproducibility and clinical reliability of herbal products (68).

Herbal topical gels also support **combination therapy**. They can be safely used alongside compression stockings, physiotherapy, and lifestyle modifications without significant drug interactions. This integrative approach often produces better symptom control compared with single treatment modalities (69).

Economically, herbal gels are relatively **cost-effective and accessible**, especially in developing countries where medicinal plants are readily available. Their affordability and non-invasive nature make them suitable for long-term management of chronic venous disorders (70).

Overall, the advantages of herbal topical gels highlight their potential as effective adjunct or alternative therapies in varicose vein management. By combining traditional herbal knowledge with modern drug delivery systems, these formulations provide a holistic approach addressing both pathological mechanisms and patient comfort.

9. CONCLUSION

Varicose veins represent a multifactorial vascular disorder characterized by venous hypertension, valve incompetence, inflammation, and progressive structural deterioration of superficial veins. Conventional treatment methods, although effective in certain stages, may involve invasive procedures, high costs, or undesirable side effects, creating the need for safer and more patient-friendly alternatives. Herbal topical gels have emerged as promising therapeutic systems that combine traditional medicinal knowledge with modern pharmaceutical technology.

Medicinal plants rich in flavonoids, saponins, tannins, and polyphenols demonstrate significant venotonic, anti-inflammatory, antioxidant, and anti-edematous activities that directly address the underlying mechanisms of chronic venous disease. When formulated as gels, these phytoconstituents achieve localized delivery, improved penetration, and enhanced patient acceptability. The cooling effect, ease of application, and minimal systemic exposure further support their suitability for long-term management.

Scientific evidence suggests that herbal topical gels not only alleviate symptoms such as pain, swelling, heaviness, and itching but may also improve microcirculation and vascular integrity. Their compatibility with lifestyle modification and compression therapy makes them valuable components of integrative management strategies. Continued research focusing on formulation optimization, clinical validation, and phytochemical standardization will strengthen their therapeutic reliability. In conclusion, herbal topical gels represent a safe, effective, and economical approach for managing varicose veins, offering significant potential for future development in evidence-based phytopharmaceutical care.

REFERENCES

1. Eberhardt RT, Raffetto JD. Chronic venous insufficiency. *Circulation*. 2014;130:333–346.
2. Bergan JJ et al. Chronic venous disease mechanisms. *New England Journal of Medicine*. 2006;355:488–498.
3. Pittler MH, Ernst E. Horse chestnut extract for venous insufficiency. *Cochrane Database Systematic Reviews*. 2012.
4. Middleton E, Kandaswami C. Effects of flavonoids on vascular health. *Pharmacological Reviews*. 2000;52:673–751.
5. Swarbrick J. Topical drug delivery systems. *Pharmaceutical Technology*. 2011.
6. Shah VP, Maibach HI. Topical drug bioavailability and bioequivalence. *Dermatologic Therapy*. 2013.
7. Kumar S, Pandey AK. Chemistry and biological activities of flavonoids. *Scientific World Journal*. 2013.
8. Nicolaides AN. Investigation of chronic venous insufficiency. *Circulation*. 2000;102:E126–E163.
9. Caggiati A et al. Pathophysiology of varicose veins. *Journal of Vascular Surgery*. 2018.
10. Dhiman S, Singh TG. Herbal approaches in vascular disorders. *Journal of Ethnopharmacology*. 2019.
11. Moore KL, Dalley AF. *Clinically Oriented Anatomy*. Lippincott Williams & Wilkins; 2018.
12. Standring S. *Gray's Anatomy: The Anatomical Basis of Clinical Practice*. Elsevier; 2016.
13. Meissner MH. Lower extremity venous anatomy. *Seminars in Interventional Radiology*. 2005;22:147–156.
14. Caggiati A. Anatomy of perforating veins. *Phlebology*. 2010;25:2–10.
15. Labropoulos N, Leon LR. Venous valve anatomy and function. *Journal of Vascular Surgery*. 2004;40:124–130.
16. Recek C. Calf muscle pump physiology. *Phlebology*. 2013;28:147–154.
17. Sansilvestri-Morel P et al. Structural changes in varicose veins. *Journal of Vascular Research*. 2007;44:283–294.
18. Coleridge Smith PD. Microcirculation in venous disease. *Angiology*. 2006;57:3–10.
19. Mortimer PS. Lymphatic system and venous disorders. *British Journal of Dermatology*. 2000;143:1–7.
20. Cornu-Thenard A et al. Genetic factors in varicose veins. *Clinical Genetics*. 1994;46:118–123.

21. Raffetto JD, Khalil RA. Mechanisms of varicose vein formation. *Journal of Vascular Research*. 2008;45:1–8.
22. Labropoulos N et al. Venous reflux and chronic venous disease. *Journal of Vascular Surgery*. 2005;42:627–633.
23. Takase S et al. Inflammatory mechanisms in chronic venous insufficiency. *Journal of Vascular Surgery*. 2004;39:1329–1336.
24. Gillespie DL et al. Matrix metalloproteinases in venous disease. *Annals of Vascular Surgery*. 2002;16:689–695.
25. Lim CS, Davies AH. Pathogenesis of primary varicose veins. *British Journal of Surgery*. 2009;96:1231–1242.
26. Wali MA, Eid RA. Oxidative stress in venous disorders. *Angiology*. 2012;63:188–194.
27. Browse NL, Burnand KG. Pathophysiology of venous ulceration. *British Medical Journal*. 1982;285:1723–1726.
28. Smith PD. Leukocyte activation in venous hypertension. *Phlebology*. 2001;16:3–10.
29. Jawien A. Influence of hormones on venous disease. *Phlebology*. 2003;18:13–17.
30. Abraham P et al. Genetic susceptibility in varicose veins. *European Journal of Vascular Surgery*. 2010;39:594–600.
31. Beebe-Dimmer JL et al. Epidemiology of chronic venous disease. *Annals of Epidemiology*. 2005;15:175–184.
32. Tüchsen F et al. Prolonged standing and venous disorders. *Occupational Medicine*. 2000;50:414–420.
33. Criqui MH, Denenberg JO. Risk factors for venous disease. *Circulation*. 2007;115:1442–1447.
34. Cornu-Thenard A et al. Familial factors in varicose veins. *Journal of Vascular Surgery*. 1994;19:505–512.
35. Jawien A. Pregnancy and venous insufficiency. *Phlebology*. 2003;18:13–17.
36. Robertson L, Evans C. Obesity and venous disease. *European Journal of Vascular Surgery*. 2013;46:337–343.
37. Thaler E, Huch R. Physical inactivity and venous circulation. *Vasa*. 2000;29:127–132.
38. Kahn SR. Post-thrombotic syndrome mechanisms. *Blood Reviews*. 2009;23:1–9.
39. Nicolaides AN. Clinical manifestations of venous disease. *Circulation*. 2000;102:E126–E163.
40. Bergan JJ et al. Chronic venous disorders overview. *New England Journal of Medicine*. 2006;355:488–498.
41. Blumenthal M. Herbal medicine for vascular disorders. *American Botanical Council*. 2003.
42. Pittler MH, Ernst E. Horse chestnut extract review. *Cochrane Database*. 2012.
43. Sirtori CR. Aescin pharmacology. *Pharmacological Research*. 2001;44:183–193.
44. Brinkhaus B et al. Centella asiatica review. *Phytomedicine*. 2000;7:427–448.
45. Cesarone MR et al. Centella in venous insufficiency. *Angiology*. 2001;52:S49–S54.
46. McKay DL, Blumberg JB. Witch hazel properties. *Journal of Inflammation Research*. 2006.
47. Dweck AC. Witch hazel topical uses. *International Journal of Cosmetic Science*. 2002.
48. Bagchi D et al. Proanthocyanidins and vascular health. *Toxicology*. 2000;148:187–197.
49. Belcaro G et al. Grape seed extract in venous disorders. *Panminerva Medica*. 2010;52:55–62.
50. Bouskela E et al. Ruscus aculeatus pharmacology. *Angiology*. 1993;44:36–44.
51. Agnoli C et al. Butcher's broom in venous disease. *Drugs under Experimental and Clinical Research*. 1988.
52. Preethi KC et al. Calendula anti-inflammatory activity. *Indian Journal of Experimental Biology*. 2009.
53. Parente LM et al. Calendula wound healing. *Journal of Wound Care*. 2012.
54. Surjushe A et al. Aloe vera dermatological effects. *Indian Journal of Dermatology*. 2008.

55. Choi S, Chung MH. Aloe vera mechanisms. *Journal of Ethnopharmacology*. 2003.
56. Smith JV, Luo Y. Ginkgo biloba review. *Pharmacological Research*. 2004.
57. Kleijnen J, Knipschild P. Ginkgo clinical trials. *Lancet*. 1992.
58. Kohlmünzer S. Sweet clover pharmacology. *Phytotherapy Research*. 1991.
59. Cesarone MR et al. Melilotus in edema. *Angiology*. 1998.
60. Aggarwal BB et al. Curcumin anti-inflammatory mechanisms. *Biochemical Pharmacology*. 2007.
61. Benson HAE. Transdermal and topical drug delivery principles. *Current Drug Delivery*. 2005;2:23–33.
62. Barry BW. Dermatological formulations and percutaneous absorption. *Journal of Controlled Release*. 1987;6:85–97.
63. Williams AC, Barry BW. Penetration enhancers. *Advanced Drug Delivery Reviews*. 2012;64:128–137.
64. Lieberman HA, Rieger MM. *Pharmaceutical Dosage Forms: Disperse Systems*. Marcel Dekker; 1998.
65. Aulton ME. *Pharmaceutics: The Design and Manufacture of Medicines*. Elsevier; 2018.
66. Wagner H. Synergy in phytomedicine. *Fitoterapia*. 2011;82:34–37.
67. Lodén M. Role of moisturizers in skin barrier repair. *Clinics in Dermatology*. 2012;30:286–296.
68. Kunle OF et al. Standardization of herbal medicines. *African Journal of Biotechnology*. 2012;11:10085–10093.
69. Nicolaides AN. Conservative management of venous disease. *International Angiology*. 2014;33:87–94.
70. Ekor M. Safety of herbal medicine use. *Frontiers in Pharmacology*. 2014;4:177.