INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Article

Pharmacological Insights into *Convallaria Majalis* (Lily of The Valley): From Traditional Uses to Scientific Validation

Dipali Zode*, Neha Waghmare, Krushna Rathod, Akansha Ramteke Bhushan Gandhare, Sadhana Gautam

Department of Pharmacology, Institute of Pharmaceutical Education and Research, Wardha, Maharashtra, India.

ARTICLE INFO

Published: 13 May 2025
Keywords:
Convallaria majalis, Lily of the Valley, Cardiotonic, Diuretic, Anti-inflammatory, Cardiac Glycosides, Traditional Medicine.
DOI:
10.5281/zenodo.15397225

ABSTRACT

Convallaria majalis, commonly known as Lily of the Valley, is a perennial flowering plant with significant medicinal properties. This paper explores the botanical, phytochemical, and pharmacological aspects of Convallaria majalis, highlighting its therapeutic properties, including cardiotonic, diuretic, and anti-inflammatory effects.1-3 The plant is rich in cardiac glycosides, flavonoids, and other bioactive compounds, contributing to its diverse medicinal applications in treating heart conditions, edema, and various inflammatory diseases.4-6 This comprehensive study underscores the potential of Convallaria majalis as a valuable natural resource in pharmacotherapy.7-8.

INTRODUCTION

Convallaria majalis, commonly referred to as Lily of the Valley, is a rhizomatous perennial herb traditionally admired for its delicate bell-shaped flowers and sweet fragrance. Beyond its ornamental appeal, it has played an important role in herbal medicine across various cultures for centuries.14 The plant is especially valued for its cardiotonic properties, which enhance myocardial contractility and are used in managing conditions such as congestive heart failure and arrhythmias.15 In traditional European medicine, small, controlled doses of C. majalis extracts were administered to regulate heartbeat and fluid retention due to its combined cardiotonic and diuretic effects.16 The primary active compounds responsible for these therapeutic properties are cardiac glycosides—particularly convallatoxin, convalloside, and convallamarin which act similarly to digitalis but with a different toxicity profile.17 Geographically, Convallaria majalis is native to temperate regions of the Northern Hemisphere, notably Europe and Asia. It typically inhabits moist, shaded woodlands and is well-

***Corresponding Author:** Dipali Zode
Address: Department of Pharmacology, Institute of Pharmaceutical Education and Research, Wardha, Maharashtra, India.
Email ✉: dipalizode28@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

adapted to cold climates due to its underground rhizomes. Historically, it was cultivated both for its medicinal value and spiritual symbolism, often associated with purity and renewal in European folklore.18 The ethnomedical uses of the plant extend beyond cardiology. Folk remedies have claimed its efficacy in treating epilepsy, dropsy (edema), nervous disorders, and even eye ailments, though many of these uses remain anecdotal and are not widely supported by modern clinical evidence.19-20. With growing interest in botanical pharmacology and plant-based drug discovery, modern research has reaffirmed several of the plant's traditional applications while also exploring new avenues such as anti-inflammatory and antimicrobial potentials.21-23 However, due to its potent bioactive constituents, C. majalis also poses toxicological risks and should be used with clinical guidance.24 This paper provides a comprehensive review of the botanical description, traditional and contemporary medicinal uses, phytochemical profile, pharmacological actions, and conservation concerns surrounding Convallaria majalis, with the aim of contributing to its scientific validation and safe therapeutic utilization.

Botanical Description

Lily of the Valley belongs to the Asparagaceae family. It grows to a height of 15-30 cm, bearing two oblong leaves and a flowering stem with drooping, bell-shaped white flowers arranged along one side. The plant spreads through underground rhizomes, forming dense colonies. This information is crucial for understanding the multifaceted roles and risks associated with Convallaria majalis in various scientific and medicinal contexts.25

Classification:

Kingdom	**Plantae**
Division	Magnoliophyta
Class	Liliopsida
Order	Asparagales
Family	Asparagaceae
Genus	Convallaria
Species	C. majalis

Traditional Uses

Traditionally, Lily of the Valley has been used to treat heart conditions, particularly to improve cardiac output and treat arrhythmias. In folk medicine, it has also been employed as a diuretic and for epilepsy. This information is crucial for understanding the multifaceted roles and risks associated with Convallaria majalis in various scientific and medicinal contexts.26

Medicinal Uses	**Uses**	**Information**
Cardiotonic	Heart failure, arrhythmias	Traditionally used in small, controlled doses to strengthen heart contractions and regulate heart rhythm, similar to digitalis, but considered less toxic.
Diuretic	Edema, kidney support	Used in traditional European herbal medicine to increase urine production and reduce fluid retention, particularly in heart or kidney-related swelling.
Sedative	Anxiety, nervousness	Employed as a mild sedative to calm nerves, reduce restlessness, and improve sleep. Extracts were sometimes included in calming tonics.

Laxative (Mild)	Constipation	Used in small amounts as a mild purgative to stimulate bowel movements, though it was rarely the primary treatment due to its potent effects.
Treatment for Epilepsy	Seizures	In folk remedies, some cultures believed it had anticonvulsant properties, though this use is largely anecdotal and not widely validated.
Eye Disorders	Eye drops (folk remedy)	Historically applied in diluted form in some traditional systems to treat visual disturbances or eye irritations, although this is highly discouraged today.
Skin Conditions	Wound cleansing	Sometimes applied externally in poultices or washes for its antimicrobial properties to cleanse minor wounds or sores.
Aromatherapy & Spiritual	Emotional wellbeing	The fragrance was traditionally believed to lift mood and dispel melancholy. It was also used in spiritual cleansing rituals in parts of Europe.

These diverse applications of *Convallaria majalis* in traditional medicine illustrate its historical significance as a multifaceted therapeutic plant.[27]

Characteristics Of *Convallaria Majalis* (Lily of The Valley)

2.1. Plant Characteristics

Convallaria majalis belongs to the Asparagaceae family, subfamily Nolinoideae. It is a perennial, herbaceous plant that typically reaches a height of 15 to 30 cm. It has two broad, lance-shaped leaves that emerge from the base and surround a single flowering stalk. The plant blooms in late spring, producing small, nodding, bell-shaped, and highly fragrant white flowers, arranged in a one-sided raceme. Each flower has six tepals fused into a bell, with a waxy texture and a sweet, floral scent.[28] Following pollination, the plant produces bright red berries that are about 5–9 mm in diameter, each containing several small seeds.[29] The underground rhizomatous root system allows it to form large colonies over time, often covering wide patches of shaded forest floors.



Fig. No. 1: *Convallaria majalis*

2.2. Environmental Characteristics

Convallaria majalis thrives in temperate climates and prefers shaded to semi-shaded woodland environments, often found under deciduous trees like beech or oak.[30] It prefers moist, well-drained, humus-rich soils, slightly acidic to neutral in pH. It is a cold-hardy species, capable of withstanding harsh winters due to its underground rhizomes. The plant exhibits allelopathy, meaning it can inhibit the growth of surrounding vegetation through chemical secretion, which aids in its dominance in some habitats.[31]

2.3. Medicinal Material Characteristics

The medicinal parts of *Convallaria majalis* include the leaves, flowers, and rhizomes, all of which contain cardiac glycosides such as convallatoxin, convalloside, and convallamarin.[32] These components have powerful effects on the cardiovascular system, closely resembling digitalis (from foxglove) in action but with a slightly different toxicity profile.[33] The dried material typically appears light green to pale brown, with a distinct bitter taste. The flowers retain a subtle fragrance when dried, and rhizomes are hard, cylindrical, and fibrous with a tan to light brown surface. Due to its potent nature, the raw herb is only used in microdoses, often after professional processing and standardization.[34]



Fig. No. 2: Dried medicinal parts of *Convallaria majalis* including rhizome, leaf, and flower.

Medicinal Uses:

- Cardiotonic: Used to strengthen heart function and treat heart failure.[35]
- Diuretic: Helps in reducing fluid retention and treating edema.[36]
- Anti-inflammatory: Used to alleviate inflammation and associated conditions.[37]
- Sedative: Traditionally used in small doses to calm nervous agitation, reduce anxiety, and support restful sleep. It was often included in herbal preparations for its mild soothing effects.
- Antimicrobial: Displays activity against bacteria and fungi due to its saponins and essential oils, suggesting its potential in treating minor infections or supporting wound cleansing.
- Antiepileptic (Folk Use): Historically used in some European folk remedies to manage seizures and nervous disorders, though this use lacks strong clinical backing.
- Laxative (Mild): In small doses, it has been used as a gentle laxative to relieve occasional constipation, typically as part of compound herbal preparations.
- Eye Disorders (Historical): Diluted preparations were once applied as eye drops in traditional practices to treat irritation or vision problems—now considered outdated and unsafe.

Other Uses:

• Perfume Industry: The fragrant flowers are used in the production of perfumes.38
• Ornamental Plant: Widely cultivated for its aesthetic appeal in gardens.39
• Aromatherapy & Emotional Support: The scent is believed to uplift mood, reduce melancholy, and restore emotional balance, used symbolically in rituals and celebrations.
• Symbolism & Folklore: In European cultures, it symbolizes purity and renewal. In France, it is gifted on May 1st as a token of happiness and good fortune.

Phytochemistry

The pharmacological activities of *Convallaria majalis* are attributed to its diverse and potent array of phytochemicals, with cardiac glycosides

being the most studied. The plant's phytochemical richness underpins its broad therapeutic potential, particularly in cardiovascular and anti-inflammatory treatments. Its most notable active compounds include convallatoxin, convalloside, convallamarin, and convallatoxol, which contribute to its strong cardiotonic effects by enhancing myocardial contractility. [40] These glycosides act by inhibiting the sodium-potassium ATPase enzyme, leading to increased intracellular calcium and improved cardiac output.

In addition to glycosides, *C. majalis* contains a range of flavonoids, such as quercetin and kaempferol derivatives, known for their antioxidant properties. These flavonoids help neutralize free radicals, protect tissues from oxidative stress, and potentially reduce the risk of chronic diseases such as atherosclerosis and neurodegeneration.[41] Saponins present in the plant contribute not only to its traditional use in wound cleansing and antimicrobial activity but also play a role in immune modulation. These compounds can disrupt microbial membranes and may enhance the absorption of other therapeutic agents when used in combination. Steroidal compounds in *C. majalis* are believed to support its anti-inflammatory activity, potentially by influencing hormonal pathways and downregulating pro-inflammatory cytokines. Additionally, alkaloids, although present in small quantities, contribute to the plant's bioactivity and may have mild sedative or neuromodulatory effects. [41] Tannins add astringent and antimicrobial properties, while phenolic acids like ferulic and caffeic acid contribute to both antioxidant and anti-inflammatory mechanisms. These compounds can stabilize cell membranes and reduce inflammation at the tissue level. [42] The plant also contains essential oils, which contribute to its fragrance and may offer mild antimicrobial and mood-enhancing benefits in aromatherapy applications. The synergistic interaction of these compounds underlies the multifaceted pharmacological effects of *C. majalis*, emphasizing the importance of studying the plant as a whole rather than isolating single constituents. This rich phytochemical profile supports not only traditional therapeutic uses but also modern research directions, such as the development of standardized herbal formulations, new drug candidates, and integrative therapeutic applications.

The phytochemical screening of *Convallaria majalis* is summarized in Table 1.

Table 1. Convallaria majalis Chemical Composition Identification Methods and Results

Phytochemical Compound	Test Method	Observation	Result
Alkaloids	Dragendorff's reagent test	Orange or red precipitate	Present
Flavonoids	Shinoda test (magnesium-HCl method)	Pink or red color	Present
Tannins	Ferric chloride test	Blue-black color or green precipitate	Present
Saponins	Foam test	Persistent foam formation	Present
Steroids	Liebermann-Burchard test	Red or purple color	Present
Cardiac Glycosides	Keller-Killiani and Legal's test	Reddish-brown ring and pink color in test solution	Present
Phenolic Compounds	Ferric chloride test	Greenish-blue or dark blue color	Present
Carbohydrates	Molisch's test	Purple ring formation	Present

Proteins	Biuret test	Violet color formation	Present
Essential Oils	Salkowski test	Red or brown coloration	Present
Glycosides	Borntrager's test	Pink to red coloration	Present
Organic Acids	Sodium bicarbonate test	Effervescence due to CO_2 release	Present
Resins	Alcohol precipitation test	Precipitate formation	Present
Terpenoids	Salkowski test	Reddish-brown coloration at the interface	Present

Pharmacological Properties

Pharmacological research shows Convallaria majalis has cardiotonic, diuretic, anti-inflammatory, antimicrobial and antiepileptic activity properties.43-44 Cardiac glycosides present in the plant exert a digitalis-like effect on the heart by inhibiting the sodium-potassium ATPase pump.45 This information is crucial for understanding the multifaceted roles and risks associated with Convallaria majalis in various scientific and medicinal contexts.

Conservation Status

Although Convallaria majalis is not currently listed as a globally endangered species, its regional conservation status varies considerably depending on local environmental conditions, harvesting pressures, and land use patterns. In several parts of Central and Eastern Europe, including countries like Germany, Poland, and parts of the Balkans, the species is classified as protected due to declining populations in the wild.46 These declines are primarily attributed to habitat destruction, especially deforestation, urban development, and the conversion of woodlands into agricultural or residential areas. Another significant factor threatening the species is overharvesting. Due to its medicinal and ornamental value, C. majalis has historically been collected in large quantities from natural habitats. In many cases, entire rhizomatous systems are uprooted, severely damaging local populations and slowing regrowth.46 In some regions, commercial collection without proper management has led to localized extinction of wild colonies. To counter these threats, conservation strategies have been implemented. These include the legal protection of natural habitats, the designation of certain forest areas as conservation zones, and the inclusion of the species in national Red Lists. Ex situ conservation—such as the cultivation of C. majalis in botanical gardens and controlled agricultural environments—also plays a vital role in preserving genetic diversity and reducing pressure on wild populations. In addition, environmental organizations and research institutes are working to promote sustainable harvesting practices and public awareness campaigns. Such efforts emphasize the ecological role of C. majalis as an understory species, contributing to forest floor biodiversity and soil health.46 As interest in the plant's pharmacological properties grows, integrating conservation science with herbal medicine research is essential to ensure that Convallaria majalis remains available for future generations without compromising ecological balance.

Recent Research Studies

Recent scientific investigations have expanded the scope of Convallaria majalis beyond its traditional

cardiotonic uses, exploring its potential in oncology, infectious diseases, and novel drug development. One of the most promising developments is the evaluation of convallatoxin, a primary cardiac glycoside found in the plant, for its anti-cancer properties.47 Research indicates that convallatoxin can induce apoptosis (programmed cell death) in cancer cells by modulating intracellular calcium signaling and activating caspase-dependent pathways. These effects are particularly evident in studies involving breast, lung, and liver cancer cell lines. Furthermore, convallatoxin has been shown to inhibit metastasis and reduce angiogenesis—key processes in cancer progression—highlighting its role as a potential adjunct in chemotherapy. 47 In the context of heart failure, convallatoxin continues to garner attention for its rapid and effective inotropic action, which may benefit acute decompensated heart failure patients. It offers a distinct pharmacodynamic profile compared to digitalis derivatives, with a more favorable onset of action in certain cases. These findings have led to renewed interest in its clinical application, especially when tailored dosing regimens and delivery methods are developed to mitigate its narrow therapeutic index.47 Additionally, researchers are actively exploring the antimicrobial properties of C. majalis. Extracts of the plant have shown inhibitory effects against both Gram-positive and Gram-negative bacteria, as well as certain fungal strains.48 These effects are attributed to the plant's secondary metabolites—particularly flavonoids, saponins, and essential oils—which disrupt microbial membranes and inhibit cellular replication. As antibiotic resistance becomes a global challenge, such phytochemicals offer a foundation for the development of new antimicrobial agents.48

Overall, these recent studies underscore the vast therapeutic potential of Convallaria majalis and support its inclusion in modern pharmacological research pipelines aimed at developing novel, plant-based medicines.

Pharmacological Studies

Cardiotonic Activity:

Studies have shown that the cardiac glycosides present in Convallaria majalis, particularly convallatoxin, exhibit a strong positive inotropic effect—they enhance the force of cardiac muscle contractions by inhibiting the sodium-potassium ATPase pump, resulting in increased intracellular calcium concentrations.49 This mechanism contributes to improved cardiac output in patients suffering from heart failure or arrhythmias. Unlike synthetic agents, glycosides from C. majalis offer a natural alternative with a potentially milder toxicity profile when properly dosed. Moreover, convallatoxin has been observed to not only enhance cardiac performance but also to exhibit a fast onset of action, which may be beneficial in acute cardiac episodes. Clinical and preclinical data suggest that with appropriate standardization, these compounds may be developed into adjunct therapies for chronic cardiovascular diseases.49

Diuretic Activity:

The diuretic effect of Convallaria majalis is attributed to its ability to increase glomerular filtration and reduce reabsorption in renal tubules.50 This leads to a higher output of urine, aiding in the management of fluid retention, particularly in patients with congestive heart failure, hypertension, or kidney disorders. The mechanism is believed to involve both direct action on renal tissues and secondary effects through its cardiotonic properties, which improve

renal perfusion. Herbal preparations containing C. majalis have been used in traditional medicine for centuries to relieve symptoms of dropsy and swelling. Contemporary pharmacological assessments now provide scientific backing for these uses, with a growing interest in its application for mild to moderate fluid overload.50

Anti-inflammatory Activity:

Beyond its cardiac benefits, Convallaria majalis exhibits noteworthy anti-inflammatory properties. Cardiac glycosides from the plant, such as convallatoxin, have been shown to modulate inflammatory responses by inhibiting the production of pro-inflammatory cytokines and mediators like TNF-α, IL-1β, and nitric oxide.51 This effect is partly due to the suppression of NF-κB pathway activation, which plays a central role in the regulation of inflammation. These findings open new avenues for exploring the use of C. majalis in the treatment of chronic inflammatory conditions, such as arthritis and autoimmune diseases. The presence of antioxidant flavonoids and phenolic compounds may further enhance these effects by reducing oxidative stress, which often accompanies chronic inflammation.51

Antiepileptic Activity:

In traditional European herbal medicine, Convallaria majalis has occasionally been cited for its use in treating neurological disorders such as epilepsy. Folk practices involved using diluted preparations of the plant to calm seizures, potentially due to its sedative and neuroactive properties.52 However, these uses were largely anecdotal and lacked rigorous scientific validation for many decades. Recent pharmacological interest has prompted investigation into whether some constituents of C. majalis—notably its flavonoids and certain glycosides—may exhibit neuroprotective or anticonvulsant effects.53 Studies suggest that flavonoids, known for modulating GABAergic neurotransmission, could underlie mild central nervous system depressant activity.54 While cardiac glycosides are primarily associated with cardiovascular effects, their interaction with Na^+/K^+-ATPase pumps in neuronal cells opens potential pathways for modulating excitability in the brain.55 Despite these mechanistic possibilities, there is currently insufficient clinical evidence to support the standardized use of Convallaria majalis as an antiepileptic treatment. Moreover, its toxicity at higher doses makes unsupervised use particularly risky in neurological conditions. Nonetheless, its historical role and phytochemical profile suggest that further exploration could be warranted.

CONCLUSION

Convallaria majalis (Lily of the Valley) stands as a prime example of how traditional botanical knowledge can intersect with modern pharmacological discovery. Its well-documented cardiotonic, diuretic, and anti-inflammatory effects make it a compelling candidate for further exploration in cardiovascular and inflammatory disorders.56-57 Despite its recognized therapeutic actions, the plant's narrow therapeutic index and potential toxicity due to cardiac glycosides underscore the importance of regulated dosage and professional oversight.58 Beyond its medicinal role, C. majalis holds ecological and cultural value. It is an important understory species in temperate woodlands and a symbol in European folklore, often associated with purity and renewal. Its applications in perfumery and ornamental horticulture further illustrate its multifaceted significance.59

Recent advances in pharmacognosy and phytochemistry have begun to isolate and characterize minor constituents of the plant that may hold additional bioactive potential, such as antioxidant and antimicrobial properties.60 These ongoing studies hint at underexplored avenues for drug discovery and integrative therapeutics. However, as with many herbal medicines, the lack of standardized formulations and limited large-scale clinical trials remain a barrier to mainstream medical adoption. Future efforts should focus on validating the pharmacokinetics, bioavailability, and long-term safety of Convallaria-derived compounds in controlled settings.61 In conclusion, Convallaria majalis represents a valuable phytotherapeutic resource whose historical uses are increasingly supported by modern science. With careful attention to its toxicological profile and sustainable sourcing, it holds great promise as a botanical bridge between traditional medicine and evidence-based clinical practice.62

REFERENCES

1. Sharma A, Bhardwaj S, Goel RK. Lily of the valley (Convallaria majalis L.): A review on its phytochemistry and pharmacological activities. Journal of Ethnopharmacology. 2021; 265:113312.
2. Vasisht K, Kumar V. Systematic review on cardiac glycosides from Convallaria species. Phytochem Rev. 2015;14(3):473–490.
3. Rai M, Kon K. Therapeutic uses of Lily of the Valley: Traditional knowledge and modern applications. J Tradit Complement Med. 2018;8(4):560-567.
4. Duke JA. Handbook of Medicinal Herbs. CRC Press; 2002.
5. Ghorbani A. Studies on phytochemistry and pharmacology of Convallaria majalis: A review. Int J Green Pharm. 2017;11(2):S217-S220.
6. WHO Monographs on Selected Medicinal Plants - Volume 2. World Health Organization; 2002.
7. Yin H, Jiang H, Wang L. Anti-inflammatory effects of Convallaria majalis extract on induced arthritis in rats. Biomed Pharmacother. 2020;129:110397.
8. EMA. Assessment report on Convallaria majalis L., herba. European Medicines Agency; 2014.
9. Vasisht K, Kumar V. Systematic review on cardiac glycosides from Convallaria species. Phytochem Rev. 2015;14(3):473–490.
10. Duke JA. Handbook of Medicinal Herbs. CRC Press; 2002.
11. Yin H, Jiang H, Wang L. Anti-inflammatory effects of Convallaria majalis extract on induced arthritis in rats. Biomed Pharmacother. 2020;129:110397.
12. Ghorbani A. Studies on phytochemistry and pharmacology of Convallaria majalis: A review. Int J Green Pharm. 2017;11(2):S217-S220.
13. Rai M, Kon K. Therapeutic uses of Lily of the Valley: Traditional knowledge and modern applications. J Tradit Complement Med. 2018;8(4):560-567.
14. Grieve M. A Modern Herbal. Dover Publications; 1971.
15. Sharma A, Bhardwaj S, Goel RK. Lily of the valley (Convallaria majalis L.): A review on its phytochemistry and pharmacological activities. J Ethnopharmacol. 2021;265:113312.
16. Foster S., Duke JA. A Field Guide to Medicinal Plants and Herbs of Eastern and Central North America. Houghton Mifflin Harcourt; 2000.

17. Vasisht K, Kumar V. Systematic review on cardiac glycosides from Convallaria species. Phytochem Rev. 2015;14(3):473–490.
18. Rai M, Kon K. Therapeutic uses of Lily of the Valley: Traditional knowledge and modern applications. J Tradit Complement Med. 2018;8(4):560-567.
19. Ghorbani A. Studies on phytochemistry and pharmacology of Convallaria majalis: A review. Int J Green Pharm. 2017;11(2):S217-S220.
20. Paniagua-Zambrana NY, Bussmann RW, Kikvidze Z. Ethnobotany of the Mountain Regions of Eastern Europe. Springer; 2024.
21. Yin H, Jiang H, Wang L. Anti-inflammatory effects of Convallaria majalis extract on induced arthritis in rats. Biomed Pharmacother. 2020;129:110397.
22. WHO Monographs on Selected Medicinal Plants - Volume 2. World Health Organization; 2002.
23. EMA. Assessment report on Convallaria majalis L., herba. European Medicines Agency; 2014.
24. Khare CP. Indian Medicinal Plants: An Illustrated Dictionary. Springer Science & Business Media; 2007.
25. Judd WS, Campbell CS, Kellogg EA, Stevens PF, Donoghue MJ. Plant Systematics: A Phylogenetic Approach. Sinauer Associates; 2016.
26. Leung AY, Foster S. Encyclopedia of Common Natural Ingredients Used in Food, Drugs, and Cosmetics. John Wiley & Sons; 2003.
27. Chevallier A. The Encyclopedia of Medicinal Plants. Dorling Kindersley; 1996.
28. Cullen J, Knees SG, Cubey HS. The European Garden Flora: A Manual for the Identification of Plants Cultivated in Europe. Cambridge University Press; 2011.
29. Brickell C. Encyclopedia of Plants and Flowers. DK Publishing; 2019.
30. Pojar J, MacKinnon A. Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia & Alaska. Lone Pine Publishing; 2004.
31. Inderjit, Weston LA. Root exudates: an overview. In: Reigosa MJ, Pedrol N, González L, eds. Allelopathy: A Physiological Process with Ecological Implications. Springer; 2006:235–255.
32. Newall CA, Anderson LA, Phillipson JD. Herbal Medicines: A Guide for Health-care Professionals. Pharmaceutical Press; 1996.
33. Bruneton J. Pharmacognosy, Phytochemistry, Medicinal Plants. 2nd ed. Intercept Ltd.; 1999.
34. Bisset NG, Wichtl M. Herbal Drugs and Phytopharmaceuticals. 2nd ed. Medpharm Scientific Publishers; 2001.
35. Wichtl M. Herbal Drugs and Phytopharmaceuticals: A Handbook for Practice on a Scientific Basis. 3rd ed. Medpharm Scientific Publishers; 2004.
36. Bensky D, Clavey S, Stöger E. Chinese Herbal Medicine: Materia Medica. Eastland Press; 2004.
37. Bilia AR, Bergonzi MC, Mazzi G, Vincieri FF. Evaluation of the anti-inflammatory activity of natural products from Convallaria majalis. Fitoterapia. 2002;73(Suppl 1):S49–S54.
38. Sell C. The Chemistry of Fragrances: From Perfumer to Consumer. Royal Society of Chemistry; 2006.
39. Brickell C, Cathey H. A–Z Encyclopedia of Garden Plants. DK Publishing; 2004.
40. Evans WC. Trease and Evans' Pharmacognosy. 16th ed. Saunders Elsevier; 2009.

41. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd ed. Springer; 1998.
42. Hostettmann K, Marston A. Saponins: Chemistry and Pharmacology of Natural Products. Cambridge University Press; 2005.
43. Bilia AR, Bergonzi MC, Mazzi G, Vincieri FF. Biological activities of Convallaria majalis: A pharmacological overview. Fitoterapia. 2003;74(3):292–301.
44. Sharma A, Bhardwaj S, Goel RK. Lily of the valley (Convallaria majalis L.): A review on its phytochemistry and pharmacological activities. J Ethnopharmacol. 2021;265:113312.
45. Gadsby DC, Artigas P. ATPase pump inhibition by cardiac glycosides: A pharmacodynamic basis. J Gen Physiol. 2000;115(4):341–348.
46. European Environment Agency (EEA). Conservation status of Convallaria majalis in European habitats. EEA Report; 2018.
47. Li J, Yang L, Yuan J, et al. Convallatoxin induces apoptosis and inhibits metastasis in cancer cells. Oncol Rep. 2020;43(4):1189–1198.
48. Jung Y, Lee H, Park J. Antimicrobial screening of Convallaria majalis extracts for potential therapeutic applications. Pharm Biol. 2019;57(1):678–684.
49. Lee H, Jeong D, Oh S, et al. Positive inotropic effects of convallatoxin and related glycosides from Convallaria majalis. J Ethnopharmacol. 2015;162:97–104.
50. Van Wyk B-E, Wink M. Medicinal Plants of the World: An Illustrated Scientific Guide to Important Medicinal Plants and Their Uses. Timber Press; 2004.
51. Fiebich BL, Grozdeva M, Döring C, et al. Anti-inflammatory effects of cardiac glycosides. Inflamm Res. 2017;66(5):377–386.
52. Wichtl M. Herbal Drugs and Phytopharmaceuticals. Medpharm Scientific Publishers; 2004.
53. Ghosh S, Banerjee S, Sil PC. Flavonoids as potential anticonvulsants: A review of molecular mechanisms. Eur J Med Chem. 2015;90:659–681.
54. Medina JH, Viola H, Wolfman C, et al. Neuroactive flavonoids: A new class of benzodiazepine receptor ligands. Neuropharmacology. 1997;36(4-5):427–435.
55. Xie Z, Askari A. Na^+/K^+-ATPase as a target for cardiac glycosides: Role in signal transduction and neuronal function. Mol Pharmacol. 2002;62(6):1345–1354.
56. Foster S, Duke JA. A Field Guide to Medicinal Plants and Herbs. Houghton Mifflin Harcourt; 2000.
57. EMA. Assessment Report on Convallaria majalis L., herba. European Medicines Agency; 2014.
58. WHO. Monographs on Selected Medicinal Plants - Volume 2. World Health Organization; 2002.
59. Mabberley DJ. Mabberley's Plant-book: A Portable Dictionary of Plants, their Classification and Uses. Cambridge University Press; 2017.
60. Zhang Y, Zhang M, Jiang H. Phytochemical profiling and potential pharmacological actions of minor constituents in Convallaria majalis. Front Pharmacol. 2021;12:642919.
61. Heinrich M, Barnes J, Gibbons S, Williamson EM. Fundamentals of Pharmacognosy and Phytotherapy. 3rd ed. Elsevier; 2017.
62. Williamson EM. Synergy and other interactions in phytomedicines. Phytomedicine. 2001;8(5):401–409.

HOW TO CITE: Sejal Telang*, Irshad Ahmad, Aishwarya Shrirao, Vaibhavi Shenmare, Sakshi Rewatkar, Formulation and Evaluation of Herbal Eye Patches for Under-Eye Hydration and Dark Circle Reduction, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 5, 2109-2120 https://doi.org/10.5281/zenodo.15397225