



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



Review Paper

Andrographis paniculata (Kalmegh): A Comprehensive Review of Its Phytochemistry, Pharmacological Activities and Therapeutic Applications

Avinash kumar*

JBS Institute of Pharmacy, Malinpur R S Ghat, Barabanki 225409.

ARTICLE INFO

Published: 22 July 2026

Keywords:

Andrographis paniculata, andrographolide, hepatoprotective, phytochemistry, pharmacology, herbal medicine

DOI:

10.5281/zenodo.21492174

ABSTRACT

Andrographis paniculata, commonly known as Kalmegh or the “King of Bitters,” is a well-known medicinal herb widely used in Ayurveda, Siddha, Unani, and Traditional Chinese Medicine. The plant contains several bioactive constituents, among which andrographolide is the major pharmacologically active compound. It exhibits a broad spectrum of biological activities, including hepatoprotective, anti-inflammatory, antimicrobial, anticancer, antioxidant, antidiabetic, and immunomodulatory effects. The present review highlights the botanical description, phytochemical constituents, pharmacological activities, traditional and modern therapeutic applications, toxicity profile, and future research prospects of Andrographis paniculata. Numerous studies have demonstrated its therapeutic potential in the management of liver disorders, infections, inflammation, metabolic diseases, and immune-related conditions. Furthermore, its favorable safety profile and growing scientific evidence support its use as a promising herbal therapeutic agent. Therefore, Andrographis paniculata continues to attract considerable attention for its potential role in integrative and evidence-based medicine

INTRODUCTION

Medicinal plants continue to play a vital role in healthcare, especially in developing countries where traditional medicine forms the basis of primary treatment [WHO 2019]. A plant of great pharmacological significance among these is

Andrographis paniculata Nees (family: Acanthaceae). Known as Chuan Xin Lian in China, Fah Talai Jone in Thailand, and Kalmegh in India, it is widely distributed throughout tropical Asia [Jarukamjorn and Nemoto 2008]. It has historically been used to treat digestive issues, respiratory infections, liver conditions, and

***Corresponding Author:** Avinash kumar

Address: JBS Institute of Pharmacy, Malinpur R S Ghat, Barabanki 225409.

Email ✉: avinashkumar11a@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.



fever [Mishra et al. 2017]. Modern pharmacological investigations attribute these therapeutic effects primarily to diterpenoid lactones, especially andrographolide [Pholphana et al. 2014]. Its hepatoprotective, anti-inflammatory, anticancer, and immunomodulatory properties are being supported by more and more data, making it a strong contender for the development of new medications [Wang et al. 2019].

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae, Plants;
 Subkingdom : Tracheobionta, Vascular plants;
 Super division : Spermatophyta, Seed plants;
 Division : Angiosperma
 Class : Dicotyledonae
 Sub class : Gamopetalae
 Series : Bicarpellatae
 Order : Personales
 Tribe : Justicieae
 Family : Acanthaceae
 Genus : Andrographis
 Species : paniculata

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae, Plants;
 Subkingdom : Tracheobionta, Vascular plants;
 Super division : Spermatophyta, Seed plants;
 Division : Angiosperma
 Class : Dicotyledonae
 Sub class : Gamopetalae
 Series : Bicarpellatae
 Order : Personales
 Tribe : Justicieae
 Family : Acanthaceae
 Genus : Andrographis
 Species : paniculata

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae, Plants;
 Subkingdom : Tracheobionta, Vascular plants;
 Super division : Spermatophyta, Seed plants;
 Division : Angiosperma

Class : Dicotyledonae
 Sub class : Gamopetalae
 Series : Bicarpellatae
 Order : Personales
 Tribe : Justicieae
 Family : Acanthaceae
 Genus : Andrographis
 Species : paniculata

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae, Plants;
 Subkingdom : Tracheobionta, Vascular plants;
 Super division : Spermatophyta, Seed plants;
 Division : Angiosperma
 Class : Dicotyledonae
 Sub class : Gamopetalae
 Series : Bicarpellatae
 Order : Personales
 Tribe : Justicieae
 Family : Acanthaceae
 Genus : Andrographis
 Species : paniculata

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae, Plants;
 Subkingdom : Tracheobionta, Vascular plants;
 Super division : Spermatophyta, Seed plants;
 Division : Angiosperma
 Class : Dicotyledonae
 Sub class : Gamopetalae
 Series : Bicarpellatae
 Order : Personales
 Tribe : Justicieae
 Family : Acanthaceae
 Genus : Andrographis
 Species : paniculata

TAXONOMICAL CLASSIFICATION

Kingdom : Plantae, Plants;
 Subkingdom : Tracheobionta, Vascular plants;
 Super division : Spermatophyta, Seed plants;
 Division : Angiosperma
 Class : Dicotyledonae



Sub class : Gamopetalae
 Series : Bicarpellatae
 Order : Personales
 Tribe : Justicieae
 Family : Acanthaceae
 Genus : Andrographis
 Species : paniculata

BOTANICAL DESCRIPTION

The small, annual, branched herb *Andrographis paniculata* can reach a height of 30 to 110 cm. The stems are hairless, green, and quadrangular. The small, white flowers with purple markings are arranged in terminal racemes, while the dark green, lanceolate leaves are opposite one another [Kumar et al. 2012].

The plant is widely found in China, Thailand, India, Sri Lanka, and other Southeast Asian nations, and it grows well in tropical and subtropical climates. In medicinal preparations, the entire plant is utilized, but the leaves and roots are particularly utilized [Akbar 2011]. It grows best in warm, humid climates with temperatures ranging from 25–35°C and annual rainfall between 1000–2000 mm. The plant thrives in well-drained

loamy soils with a pH of 6.0–7.5. Propagation is mainly achieved through seeds, and harvesting is generally carried out during the flowering stage when the concentration of andrographolide reaches its maximum level.

PHYTOCHEMISTRY

Diterpenoid lactones are the most important of the many phytoconstituents found in kalmegh. The most prevalent and pharmacologically significant of the more than 20 diterpenoids that have been identified is andrographolide [Mishra et al. 2017]. Other substances include flavonoids like andrographidine A–E, andrographiside, neoandrographolide, and dehydroandrographolide [Jarukamjorn and Nemoto 2008].

Andrographolide exhibits a variety of pharmacological mechanisms, such as the modification of the JAK-STAT, MAPK, and NF-κB signaling pathways [Jayakumar et al. 2013]. Alkaloids and terpenes enhance the plant's antimicrobial and anti-inflammatory properties, while flavonoids and phenolic acids support its antioxidant potential [Pholphana et al. 2014].

Table 1: Major Phytoconstituents of *Andrographis paniculata*

Phytoconstituent	Chemical Class	Pharmacological Activity
Andrographolide	Diterpenoid lactone	Anti-inflammatory, anticancer, hepatoprotective
Neoandrographolide	Diterpenoid lactone	Antioxidant, immunomodulatory
Dehydroandrographolide	Diterpenoid lactone	Antimicrobial
Andrographiside	Glycoside	Antioxidant
Flavonoids	Polyphenols	Free radical scavenging
Phenolic acids	Phenolics	Antioxidant

PHARMACOLOGICAL ACTIVITIES

1. Hepatoprotective Activity

A. paniculata's hepatoprotective effect is one of its most researched characteristics. Hepatocytes have been demonstrated to be protected by andrographolide from toxicity caused by

chemicals like alcohol, paracetamol, and carbon tetrachloride (CCl₄). It decreases lipid peroxidation and raises levels of antioxidant enzymes such as catalase and superoxide dismutase (SOD) [Shen et al. 2002; Trivedi, Rawal, and Patel 2007]. Additionally, clinical research validates its function in restoring normal



levels of serum liver enzymes like ALT, AST, and ALP [Mishra et al. 2017].

2. Anti-inflammatory Activity

Kalmegh has potent anti-inflammatory properties. *A. paniculata* extracts suppress pro-inflammatory cytokines like TNF- α , IL-1 β , and IL-6 and prevent the production of nitric oxide [Jayakumar et al. 2013; Pholphana et al. 2014]. By reducing NF- κ B activation, andrographolide suppresses the expression of COX-2 and iNOS, two important mediators of inflammation [Chao and Lin 2010].

3. Antimicrobial Activity

Kalmegh's ethanolic and aqueous extracts have broad-spectrum antibacterial qualities. It exhibits antibacterial activity against *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus* [Singha et al. 2003]. There have also been reports of antiviral qualities against chikungunya, dengue, influenza, and HIV [Coon and Ernst 2004; Jayakumar et al. 2013]. Its antifungal properties include preventing the growth of *Candida albicans* [Akbar 2011].

4. Anticancer Activity

Andrographolide exerts significant anticancer effects through induction of apoptosis, cell cycle arrest, and inhibition of angiogenesis [Wang et al. 2019]. It suppresses cancer cell proliferation in breast, colon, prostate, and lung cancers [Rajagopal et al. 2003]. Mechanistically, it modulates apoptosis-regulating proteins (Bax,

Bcl-2), inhibits STAT3 and NF- κ B signaling, and enhances caspase activity [Zhou et al. 2012].

5. Antioxidant Activity

Extracts of *A. paniculata* have demonstrated potent free-radical scavenging activity. They increase endogenous antioxidant enzymes like glutathione peroxidase and reduce oxidative stress in experimental models [Verma and Vinayak 2008]. This property complements its hepatoprotective and anti-inflammatory effects [Mishra et al. 2017].

6. Antidiabetic Activity

Several studies report that *A. paniculata* improves glucose metabolism and insulin sensitivity. Andrographolide stimulates glucose uptake, inhibits α -glucosidase activity, and preserves pancreatic β -cell function [Yu et al. 2008]. Animal studies confirm its hypoglycemic effect in alloxan- and streptozotocin-induced diabetic models [Zhang and Tan 2000].

7. Immunomodulatory Activity

Kalmegh acts as an immune enhancer by stimulating lymphocyte proliferation, macrophage activation, and antibody production [Mishra et al. 2017]. Clinical studies show its effectiveness in reducing symptoms of upper respiratory tract infections and common cold [Coon and Ernst 2004; Chandrasekaran et al. 2012]. This makes it a valuable candidate for immune-boosting formulations.



Table 2: Pharmacological Activities and Mechanisms

Activity	Bioactive Compound	Mechanism
Hepatoprotective	Andrographolide	Reduces oxidative stress and lipid peroxidation
Anti-inflammatory	Andrographolide	Inhibits NF- κ B and COX-2 pathways
Antimicrobial	Diterpenoids	Disrupts microbial growth
Anticancer	Andrographolide	Induces apoptosis and cell cycle arrest
Antioxidant	Flavonoids	Scavenges reactive oxygen species
Antidiabetic	Andrographolide	Enhances glucose uptake
Immunomodulatory	Andrographolide	Stimulates lymphocyte proliferation

TRADITIONAL & MODERN USES

In Ayurveda, *A. paniculata* is classified as a “pitta pacifying” herb and is used for treating fever, jaundice, diarrhea, and skin diseases [Kumar et al. 2012]. In Traditional Chinese Medicine (TCM), it is prescribed for sore throat, cough, and upper respiratory infections [Jarukamjorn and Nemoto 2008]. Unani medicine recognizes it for its bitter tonic and liver-protective roles.

Standardized extracts and herbal capsules are examples of contemporary formulations that are promoted for infection control, immune system stimulation, and liver protection [Chandrasekaran et al. 2012]. It improves therapeutic efficacy against a variety of illnesses when added to polyherbal formulations.

CLINICAL STUDIES

Several clinical investigations have demonstrated the therapeutic efficacy of *Andrographis paniculata* in human subjects. Randomized controlled trials have shown that standardized extracts significantly reduce the severity and duration of symptoms associated with upper respiratory tract infections and the common cold. A meta-analysis reported improvements in sore throat, cough, fatigue, and nasal symptoms when

compared with placebo treatment. Clinical evidence also suggests hepatoprotective benefits through normalization of liver enzyme levels in patients with hepatic dysfunction. Furthermore, the immunomodulatory activity of andrographolide has attracted attention for its potential role in supporting immune health [Coon JT et al. 2004].

TOXICITY & SAFETY STUDIES

A. paniculata has a broad safety margin, according to toxicological research. Studies on acute toxicity in rodents showed that doses up to 2 g/kg had no discernible harmful effects [Akbar 2011].

A. paniculata has a broad safety margin, according to toxicological research. Studies on acute toxicity in rodents showed that doses up to 2 g/kg had no discernible harmful effects [Mishra et al. 2017]. Clinical trials confirm its safety in human use for up to 12 weeks [Coon and Ernst 2004]. However, because of the lack of sufficient evidence, caution is advised during pregnancy and lactation.

FUTURE PROSPECTS

Despite extensive research, gaps remain in understanding the full pharmacological potential



of *A. paniculata*. Future research should emphasize:

- Clinical trials with larger sample sizes to validate preclinical findings.
- Standardization of extracts and bioactive markers for consistent therapeutic outcomes.
- Development of novel formulations (e.g., nanoparticles) to enhance bioavailability.
- Exploration of synergistic effects with conventional drugs in cancer, diabetes, and liver diseases.

CONCLUSION

Andrographis paniculata (Kalmegh) is one of the most valuable medicinal plants widely utilized in traditional systems of medicine and increasingly recognized in modern healthcare. The plant possesses a diverse range of pharmacological activities, including hepatoprotective, anti-inflammatory, antimicrobial, antioxidant, anticancer, antidiabetic, and immunomodulatory effects, primarily attributed to its major bioactive constituent, andrographolide. Scientific studies have provided substantial evidence supporting its traditional therapeutic uses and demonstrated its potential in the prevention and management of various diseases. Furthermore, its favorable safety profile and broad therapeutic spectrum make it a promising candidate for the development of novel herbal formulations and phytopharmaceutical products. However, additional well-designed clinical trials, standardization of extracts, and advanced drug delivery approaches are required to establish its efficacy and safety on a global scale. Overall, *Andrographis paniculata* represents a promising natural therapeutic agent with significant potential for future applications in integrative and evidence-based medicine.

REFERENCES

1. Akbar, Shah. 2011. “*Andrographis paniculata*: A Review of Pharmacological Activities and Clinical Effects.” *Alternative Medicine Review* 16 (1): 66–77.
2. Jarukamjorn, Kanokwan, and Nipon Nemoto. 2008. “Pharmacological Aspects of *Andrographis paniculata* on Health and Its Major Diterpenoid Constituent Andrographolide.” *Journal of Health Science* 54 (4): 370–381.
3. Mishra, Shailendra K., Amit Kumar, Ramesh Kumar, and Anil K. Yadav. 2017. “Pharmacological Properties of *Andrographis paniculata* and Its Active Constituents: A Review.” *Journal of Ayurveda and Integrative Medicine* 8 (4): 210–216.
4. Pholphana, Nattaya, et al. 2014. “Anti-Inflammatory Activities of Extracts from *Andrographis paniculata*.” *Journal of Ethnopharmacology* 156: 39–46.
5. Shen, Yu-Cheng, et al. 2002. “The Hepatoprotective Effects of *Andrographis paniculata* on CCl₄-Induced Liver Injury in Rats.” *Planta Medica* 68 (5): 432–436.
6. Trivedi, Narendra P., Rakesh Rawal, and Bhagyesh Patel. 2007. “Hepatoprotective Effects of *Andrographis paniculata* against Paracetamol-Induced Liver Damage.” *Indian Journal of Pharmacology* 39 (2): 76–81.
7. Kumar, Ramesh, et al. 2012. “*Andrographis paniculata*: A Herbal Panacea.” *International Journal of Pharmacy and Pharmaceutical Sciences* 4 (1): 22–29.
8. Jayakumar, Thangavel, et al. 2013. “Andrographolide and Its Anti-Inflammatory Activity in Human Neutrophils.” *Journal of Ethnopharmacology* 145 (1): 425–432.
9. Chao, W. W., and B. F. Lin. 2010. “Isolation and Identification of Bioactive Compounds in



- Andrographis paniculata* (Chuanxinlian)." Chinese Medicine 5 (1): 17.
10. Singha, Pranab K., et al. 2003. "Antimicrobial Activity of *Andrographis paniculata*." Fitoterapia 74 (7–8): 692–694.
11. Coon, J. T., and Edzard Ernst. 2004. "*Andrographis paniculata* in the Treatment of Upper Respiratory Tract Infections: A Systematic Review of Safety and Efficacy." Planta Medica 70 (4): 293–298.
12. Rajagopal, Subramaniam, et al. 2003. "Andrographolide, a Potential Cancer Therapeutic Agent." International Journal of Cancer 106 (5): 715–722.
13. Zhou, J., et al. 2012. "Andrographolide Inhibits Tumor Growth by Inducing Apoptosis and Suppressing Angiogenesis in Human Cancer Cells." Biochemical Pharmacology 84 (2): 240–247.
14. Verma, Nidhi, and Manisha Vinayak. 2008. "Antioxidant Action of *Andrographis paniculata* in Prevention of Oxidative Stress-Induced Cellular Damage." Molecular and Cellular Biochemistry 310 (1–2): 1–7.
15. Yu, B. C., et al. 2008. "Andrographolide Stimulates Glucose Uptake in 3T3-L1 Adipocytes." Planta Medica 74 (2): 153–158.
16. Zhang, C., and B. K. Tan. 2000. "Antihyperglycemic and Antioxidant Properties of *Andrographis paniculata* in Diabetic Rats." Clinical and Experimental Pharmacology and Physiology 27 (5–6): 358–363.
17. Chandrasekaran, C., et al. 2012. "Review of Clinical Trials with *Andrographis paniculata*." Phytotherapy Research 26 (2): 227–233.
18. Wang, Jun, et al. 2019. "Andrographolide as an Anticancer Agent: A Review." Biomedicine & Pharmacotherapy 117: 109–117.
19. WHO. 2019. WHO Global Report on Traditional and Complementary Medicine 2019. Geneva: World Health Organization 20–50.
20. Gupta, S., et al. 2017. "Therapeutic Potential of Andrographolide against Cancer." Frontiers in Pharmacology 8: 571.
21. Hossain, M. S., et al. 2014. "Pharmacological and Toxicological Aspects of *Andrographis paniculata*." Journal of Pharmacognosy and Phytochemistry 3 (1): 98–104.
22. Kumar, R., and S. Verma. 2011. "Phytochemistry and Pharmacological Profile of *Andrographis paniculata*." International Journal of Pharmaceutical Sciences Review and Research 9 (2): 101–106.
23. Li, J., et al. 2017. "Immunomodulatory Activity of Andrographolide." International Immunopharmacology 52: 24–33.
24. Mahajan, A., et al. 2010. "Andrographolide: A Natural Product with Immense Therapeutic Potential." Indian Journal of Natural Products and Resources 1 (3): 292–300.
25. Mishra, S. K., and R. K. Yadav. 2014. "Clinical Applications of *Andrographis paniculata* and Andrographolide." Asian Pacific Journal of Tropical Biomedicine 4 (Suppl 1): S3–S8.
26. Panda, S., and A. K. Kar. 2015. "Biological Actions of Andrographolide in Health and Disease." Indian Journal of Experimental Biology 53 (6): 389–396.
27. Puri, A., et al. 1993. "Immunostimulant Activity of *Andrographis paniculata*." Journal of Ethnopharmacology 40 (1): 43–49.
28. Saxena, R. C., et al. 2010. "A Randomized Double-Blind Placebo-Controlled Clinical Trial of *Andrographis paniculata* in Upper Respiratory Tract Infections." Phytomedicine 17 (3–4): 178–185.
29. Sheeja, K., and G. Kuttan. 2007. "Immunomodulatory and Antitumor Activity



- of *Andrographis paniculata*.” International Immunopharmacology 7 (4): 401–409.
30. Srivastava, S., et al. 2004. “Hepatoprotective Effects of Andrographolide in Experimental Liver Injury.” Indian Journal of Medical Research 120 (6): 546–552.
31. Subramanian, R., et al. 2012. “*Andrographis paniculata* and Its Bioactive Phytochemicals: A Review.” Journal of Natural Remedies 12 (1): 1–15.
32. Tang, W., and G. Eisenbrand. 1992. Chinese Drugs of Plant Origin: Chemistry, Pharmacology, and Use in Traditional and Modern Medicine. Berlin: Springer.
33. Tan, W. S. D., et al. 2016. “Andrographolide and Its Derivatives: Versatile Biological Activities and Clinical Applications.” European Journal of Pharmacology 770: 96–116.
34. Thakur, A. K., et al. 2012. “Evaluation of Anti-Diabetic and Antioxidant Properties of *Andrographis paniculata*.” Journal of Pharmacy Research 5 (1): 241–245.
35. Unnati, S., et al. 2014. “*Andrographis paniculata* in Clinical Practice: Review of Efficacy and Safety.” International Journal of Green Pharmacy 8 (2): 69–75.
36. Vasu, S., et al. 2012. “Antimicrobial and Antioxidant Activity of *Andrographis paniculata*.” International Journal of Pharmacy and Pharmaceutical Sciences 4 (Suppl 2): 282–285.
37. Wang, Z., et al. 2010. “Andrographolide Inhibits Inflammatory Cytokine Production by Blocking NF- κ B Signaling Pathway.” Journal of Pharmacology and Experimental Therapeutics 332 (2): 506–514.
38. Xu, Y., et al. 2018. “*Andrographis paniculata* in the Treatment of Type 2 Diabetes Mellitus: A Review.” Frontiers in Pharmacology 9: 1294.
39. Yang, T., et al. 2012. “Pharmacokinetics and Bioavailability of Andrographolide.” Planta Medica 78 (14): 1529–1533.
40. Yende, S. R., et al. 2010. “Antimicrobial Activity of *Andrographis paniculata* Extracts.” International Journal of Phytomedicine 2 (3): 292–297.
41. Yu, A. L., et al. 2017. “*Andrographis paniculata*: A Review of Its Traditional Uses, Phytochemistry and Pharmacology.” Frontiers in Pharmacology 8: 344.
42. Zhang, Z., et al. 2014. “Andrographolide Exerts Anticancer Activity in Multiple Cancer Cell Lines.” Biomedicine & Pharmacotherapy 68 (6): 761–769.
43. Zhao, F., et al. 2013. “*Andrographis paniculata* and Its Major Compound Andrographolide: A Review of Traditional Use, Pharmacology and Toxicology.” Journal of Traditional and Complementary Medicine 3 (2): 105–112.
44. Zhu, Q., et al. 2015. “Immunomodulatory Effects of *Andrographis paniculata* Extract in Mice.” Phytomedicine 22 (2): 274–281.
45. Gupta, P. K., et al. 2018. “Clinical Evaluation of *Andrographis paniculata* in Liver Disorders.” Journal of Clinical and Diagnostic Research 12 (5): FC01–FC05.
46. World Health Organization. 2004. WHO Monographs on Selected Medicinal Plants, Volume 2. Geneva: WHO.
47. National Medicinal Plants Board (NMPB). 2015. *Andrographis paniculata* (Kalmegh): Cultivation and Therapeutic Uses. Ministry of AYUSH, Government of India.
48. Singh, A., et al. 2018. “Nanotechnology-Based Formulations of *Andrographis paniculata*: A New Horizon for Drug Delivery.” Journal of Drug Delivery Science and Technology 46: 400–407.
49. Zhao, L., et al. 2019. “Andrographolide: A Review of Its Pharmacology,



Pharmacokinetics, and Toxicology.” Frontiers in Pharmacology 10: 729.

50. Coon JT, Ernst E. *Andrographis paniculata* in the Treatment of Upper Respiratory Tract Infections: A Systematic Review. Planta Med. 2004;70(4):293–298.

HOW TO CITE: Avinash kumar, *Andrographis paniculata* (Kalmegh): A Comprehensive Review of Its Phytochemistry, Pharmacological Activities and Therapeutic Applications, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 7, 5443-4551, <https://doi.org/10.5281/zenodo.21492174>

