



Hepatoprotective Potential of *Andrographis paniculata* (Burm.f.) Wall. ex Nees: Mechanisms and Experimental Evidence – A Review

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Received: 14-11-2025; Revised: 28-01-2026; Accepted: 06-02-2026; Published online: 20-02-2026.

ABSTRACT

Andrographis paniculata (Burm.f.) Wall. ex Nees (family - Acanthaceae), popularly known as the “King of Bitters,” is a traditional medicinal plant that exhibits broad hepatoprotective effects in experimental models of liver injury. Its extracts and the major bioactive constituent, andrographolide, have been shown to normalize liver enzyme levels, reduce oxidative stress and inflammation, and preserve hepatic cellular structure against diverse chemical and drug-induced toxicities. These protective effects are primarily mediated through antioxidant activity, inhibition of lipid peroxidation, and modulation of inflammatory and apoptotic pathways. This review highlights the evidence-based hepatoprotective potential of *A. paniculata* against liver damage induced by various drugs, chemicals, and pathological conditions.

Keywords: *Andrographis paniculata*, King of Bitters, Hepatoprotective, Antioxidant, Antiinflammatory, Drug-induced liver damage.

INTRODUCTION

Liver is the largest organ in the human body plays a critical role in carbohydrate, lipid and protein metabolism. Furthermore, the liver performs vital role in the detoxification of variety of pharmaceutical drugs, environmental toxins and xenobiotics.¹ Excessive consumption of alcohol is the major cause affecting liver function, and addiction to junk foods, excessive use of drugs, lack of exercise and some viruses Hepatitis A, B, C, D and E can also causes liver problems. Both alcoholic and non-alcoholic causes results impairment in serum enzymes, globulin, albumin, prothrombin and bilirubin pigment levels also gets impaired and results in inflammation and deposition of fat in the liver known as steatosis which may lead to liver cancer.² Hepatic disease or dysfunction are gradually increasing in recent years, and World Health Organisation (WHO) has projected it as the eleventh most important cause of death in the world by 2030 and may be the tenth most common cause of death in India by 2020.³

Hence, the drug which could protect the liver from toxins and prevent liver disease would be a useful addition to the therapeutic agents currently available. In the absence of any such medicine in allopathy, there is an emerging focus on the scientific evaluation of traditional medicines which are claimed to possess hepatoprotective activity.⁴ The use of herbal drugs for the treatment of liver diseases is well documented in traditional medicine, and there are over 100 Ayurvedic formulations used as hepatoprotective drugs.⁵

Andrographis paniculata (Burm.f.) Wall. ex Nees (family - Acanthaceae), popularly known as “King of Bitters” (Sanskrit – Bhunimba, Malayalam – Nilaveppu, Tamil – Nilavembu) is a traditional medicinal plant widely distributed in Southeast Asia. The plant is annual erect much branched herb; stem sharply 4-angled; leaves simple, opposite, short-petioled, glabrous, elliptic to lanceolate,

narrowed at both ends, 10 × 2.5 cm; inflorescence in terminal and axillary panicles; flowers small, white with purplish blotches; fruit capsule, linear compressed; seeds 8-10 on retinacula.



This herb has been used throughout the centuries against different diseases especially for treating liver disorder in traditional systems like Siddha and Ayurveda, and demonstrated a number of various pharmacological actions such as anticancer, immunomodulatory, anti-inflammatory, antipyretic, hepatoprotective, hypotensive, hypoglycemic, antiplatelet and antithrombotic activity have well been reported.⁶ Traditionally the leaves are used for curing liver ailments in the following ways. The powdered leaves added with garlic are recommended along with buttermilk twice daily for jaundice remedial. Fresh or powdered leaves are recommended as liver tonic. The leaves and young twigs paste 20-30 g is given three times daily for treating jaundice. The leaf paste along with black pepper can be administered to jaundice patients in early morning for better cure.²

The therapeutic potential particularly hepatoprotective activity of *A. paniculata* attributed to a number of active phytocompounds, and the major diterpenoids found in leaves are andrographolide, neoandrographolide, kalmeghin, 14-deoxyandrographolide, andrographiside, 14-



deoxyandrographiside, 14-deoxy-11,12-didehydroandrographolide and 14-deoxy-11, 12-didehydro-andrographiside.⁷ The antihepatotoxic activities of *A. paniculata* have been proved by numerous studies. This review highlights the evidence-based hepatoprotective activities of *A. paniculata* against liver damage caused by various drugs, chemicals and other disorders.

MATERIALS AND METHODS

The present review comprises relevant research papers and review articles that provide the complete study of *A. paniculata* for hepatoprotective activities pertaining to liver function and the traditional and ethnobotanical uses. Extensive literature exploration on the hepatoprotective

properties of *A. paniculata* was conducted using specialised and dedicated search engines and websites like Google Scholar, PubMed, Science Direct, Sci-Hub, SciFinder, etc. The selected papers were examined for information such as study type, control group, disease type, measurement scale, dosage, intervention process, results and references.

HEPATOPROTECTIVE STUDIES OF ANDROGRAPHIS PANICULATA: EXPERIMENTAL EVIDENCE

Numerous experimental researches summarized in the table reveals that *Andrographis paniculata* extracts and its major bioactive constituent andrographolide exert significant hepatoprotective effects against chemically induced liver injury across diverse animal models.

Hepatoprotective Studies of *Andrographis paniculata*: Experimental Evidence

S. No.	Extract & Dose	Model / Toxin Exposure	Key Findings	Mechanism Indicated	Reference
1	Alcoholic extract 300 mg/kg	Rats; CCl ₄ - 1 mg/kg	↓ SGPT, ALP; improved liver morphology	Antioxidant, membrane stabilization	Rana & Avadhoot, 1991. ⁸
2	Aqueous leaf extract 12 mg/kg	Mice; BHC - 500 ppm/kg	Normalized SGPT, SGOT, ALP; ↓ tumors	Hepatoprotective, chemopreventive	Neha & Rawal, 1998. ⁹
3	Andrographolide 5–10 mg/kg	Mice; BHC - 500 ppm/kg	↑ GSH, SOD, CAT; ↓ LPO	Antioxidant enhancement	Neha et al., 2007. ¹⁰
4	Aqueous extract 200 & 400 mg/kg	Rats; Diclofenac - 150 mg/kg	↓ AST, ALT, ALP, LPO; ↑ antioxidants	Free radical scavenging	Soumendra et al., 2009. ⁶
5	Methanolic extract 10 & 100 mg/kg	Mice; Paracetamol - 500 mg/kg	Histological recovery	Cellular protection	Sutha Devaraj et al., 2010. ¹¹
6	Aqueous extract 50–200 mg/kg	Rats; Ethanol - 20% v/v	↓ Transaminases; less necrosis	Hepatocyte protection	Vetriselvan et al., 2010. ¹²
7	Aqueous leaf extract 250 mg/kg	Rats; Ethanol - 7.9 g/kg	↓ ALT, AST, ALP	↓ Lipid peroxidation	Sivaraj et al., 2011. ¹³
8	Ethanol extract 100, 200 & 300 mg/kg	Rats; CCl ₄ - 1.2 ml/kg	↓ LPO; ↑ antioxidant enzymes	Phenolic antioxidant activity	Pei Hoon Koh et al., 2011. ¹⁴
9	Aqueous extract 125 & 250 mg/kg	Rats; Gentamicin - 80 mg/kg	Restored antioxidant status	Oxidative stress reduction	Sivachandran & Hariharan, 2013. ¹⁵
10	Ethanol leaf extract 250 & 500 mg/kg	Rats; thioacetamide - 200 mg/kg,	↓ fibrosis, oxidative stress	Antioxidant + antiproliferative	Daleya et al., 2014. ¹⁶
11	Alcoholic 250 µg/mL; aqueous 800 µg/mL	Hepatocytes (Wistar mice); CCl ₄ - 15 mM	↑ Hepatocyte viability	Cytoprotection	Pallav & Ragini, 2015. ¹⁷
12	Aqueous extract 250 & 500 mg/kg	Rats; CCl ₄ - 1 ml/kg	↓ SGOT, SGPT, bilirubin	Hepatocyte regeneration	Alasyam et al., 2016. ¹⁸
13	Ethanol extract 500 mg/kg	Rats; Cisplatin - 7.5 mg/kg	↑ SOD, CAT, GPx; ↓ MDA	Antioxidant restoration	Rajendrakumar et al., 2020. ¹⁹
14	Aqueous extract 100 mg/kg	Rabbits; BHT - 1 mg/kg	↓ AST, ALT, TNF-α	Anti-inflammatory, detox support	Al Ibrahim et al., 2022. ²⁰
15	Ethanol extract 300 mg/kg	Rats; CCl ₄ - 0.1 ml/kg	↓ Transaminases, LPO	Free radical scavenging	Ali et al., 2023. ²¹
16	Aqueous extract 50, 100 & 200 mg/kg	Rats; CCl ₄ - 1.4 ml/kg	↓ ALT, AST; DNA protection	Cytoprotection	Abdel-Salam & Shaffie, 2023. ²²
17	Aqueous extract 500 mg/kg/	Rats; Methotrexate - 20 mg/kg	↓ TNF-α, IL-6, caspase-3	Anti-inflammatory, anti-apoptotic	Parthasarathy & Prince, 2023. ²³



18	Methanolic extract 100–400 mg/kg; andrographolide 10–20 mg/kg	Rats; CCl ₄ - 1% w/v	↓ AST, ALT, LPO	Antioxidant-mediated	Anju & Padmakshi, 2024. ²⁴
19	Ethanol extract 125–500 mg/kg/	Rats; Doxorubicin - Total 16 mg/kg	↓ ALP, IL-1 β	Anti-inflammatory	Oluebube et al., 2024. ²⁵
20	Extract 311 mg/kg	Rats; CCl ₄ 0.5 ml/kg; alcohol 3.75 ml/kg	↓ AST, ALT, ALP	Functional recovery	Majumdar et al., 2024. ²⁶
21	Methanolic extract 200 & 400 mg/kg	Rats; Aspirin - 10 mg/kg	↓ AST, ALT, MDA; ↑ SOD	Antioxidant	Arhoghro et al., 2024. ²⁷
22	Aqueous extract 200–1000 mg/kg	Rats; Sodium arsenite - 5 mg/kg	↓ ALT, AST, micronuclei	Hepatoprotective + antigenotoxic	Adegboyega et al., 2025. ²⁸

Abbreviation: SGPT - Serum Glutamate Pyruvate Transaminase, ALP – Alkaline Phosphatase, SGOT - Serum Glutamic Oxaloacetic Transaminase, GSH – Glutathione, SOD – Superoxide Dismutase, CAT – Catalase, LPO – Lipid peroxidation, AST - Aspartate Aminotransferase, ALT - Alanine Aminotransferase, GPx - Glutathione peroxidase, MDA – Malondialdehyde, TNF- α - Tumor Necrosis Factor-alpha, IL-6 - Interleukin-6, IL-1 β - Interleukin-1 beta.

CONCLUSION

Extensive experimental evidence from in vivo and in vitro studies demonstrates the hepatoprotective potential of *A. paniculata* across diverse models of liver injury. In chemical carcinogen-induced hepatotoxicity models, aqueous and purified andrographolide extracts significantly normalized hepatic marker enzymes, restored protein levels, reduced lipid peroxidation, enhanced antioxidant defenses, and inhibited neoplastic transformation, indicating both hepatoprotective and chemopreventive effects. In drug and toxin-induced liver injury models including paracetamol, ethanol, carbon tetrachloride, thioacetamide, cisplatin, butylated hydroxytoluene, methotrexate, doxorubicin, gentamicin and sodium arsenite, *A. paniculata* extracts consistently reduced serum transaminases, bilirubin, inflammatory cytokines, and oxidative stress markers, while improving antioxidant enzyme activities and preserving hepatic cellular structure.

Histopathological analyses across studies confirmed reduction of hepatocellular degeneration, necrosis, fibrosis, and fatty infiltration. Mechanistic investigations further revealed that these protective effects are mediated through antioxidant activity, suppression of lipid peroxidation, modulation of inflammatory responses, maintenance of cytochrome P450 function, and induction of apoptosis in hepatocellular carcinoma cells. Collectively, these findings establish *A. paniculata* and its bioactive constituent andrographolide as potent hepatoprotective agents with broad-spectrum efficacy against chemically induced liver damage. Overall, the cumulative preclinical evidence strongly supports *A. paniculata* as a multifunctional hepatoprotective agent, with mechanisms centered on antioxidant defense, inflammation control, apoptosis modulation, and preservation of hepatic structural integrity.

ACKNOWLEDGEMENT

The authors are thankful to Mr. Pradeep Cholayil (Chairman & Managing Director), Mrs. Jayadevi Pradeep Cholayil (Directress) and Anupam Katheriya (CEO) - Cholayil Private Limited for their constant support and encouragement.

Source of Support: The author(s) received no financial support for the research, authorship, and/or publication of this article

Conflict of Interest: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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