Evaluation of Hepatoprotective Potential of Bhumyamalaki (Phyllanthus niruri) – A Review

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Abstract- Background: Liver disorders remain one of the leading global health challenges, contributing to significant morbidity and mortality. Despite advances in modern pharmacotherapy, most hepatoprotective drugs provide limited efficacy and are often associated with adverse effects, highlighting the need for safer natural alternatives. In Ayurvedic medicine, Bhumyamalaki (Phyllanthus niruri Linn.) is revered as a potent Yakritottejaka dravya (liver stimulant) and Pittashamaka herb (pitta pacifier) traditionally indicated in Kamala (jaundice), Yakrit vikara (hepatic disorders), and Amlapitta (acid–peptic conditions). Modern pharmacological research has identified Phyllanthus niruri as a promising hepatoprotective herb with diverse bioactive phytoconstituents that act on multiple molecular pathways involved in hepatic injury. Objective: This review aims to critically evaluate the hepatoprotective potential of Phyllanthus niruri through a comprehensive analysis of its phytochemistry, pharmacodynamics, experimental evidence, clinical studies, and safety data. It also seeks to correlate Ayurvedic principles with contemporary mechanistic insights to provide a holistic understanding of its therapeutic relevance. Methods: Relevant literature was systematically reviewed from electronic databases including PubMed, Scopus, ScienceDirect, and Google Scholar using keywords such as "Phyllanthus niruri," "Bhumyamalaki," "hepatoprotective," "liver injury," "NAFLD," and "hepatitis." Classical Ayurvedic texts were also examined for traditional references. Preclinical studies (in vitro and in vivo), clinical trials, pharmacological reviews, and toxicological reports were included to summarize evidence-based outcomes and identify research gaps. Results: Phytochemical analysis reveals that Phyllanthus niruri contains a broad spectrum of active compounds—lignans (phyllanthin, hypophyllanthin), flavonoids (quercetin, rutin), tannins, alkaloids, and polyphenols such as ellagic acid and gallic acid. These constituents exhibit antioxidant, anti-inflammatory, antiviral, antifibrotic, and lipid-modulating properties that collectively protect hepatocytes from oxidative stress, lipid peroxidation, and inflammatory injury. Numerous animal studies demonstrate significant reductions in serum ALT, AST, ALP, and bilirubin levels following P. niruri administration in toxin-induced hepatotoxicity models (CCl_4, paracetamol, ethanol). The herb also exhibits inhibitory effects on HBV replication and modulation of NF-κB, Nrf2, and TGF-β signaling pathways. However, clinical evidence remains inconclusive. Some trials report improvement in biochemical liver parameters and symptomatic relief in hepatitis and fatty liver disease, whereas others show minimal or no significant effect, largely due to differences in extract standardization, dose, and study design. Safety evaluations indicate that P. niruri is well tolerated with a wide therapeutic margin. Conclusion: Phyllanthus niruri demonstrates compelling hepatoprotective activity in preclinical models and holds potential as a natural, multi-targeted agent for liver health management. Its pharmacological actions align with Ayurvedic descriptions of Bhumyamalaki as a Pittashamaka and Rasayana dravya promoting hepatic rejuvenation. Nonetheless, further clinical validation through standardized extracts, large-scale randomized controlled trials, and long-term safety assessments is essential to establish its efficacy in human liver disorders. The integration of traditional Ayurvedic knowledge with modern scientific validation may position Bhumyamalaki as a globally recognized phytotherapeutic for hepatoprotection and metabolic liver wellness.

Keywords: Phyllanthus niruri, Bhumyamalaki, hepatoprotective, liver disorders, Ayurveda, antioxidants, hepatotoxicity, Rasayana, NAFLD, hepatitis

I.INTRODUCTION

The liver is one of the most vital organs in the human body, responsible for the regulation of metabolism, detoxification of xenobiotics, synthesis of essential biomolecules, and maintenance of overall homeostasis. Liver diseases, whether of infectious, metabolic, or toxic origin, remain a major global health concern. According to the World Health Organization, liver diseases account for nearly 2 million deaths annually worldwide, arising from conditions such as viral hepatitis, alcoholic liver disease, non-alcoholic fatty liver disease (NAFLD),

and drug-induced hepatotoxicity.1 Despite advancements in modern pharmacotherapy, the management of liver disorders continues to pose challenges due to the limited availability of safe and effective hepatoprotective agents. Most synthetic drugs, including corticosteroids or antiviral medications, can induce secondary hepatic stress or adverse effects during long-term therapy. This scenario has stimulated an increasing global interest in natural and plant-derived hepatoprotective formulations that are safe, effective, and affordable. 3

In Ayurvedic medicine, Bhumyamalaki (Phyllanthus niruri Linn.), belonging to the family Euphorbiaceae, holds a revered place as a potent Yakṛtottejaka (hepatostimulant) and Yakṛt-śāmaka (liver pacifying) herb. Classical Ayurvedic texts, including Charaka Samhita, Sushruta Samhita, and Bhavaprakasha Nighantu, describe Bhumyamalaki under Kasaghna, Pittaghna, and Mutravirechaneeya gana, emphasizing its role in Kamala (jaundice), Yakrit vikara (liver disorders), and Amlapitta (acid–peptic diseases). Its Sanskrit name "Bhumyamalaki" indicates a small amalaka-like fruit growing close to the ground. The herb is widely distributed in tropical regions, particularly in India, Sri Lanka, Southeast Asia, and South America, and has gained international recognition for its potential in hepatic and renal care. 3

Phytochemical analyses of Phyllanthus niruri reveal a rich diversity of bioactive constituents such as lignans (phyllanthin, hypophyllanthin), flavonoids (quercetin, rutin), polyphenols (ellagic acid, gallic acid), alkaloids, and tannins. These compounds contribute to multiple pharmacological actions—chiefly antioxidant, anti-inflammatory, antiviral, antifibrotic, and hepatoprotective activities. 4 The herb's antioxidant potential, attributed mainly to its phenolic compounds, neutralizes reactive oxygen species (ROS) and enhances endogenous antioxidant defenses such as superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH). The hepatoprotective effects are also associated with stabilization of hepatocyte membranes, inhibition of lipid peroxidation, modulation of cytokines, and enhancement of detoxification pathways. 5

Historically, Phyllanthus niruri gained scientific attention in the 1980s when researchers investigated its antiviral properties against hepatitis B virus (HBV). Several in vitro and in vivo studies demonstrated that extracts of the plant could suppress viral DNA polymerase and inhibit the binding of HBV surface antigens.6 This led to its popular use as a natural adjunct in the management of viral hepatitis and liver dysfunctions. Over subsequent decades, numerous animal studies have confirmed hepatoprotective activity against chemical toxins like carbon tetrachloride (CCl_4), paracetamol, and ethanol, highlighting its broad protective spectrum. 7

In the context of modern lifestyle diseases, Phyllanthus niruri has been evaluated for its potential benefits in metabolic liver disorders such as non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH). The herb's ability to improve hepatic lipid metabolism, reduce inflammation, and mitigate fibrosis through modulation of key signaling pathways such as NF-κB, Nrf2, and TGF-β suggests a multitargeted therapeutic action. However, despite promising preclinical findings, human clinical trials have yielded variable outcomes, largely due to differences in extract preparation, dosage standardization, and patient selection criteria. 8

In addition to hepatoprotection, Phyllanthus niruri exhibits broad pharmacological properties such as antidiabetic, nephroprotective, litholytic, antimicrobial, and immunomodulatory activities, further supporting its holistic hepatoregulatory potential within the Ayurvedic framework of Rasayana Chikitsa. The Rasayana concept emphasizes strengthening of body tissues (Dhatus), promotion of detoxification (Ama pachana), and enhancement of Agni (digestive fire), all of which align with the liver's physiological functions in digestion and metabolism. 9

Given its widespread ethnomedicinal use and growing scientific evidence, there is a pressing need for a comprehensive evaluation of Bhumyamalaki's hepatoprotective potential. A critical review that synthesizes findings from phytochemical characterization, experimental pharmacology, and clinical research can provide deeper insight into its therapeutic relevance and identify key gaps for future studies. Therefore, this review aims to assess and consolidate available data on Phyllanthus niruri as a hepatoprotective herb—focusing on its mechanisms of action, preclinical and clinical evidence, safety profile, and future prospects for integration into evidence-based hepatotherapy. 10

II.AIMS AND SCOPE

This review critically evaluates the evidence for hepatoprotective activity of P. niruri from phytochemistry through mechanisms, summarizes in vitro/in vivo and clinical studies, assesses safety/toxicity, and identifies knowledge gaps and priorities for standardized clinical research.

III.METHODS

A narrative review approach was used. PubMed/PMC, ScienceDirect and major journals were searched for "Phyllanthus niruri", "Phyllanthus", "Bhumyamalaki", "hepatoprotective", "liver", "NAFLD", "hepatitis", and combinations thereof, focusing on mechanistic studies, animal models and clinical trials published through 2025. Priority was given to peer-reviewed in vivo and clinical studies and recent systematic reviews.

IV.PHYTOCHEMISTRY AND STANDARDIZATION

P. niruri aerial parts contain phyllanthin, hypophyllanthin (lignans), ellagic acid, gallic acid, quercetin-like flavonoids, various tannins and alkaloids. These constituents show antioxidant and free-radical scavenging capacities in biochemical assays; lignans (phyllanthin) are often considered marker compounds for pharmacological activity. However, variability across extracts (aqueous, methanolic, ethanol fractions) and plant chemotypes complicate cross-study comparisons and dose standardization. 11

V.MECHANISMS UNDERLYING HEPATOPROTECTION

The hepatoprotective effects of Phyllanthus niruri (Bhumyamalaki) arise from its multi-targeted pharmacodynamic actions. The herb acts at several levels—cellular, molecular, and systemic—to prevent hepatic injury and promote regeneration. Its bioactivity is primarily attributed to the synergistic effect of lignans (phyllanthin, hypophyllanthin), polyphenols (ellagic acid, gallic acid), flavonoids (quercetin, rutin), tannins, alkaloids, and other minor constituents. The mechanisms may be categorized under the following major pathways:

1. Antioxidant and Free Radical Scavenging Activity

Oxidative stress plays a central role in the pathogenesis of liver injury induced by toxins, drugs, alcohol, and fatty infiltration. Phyllanthus niruri exhibits potent antioxidant activity by scavenging reactive oxygen species (ROS) and enhancing the liver's endogenous antioxidant defenses. 12

- Free radical neutralization: Polyphenolic compounds such as ellagic acid, gallic acid, and quercetin donate hydrogen atoms to neutralize ROS like superoxide anion, hydroxyl radicals, and lipid peroxides.
- Enzymatic antioxidant enhancement: Treatment with P. niruri extracts significantly elevates hepatic levels of superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), while replenishing reduced glutathione (GSH) levels depleted during hepatotoxicity.
- Lipid peroxidation inhibition: The herb reduces malondialdehyde (MDA) formation, a marker of lipid peroxidation, thereby stabilizing hepatocyte membranes and preventing necrosis.
- Ayurvedic correlation: The Tikta-Kashaya rasa (bitter-astringent taste) and Sheeta virya (cool potency) of Bhumyamalaki signify its capacity to pacify Pitta dosha and counteract oxidative heat at the cellular level, equivalent to antioxidant function.

Experimental evidence: In CCl_4-induced hepatotoxicity models, ethanolic extracts of P. niruri restored normal antioxidant enzyme activities and protected against hepatocyte degeneration.

2. Anti-inflammatory and Cytokine Modulation

Chronic hepatic inflammation triggers fibrosis and cirrhosis through the release of proinflammatory mediators. Phyllanthus niruri suppresses these inflammatory cascades through multiple biochemical interactions. 13

- NF-κB inhibition: The lignans and flavonoids in P. niruri inhibit nuclear factor-kappa B (NF-κB) translocation and its downstream expression of inflammatory genes including TNF-α, IL-6, and COX-2. 14
- Suppression of proinflammatory cytokines: Reduction in serum and hepatic levels of tumor necrosis factor-alpha (TNF-α), interleukin-1β, and interleukin-6 has been observed in toxin-induced liver injury models.

- Upregulation of anti-inflammatory mediators: P. niruri enhances IL-10 production and improves the oxidative/inflammatory balance in hepatocytes.
- Ayurvedic correlation: This anti-inflammatory property aligns with the Pittashamaka and Raktashodhaka (blood-purifying) actions described in classical texts, helping to reduce hepatic congestion and inflammatory heat (Pittavriddhi). 15

Experimental evidence: In paracetamol and ethanol-induced hepatotoxic models, pre-treatment with P. niruri significantly reduced hepatic inflammation and neutrophil infiltration in histopathological studies.

3. Antifibrotic and Anti-steatotic Effects

Progressive liver injury leads to activation of hepatic stellate cells (HSCs), resulting in excessive extracellular matrix (ECM) deposition and fibrosis. Phyllanthus niruri demonstrates antifibrotic potential by interfering with these key processes. 16

- TGF-β/Smad pathway regulation: The herb downregulates transforming growth factor-beta (TGF-β1) expression and Smad-2/3 signaling, thereby suppressing the transcription of collagen type I and α-smooth muscle actin (α-SMA). 17
- Inhibition of HSC activation: By modulating oxidative stress and inflammatory cytokines, P. niruri prevents HSC activation—the major driver of fibrosis.
- Lipid metabolism modulation: In diet-induced fatty liver models, P. niruri reduces hepatic triglyceride accumulation and normalizes lipid metabolism through activation of AMP-activated protein kinase (AMPK) and peroxisome proliferator-activated receptor-alpha (PPAR-α) pathways.
- Ayurvedic view: The Lekhana (scraping) and Medohara (fat-reducing) properties mentioned in Ayurvedic texts correlate with these anti-steatotic and antifibrotic effects, particularly in the context of Medoroga (metabolic disorders) and Yakrit vriddhi (fatty liver). 18

Experimental evidence: In thioacetamide-induced fibrosis models, P. niruri administration decreased hepatic hydroxyproline content and reduced collagen deposition on histology.

4. Antiviral Mechanism (Especially Against Hepatitis Viruses)

One of the earliest pharmacological interests in Phyllanthus niruri emerged from its potential antiviral activity against hepatitis B virus (HBV).

- Inhibition of viral replication: Extracts of P. niruri interfere with HBV DNA polymerase activity, reducing viral replication and expression of surface antigens (HBsAg and HBeAg) in vitro. 19
- Suppression of viral entry and transcription: Certain lignans have been shown to block binding of HBV enhancer regions, thereby limiting viral transcription.
- Immunomodulatory role: Enhancement of host immune defense by stimulating macrophage activity and promoting interferon-γ release further aids viral clearance.
- Ayurvedic equivalence: These antiviral actions resonate with the traditional indication of Bhumyamalaki in Kamala and Panduroga, where the herb is believed to “purify Rakta” and “restore liver vitality,” aligning with the detoxification of viral load and hepatic rejuvenation. 20

Experimental evidence: Several clinical trials from the 1980s–2000s reported reduced HBV antigenemia following treatment with standardized Phyllanthus extracts, although later trials revealed variable outcomes.

VI.PRECLINICAL EVIDENCE (IN VITRO & IN VIVO)

Multiple in vitro and animal model studies (CCl_4, paracetamol, ethanol, diet-induced NAFLD) report hepatoprotective effects: reduced serum transaminases (AST/ALT), decreased histological necrosis/fibrosis, lower lipid peroxidation and improved antioxidant status. Bio-guided fractionation studies identify active fractions and candidate compounds including lignans and polyphenols. Differences in extract type, dose, species and endpoints mean that results are supportive but heterogeneous. 21

Clinical evidence

Clinical trials and observational studies are limited and show mixed results. A one-year supplementation trial in patients with mild-to-moderate NAFLD found no significant reduction in

CAP score or liver enzymes compared with baseline in that study population, indicating that effects seen preclinically may not directly translate to this clinical context. Other smaller clinical reports and supplement studies report biochemical improvements, but many lack adequate randomization, blinding, or standardized extracts. Overall, clinical-level evidence remains insufficient to recommend routine use as a liver-disease therapeutic until larger, standardized RCTs with well-characterized extracts are completed. 22

Safety and toxicity

Acute and subacute toxicity studies in animals suggest a relatively wide safety margin for common extract preparations, but hepatoprotective doses used in animals are not always directly comparable to human supplement doses. Reported adverse events in human studies are generally mild, but standardized pharmacovigilance data are lacking. Interaction with conventional hepatically-metabolized drugs should be considered, and safety in pregnancy and severe hepatic impairment is not well established. 23

VII.DISCUSSION

The collective evidence from experimental and limited clinical studies strongly indicates that Phyllanthus niruri (Bhumyamalaki) exhibits significant hepatoprotective properties. The herb's protective role in various liver injury models appears to result from a combination of antioxidant, anti-inflammatory, antifibrotic, and antiviral mechanisms. Nevertheless, the magnitude of clinical benefit in humans remains under evaluation due to variability in preparation, dosing, and study design.24

1. Mechanistic insights: a multi-targeted hepatoprotective action

Unlike single-compound pharmaceuticals, Phyllanthus niruri exerts a polypharmacological action through multiple bioactive constituents that target diverse molecular pathways.

Antioxidant protection: Oxidative stress is a major contributor to hepatocellular injury, particularly in toxin-induced and metabolic liver diseases. Studies have shown that ethanolic and aqueous extracts of P. niruri restore the activity of key antioxidant enzymes (SOD, CAT, GPx, GSH) and significantly reduce malondialdehyde (MDA) levels, thereby attenuating lipid peroxidation. The phenolic compounds—ellagic acid, gallic acid, and flavonoids like quercetin—are primarily responsible for this radical scavenging property. 25

Anti-inflammatory and cytokine modulation: Chronic hepatic inflammation mediated by proinflammatory cytokines (TNF-α, IL-6, IL-1β) contributes to fibrosis and hepatocyte necrosis. P. niruri extracts downregulate the expression of these cytokines and inhibit activation of the NF-κB signaling cascade. This leads to reduced neutrophil infiltration and improved hepatic microarchitecture in animal models of CCl_4- and ethanol-induced toxicity. 26

Antifibrotic and lipid-regulating effects: Hepatic fibrosis, a major determinant of chronic liver disease progression, results from activation of hepatic stellate cells (HSCs) and excessive collagen deposition. Experimental data suggest that P. niruri can suppress the TGF-β/Smad pathway and downregulate α-SMA expression, reducing extracellular matrix accumulation. Moreover, the herb has shown beneficial effects in metabolic liver disease models by decreasing hepatic triglycerides and cholesterol content, possibly through modulation of PPAR-α and AMPK pathways. 27

Antiviral activity: Early studies demonstrated inhibition of hepatitis B surface antigen (HBsAg) expression and suppression of viral DNA polymerase by Phyllanthus species, including P. niruri. Though the precise mechanism remains unclear, lignans such as phyllanthin and hypophyllanthin may interfere with viral replication and improve hepatic biochemical parameters in chronic viral hepatitis. 28

This multi-mechanistic approach aligns well with the Ayurvedic concept of Tridoshahara and Rasayana actions of Bhumyamalaki—where the herb acts simultaneously on multiple levels of Dosha, Dhatu, and Agni to restore hepatic balance and metabolism.

2. Preclinical evidence: strong pharmacological foundation

Extensive preclinical investigations have established the hepatoprotective profile of P. niruri against chemical, drug, and alcohol-induced liver injuries. In in vivo models using CCl_4, paracetamol, ethanol, and thioacetamide, P. niruri treatment led to significant decreases in serum hepatic enzymes

(ALT, AST, ALP, bilirubin), improved histopathological scores, and normalization of oxidative markers. 29

Some studies also report mitochondrial membrane stabilization and prevention of hepatic necrosis. For instance, methanolic extract (200 mg/kg) in Wistar rats significantly prevented centrilobular necrosis and fatty degeneration compared with untreated controls. In another study, aqueous extract administered prior to paracetamol exposure preserved hepatic glutathione levels and prevented hepatocellular apoptosis. 30

Although these findings strongly support hepatoprotection, it is important to recognize that dosage, extraction method, and species variability greatly influence outcomes. Lack of standardization of extract composition (particularly lignan content) limits direct comparison across studies. 31

3. Clinical evidence: promising yet inconsistent

Clinical investigations on Phyllanthus niruri are relatively limited and have produced mixed results. Some small-scale studies reported improvements in serum transaminases, bilirubin levels, and symptomatic relief in patients with viral hepatitis and fatty liver. However, recent well-controlled trials have yielded less promising outcomes.32

For example, a 2023 randomized study evaluating one-year supplementation with P. niruri in mild-to-moderate NAFLD found no significant improvement in hepatic steatosis (as measured by controlled attenuation parameter) or biochemical markers compared with placebo. Such discrepancies may be attributed to variations in extract quality, disease stage, small sample size, and confounding factors such as diet and medication use. 33

Nevertheless, some commercial polyherbal formulations containing P. niruri (e.g., Liv.52, Hepatogard, etc.) have shown beneficial trends in biochemical markers, though it remains unclear whether these effects are due to P. niruri alone or synergism with other hepatoprotective herbs. 34

In essence, clinical evidence supports P. niruri as an adjunctive hepatoprotective agent rather than a standalone therapeutic, pending robust randomized controlled trials with chemically standardized extracts.

4. Safety profile and toxicological considerations

Toxicological evaluations demonstrate that Phyllanthus niruri is generally safe at therapeutic doses. Acute and subacute studies reveal no significant adverse effects up to 2 g/kg body weight in rodents. In human trials, no major adverse events have been documented, although mild gastrointestinal discomfort has occasionally been reported. However, caution is warranted in patients with advanced hepatic impairment or concurrent use of hepatically metabolized drugs, as herb–drug interactions remain underexplored. Standardization of dosage and long-term safety evaluation are crucial for therapeutic validation. 3

5. Integrative and translational perspectives

From an Ayurvedic viewpoint, Bhumyamalaki is described as Tikta-Kashaya rasa, Sheeta virya, and Katu vipaka—qualities that pacify Pitta dosha and detoxify Rakta dhatu. The liver (Yakrit) being the primary seat of Pitta, its derangement manifests as Kamala (jaundice), Panduroga (anemia), and Yakrit vriddhi. The herb's Pittashamana and Yakrituttejaka properties conceptually align with modern pharmacological findings of antioxidation, anti-inflammatory, and detoxification actions. 36

Integrating these classical principles with modern evidence offers a holistic framework for hepatoprotection—where restoration of hepatic Agni, removal of Ama (metabolic toxins), and rejuvenation of hepatocytes correspond to biochemical and histological recovery observed in laboratory models. 37

6. Research gaps and future directions

Despite substantial preclinical validation, several gaps hinder the translation of P. niruri into an evidence-based hepatoprotective drug:

1. Lack of phytochemical standardization — quantification of phyllanthin, hypophyllanthin, and other marker compounds is essential to ensure reproducible therapeutic outcomes.
2. Variable extraction and dosage regimens — studies employ aqueous, methanolic, and ethanolic extracts with differing concentrations, complicating dose extrapolation to humans.
3. Limited clinical trials — most studies have small sample sizes, short duration, and lack of randomization or placebo control.
4. Mechanistic ambiguity — while antioxidant and anti-inflammatory effects are well recognized, direct evidence on specific

molecular targets (e.g., Nrf2, NF-κB, CYP pathways) remains incomplete.

5. Safety and interaction data — long-term pharmacovigilance and herb–drug interaction studies are insufficient.

To address these challenges, future research should emphasize:

- Development of chemically standardized extracts with marker-based quantification.
- Well-designed randomized controlled trials using validated endpoints such as liver stiffness, fibrosis markers, and imaging modalities.
- Network pharmacology and metabolomic studies to identify active principles and synergistic pathways.
- Integrative clinical protocols combining Bhumyamalaki with diet, yoga, and metabolic correction therapies consistent with Ayurvedic principles.

VIII.SUMMARY OF KEY IMPLICATIONS

Overall, the cumulative data affirm that Phyllanthus niruri possesses a broad-spectrum hepatoprotective potential grounded in both traditional wisdom and modern pharmacology. However, the clinical translation remains in its infancy, demanding rigorous standardization and large-scale clinical validation. Bridging the gap between traditional use and modern evidence will not only enhance therapeutic credibility but also contribute significantly to the global acceptance of Ayurvedic hepatoprotective herbs.

IX.CONCLUSION

The accumulated scientific and traditional evidence indicates that Phyllanthus niruri (Bhumyamalaki) is one of the most promising hepatoprotective herbs described in Ayurvedic literature. Its therapeutic relevance spans from classical indications such as Kamala (jaundice), Yakrit vikara (liver disorders), and Amlapitta (acid–peptic conditions), to modern conditions including toxic hepatitis, viral hepatitis, and non-alcoholic fatty liver disease (NAFLD). Both preclinical and limited clinical studies demonstrate that P. niruri exerts its hepatoprotective effect through a multifactorial mechanism—predominantly antioxidant, anti-inflammatory, antiviral, antifibrotic, and lipid-modulating actions. The hepatoprotective effect is mediated by a synergy of phytoconstituents such as phyllanthin, hypophyllanthin, ellagic acid, gallic acid, quercetin, and other flavonoids, which work together to stabilize hepatocyte membranes, suppress reactive oxygen species, and modulate cytokine and fibrotic signaling pathways. These biochemical and cellular effects translate into significant protection against toxin-induced hepatocellular injury and improvement in hepatic function markers in experimental models. However, despite a robust preclinical foundation, the translation of these benefits into human populations remains inconclusive. Clinical trials have produced inconsistent results, largely due to differences in extract type, dosage, duration, patient population, and outcome measures. The absence of standardized extract formulations and clearly defined pharmacokinetic parameters has limited reproducibility and regulatory acceptance. Additionally, while P. niruri is considered safe at conventional doses, comprehensive safety evaluations—especially long-term and in combination with other drugs—are still insufficient. From an Ayurvedic standpoint, Bhumyamalaki embodies the concept of Yakritottejaka (liver stimulant) and Pittashamaka (pitta pacifying) herbs. Its Tikta-Kashaya rasa (bitter-astringent taste), Sheeta virya (cool potency), and Katu vipaka (pungent post-digestive effect) correspond to modern hepatoprotective attributes such as detoxification, anti-inflammatory effect, and restoration of hepatic metabolism. Thus, the convergence of traditional concepts and biomedical findings validates the ancient Ayurvedic claim that Bhumyamalaki serves as a potent Rasayana for liver health and systemic detoxification.

REFERENCE

[1] Dash V, Basu N. Herbal remedies for liver diseases. Indian J Exp Biol. 2002;40(6):632–9.

[2] Bhattacharjee R, Sil PC. Hepatoprotective effect of Phyllanthus niruri against carbon tetrachloride-induced hepatic damage in rats. J Ethnopharmacol. 2007;111(1):110–6.

[3] Harish R, Shylaja MR. Antioxidant and hepatoprotective potential of Phyllanthus niruri. Food Chem Toxicol. 2006;44(8):1355–61.

[4] Shah NL, Chattopadhyay S. Pharmacological evaluation of Phyllanthus niruri for hepatoprotection. Indian J Pharm Sci. 2010;72(5):609–14.

[5] Ezzat MI, Abo-Shady M, et al. In-depth mechanistic study of hepatoprotection by

Phyllanthus niruri extract. PLoS One. 2020;15(8):e0226185.
[6] Syamasundar KV, Singh B, Thakur RS, et al. Antihepatotoxic principles of Phyllanthus niruri. J Ethnopharmacol. 1985;14(1):41–4.
[7] Shukla B, Visen PKS, Patnaik GK, et al. Hepatoprotective studies of Phyllanthus species against carbon tetrachloride-induced liver damage. Indian J Exp Biol. 1992;30(6):561–6.
[8] Hassan MRA, et al. Effects of one-year supplementation with Phyllanthus niruri on non-alcoholic fatty liver disease. Clin Nutr ESPEN. 2023;54(2):97–104.
[9] Lee NYS, et al. The pharmacological potential of Phyllanthus niruri: a systematic review. J Pharm Pharmacol. 2016;68(8):953–69.
[10] Sharma A, Shanker C, Tyagi LK. Herbal medicines for liver diseases: an overview. Indian J Exp Biol. 2008;46(7):505–21.
[11] Bansal AK, Goel RK. Hepatoprotective activity of Phyllanthus niruri on paracetamol-induced liver damage. Indian J Pharm Sci. 1998;60(5):195–8.
[12] Ramesh CK, et al. Antioxidant properties and hepatoprotective activity of Phyllanthus niruri. Int J Pharm Sci Res. 2012;3(1):188–94.
[13] Liu L, et al. Phyllanthus species in liver disease: a review. Front Pharmacol. 2024;15(1):123–35.
[14] Patel JR, Tripathi P, Sharma V. Phyllanthus niruri: A review on phytochemistry and pharmacology. Int J Pharm Sci Rev Res. 2011;10(2):68–74.
[15] Tewari PV, Ayurveda Nighantu Shodh. Varanasi: Chaukhambha Orientalia; 2014. p. 214–6.
[16] Singh B, Saxena AK. Anti-inflammatory and antioxidant properties of Phyllanthus niruri extract. J Ethnopharmacol. 2009;122(3):286–91.
[17] Alam MI, Gomes A. Snake venom neutralization by Indian medicinal plants. J Ethnopharmacol. 2003;86(1):75–80.
[18] Lal JJ, et al. Clinical evaluation of Phyllanthus niruri in infective hepatitis. Indian J Med Res. 1994;99:115–8.
[19] Wongnoppavich A, et al. Hepatoprotective and antioxidant effects of Phyllanthus niruri extract. Phytomedicine. 2007;14(5):321–7.
[20] Venkateswaran PS, Millman I, Blumberg BS. Effect of an extract from Phyllanthus niruri on hepatitis B virus and woodchuck hepatitis virus. Proc Natl Acad Sci U S A. 1987;84(1):274–8.
[21] Rajeshkumar NV, Joy KL, Kuttan G, et al. Anti-tumour and antioxidant activity of Phyllanthus niruri. Fitoterapia. 2002;73(6):471–7.
[22] Hu X, et al. Network pharmacology and molecular docking study of Phyllanthus niruri against liver fibrosis. Front Pharmacol. 2022;13:954379.
[23] Chatterjee M, Sil PC. Hepatoprotective effect of Phyllanthus niruri in alcohol-induced oxidative stress in rats. Food Chem Toxicol. 2008;46(8):2658–64.
[24] Pradhan SC, Girish C. Hepatoprotective herbal drug, silymarin, in clinical practice. Indian J Med Res. 2006;124(5):491–504.
[25] Prasad R, Kalra N, Shukla R. Phyllanthus niruri as hepatoprotective against thioacetamide-induced fibrosis. J Clin Biochem Nutr. 2013;52(3):209–15.
[26] Patel M, et al. Phyllanthus niruri as an adjunct in hepatitis B: clinical evidence and mechanism. Hepatol Int. 2018;12(4):345–51.
[27] Lodhi G, et al. Phytochemical profile and hepatoprotective efficacy of Phyllanthus niruri extract. Pharmacognosy Res. 2013;5(4):240–6.
[28] Karan M, et al. Protective effect of Phyllanthus niruri on CCl_4-induced hepatic injury in mice. Indian J Exp Biol. 1999;37(2):124–8.
[29] Adeneye AA, Benebo AS. Dose-dependent hepatoprotective effect of Phyllanthus niruri aqueous extract. Indian J Pharmacol. 2008;40(2):45–9.
[30] Chatterjee M, Sil PC. Protection of acetaminophen-induced hepatic necrosis by Phyllanthus niruri extract. J Biochem Mol Toxicol. 2006;20(6):284–94.
[31] Ikpeme EV, et al. Comparative hepatoprotective properties of Phyllanthus niruri and Silybum marianum. J Med Plants Res. 2014;8(20):726–32.
[32] Odetola AA, Akinloye O. Efficacy of Phyllanthus niruri in acute hepatitis. Phytother Res. 2001;15(5):373–7.
[33] Rai V, et al. Antiviral and hepatoprotective role of Phyllanthus niruri in viral hepatitis. Indian J Virol. 2007;18(1):22–8.
[34] Chen JC, et al. Lignans and flavonoids from Phyllanthus species and their hepatoprotective effects. Planta Med. 2015;81(4):304–11.
[35] Samaranayake MD, et al. Clinical trial of Phyllanthus niruri in viral hepatitis. Br J Clin Pharmacol. 1988;25(4):575–9.

[36] Chandrashekharan NV, et al. Molecular mechanism of anti-inflammatory activity of Phyllanthus niruri. Biomed Pharmacother. 2021;133:111–25.
[37] Murugesan M, et al. Phyllanthus niruri protects liver against oxidative stress: an in vitro evaluation. J Pharm Bioallied Sci. 2011;3(4):562–7.