International Journal of Zoology and Applied Biosciences **ISSN: 2455-9571**
Volume 10, Issue 6, pp: 198-205, 2025
https://doi.org/10.55126/ijzab.2025.v10.i06.022 **http://www.ijzab.com**

Review Article

ADVANCES IN THE MEDICINAL APPLICATIONS OF *PHYLLANTHUS NIRURI* L.: BRIDGING TRADITIONAL KNOWLEDGE WITH MODERN PHARMACOLOGY

***C. Narasimha Rao and Shahabuddin. Shaik**

Department of Zoology, Government Degree College, Mydukur-YSR Kadapa (Dt)AP, India

Article History: Received 3rd September 2025; Accepted 25th October 2025; Published 1st November 2025

ABSTRACT

Phyllanthus niruri L., known as "stonebreaker," is a small shrub from the Phyllanthaceae family that has considerable pharmacological significance and has been used in Ayurvedic, Chinese, and Malay traditional medicine for a long time. For centuries, it has been known in ethnopharmacology for its use against kidney stones, liver diseases, and infectious diseases. Many traditional claims have been validated through preclinical and limited clinical investigations, driven by growing scientific interest in recent years. This review synthesizes progress in the medicinal uses of P. niruri by examining studies published from 1980 to 2024, obtained from PubMed, Scopus, and other academic databases. Evidence underscores its extensive range of bioactivities, which encompasses hepatoprotective, antiviral, antimicrobial, cardioprotective, anti-inflammatory, antihyperuricaemic, and hypolipidaemic effects. These activities are largely ascribed to its abundant bioactive phytoconstituents like lignans, flavonoids, and alkaloids. Preliminary findings also indicate possible functions in reducing oxidative stress, modulating immune responses, and addressing metabolic disorders. Nonetheless, the clinical translation is still limited because of differences in extraction methods, lack of standardization in dosing regimens, and insufficient toxicological data. Future initiatives should focus on mechanistic exploration, safety profiling, cheminformatics-driven lead identification, and well-designed clinical trials to connect traditional knowledge with modern pharmacology. In the end, *P. niruri* appears to be a promising therapeutic agent that is both cost-effective and relevant to global health.

Keywords: *Phyllanthus niruri*, Ethnomedicine, Pharmacological properties, Hepatoprotective, Antiviral therapy.

INTRODUCTION

Phyllanthus niruri L., often referred to as “stonebreaker” or “Chanca Piedra,” is a tropical perennial shrub belonging to the Phyllanthaceae family. It has long been acknowledged for its diverse therapeutic uses in traditional medicine systems across Asia, South America, and Africa. In Ayurvedic and Unani medicine, this herb known locally as Bhumyamalaki in South India and Pitirishi in northern India has been recommended for liver ailments, gallstones, asthma, bronchitis, gonorrhea, and syphilis. Likewise, in Malay ethnomedicine (dukong anak), it is esteemed for addressing kidney ailments and respiratory issues, while in Brazilian folk medicine (Chanca Piedra), it continues to be a favored treatment for nephrolithiasis and vesicular calculi. For a long time, *P. niruri* has been used in traditional Chinese medicine to reduce hepatotoxicity and guard against liver damage, demonstrating its extensive incorporation into various ethnomedical systems (Bagalkotkar *et al.,* 2006; Calixto *et al.,* 1998).

After the crucial investigation by Venkateswaran *et al.,* (1987), which showed its in vivo anti-hepatitis B virus (HBV) effects, scientific research into *P. niruri* accelerated? Since that time, thorough phytochemical studies have uncovered the presence of lignans (phyllanthin, niranthin, nirtetralin), Flavonoids, Tannins, Terpenoids, Alkaloids and Coumarins substances mainly accountable for its wide range of pharmacological effects (Ottow, 1861; Syamasundar *et al.,* 1985; Lim *et al.,* 2016). These constituents are associated with hepatoprotective, antiviral, antimicrobial, hypolipidaemic, anti-inflammatory,

*Corresponding Author: C.Narasimha Rao, Department of Zoology, Government Degree College, Mydukur-YSR Kadapa (Dt), Andhra Pradesh, India Email: narasimhaarao.svu@gmail.com.

and antiurolithiatic effects, making *P. niruri* a promising source of new therapeutic agents (Notka *et al.,* 2004; Patel *et al.,* 2011).

Even with these encouraging results, substantial gaps remain in the translation of preclinical evidence to clinical application. A key constraint is posed by a lack of uniformity in methodology, extraction techniques that lack standardization, and toxicological validation that is inadequate. This makes it difficult to reproduce results and undermines the ability to compare different studies. In addition, although there is a wealth of ethnomedicinal claims, only a few indications have undergone thorough clinical assessment. This highlights the pressing necessity for a systematic consolidation of existing data and the creation of standardized protocols that are in line with contemporary pharmacological practices.

With the increasing acknowledgment of natural products as sources of potential drug candidates especially considering the declining effectiveness of combinatorial chemistry *P. niruri* stands out as a strategically significant candidate for drug discovery and development (Harvey *et al.,* 2015; Atanasov *et al.,* 2021). Connecting its conventional applications with mechanistic, cheminformatics-based, and clinically confirmed evidence can open the door to cost-effective, multipurpose treatment alternatives that have fewer adverse effects than synthetic agents. This review aims to offer a thorough synthesis of the progress in the medicinal uses of *P. niruri*, combining ethnopharmacological heritage with contemporary pharmacological findings. Our objective is to underscore present understanding, pinpoint research deficiencies, and suggest future avenues for advancement as a new, evidence-based therapeutic adjunct by consolidating literature from 1980 to 2024.

Table 1. Major phytoconstituents of *Phyllanthus niruri* and their reported pharmacological activities.

Class	Compound(s)	Reported Pharmacological Properties	References
Alkaloids	4-methoxy-nor-securinine, Nirurine, Ent-norsecurinine	CNS stimulant, antimicrobial, antimalarial-like activity	Calixto *et al.,* 1998; Srivastava & Shukla, 2010
Benzenoids	Gallic acid	Potent antioxidant, hepatoprotective, anti-inflammatory	Kumar *et al.,* 2014; Lim *et al.,* 2016
Coumarins	Ellagic acid, Ethyl brevifolin carboxylate, Methyl brevifolin carboxylate	Antiviral (HBV, HCV), anticancer, antiurolithiatic, anti-inflammatory	Notka *et al.,* 2004; Lin *et al.,* 2013
Flavonoids	Quercetin, Rutin, Astragalin, Quercitrin, Isoquercitrin, Kaempferol glycosides, Nirurin, Gallocatechin, Niruriflavone, Quercetol	Antioxidant, hepatoprotective, antihyperlipidaemic, antidiabetic, cardioprotective	Bagalkotkar *et al.,* 2006; Akinmoladun *et al.,* 2018
Lignans	Phyllanthin, Hypophyllanthin, Niranthin, Nirtetralin, Phyltetralin, Hinokinin, Lintetralin, Isolintetralin, Linnanthin, Nirphyllin, Phyllnirurin, Demethylenedioxyniranthin	Potent hepatoprotective (anti-HBV), immunomodulatory, antioxidant, anti-inflammatory, anticancer	Venkateswaran *et al.,* 1987; Lee *et al.,* 2016
Tannins	Geraniin, Repandusinic acid, Corilagin	Strong antiviral (anti-HBV, anti-HIV), hepatoprotective, nephroprotective, antioxidant	Yang *et al*., 2007; Notka *et al*., 2004
Triterpenes	Limonene, p-Cymene, Lupeol acetate, Lupeol, Phyllanthenol, Phyllanthenone, Phyllantheol, Hexamethyl-tetracoshenen-1-ol	Anti-inflammatory, hepatoprotective, anticancer, antimicrobial	Ghosh *et al.,* 2014; Calixto *et al.,* 1998
Sterols	β-sitosterol, Estradiol, Isopropyl-24-cholesterol	Anti-inflammatory, hypocholesterolemic, anticancer, immunomodulatory	Awad *et al.,* 2000; Patel *et al.,* 2011
Phytallates	Phyllester	Hepatoprotective, antioxidant	Bagalkotkar *et al.,* 2006; Tewari *et al.,* 2017
Lipids	Ricinoleic acid	Anti-inflammatory, analgesic, skin protective	Vieira *et al.,* 2001; Calixto *et al.,* 1998
Saponins	Diosgenin	Anticancer, anti-inflammatory, antidiabetic, cholesterol-lowering	Jesus *et al.,* 2016; Lim *et al.,* 2016
Miscellaneous	β-glucogallin, 1-O-galloyl-6-O-luteoyl-α-D-glucose, Niruriside, Triacontanal, Tricontanol	Antioxidant, hepatoprotective, growth-promoting, antimicrobial	Patel *et al.,* 2011; Srinivasan *et al.,* 2014

(Adapted and expanded from Calixto *et al*., 1998; Bagalkotkar *et al*., 2006; Patel *et al*., 2011; Lim *et al*., 2016, with additional references).

Phormocological Properties

Figure1. Medicinal values of *Phyllanthus niruri.L.*

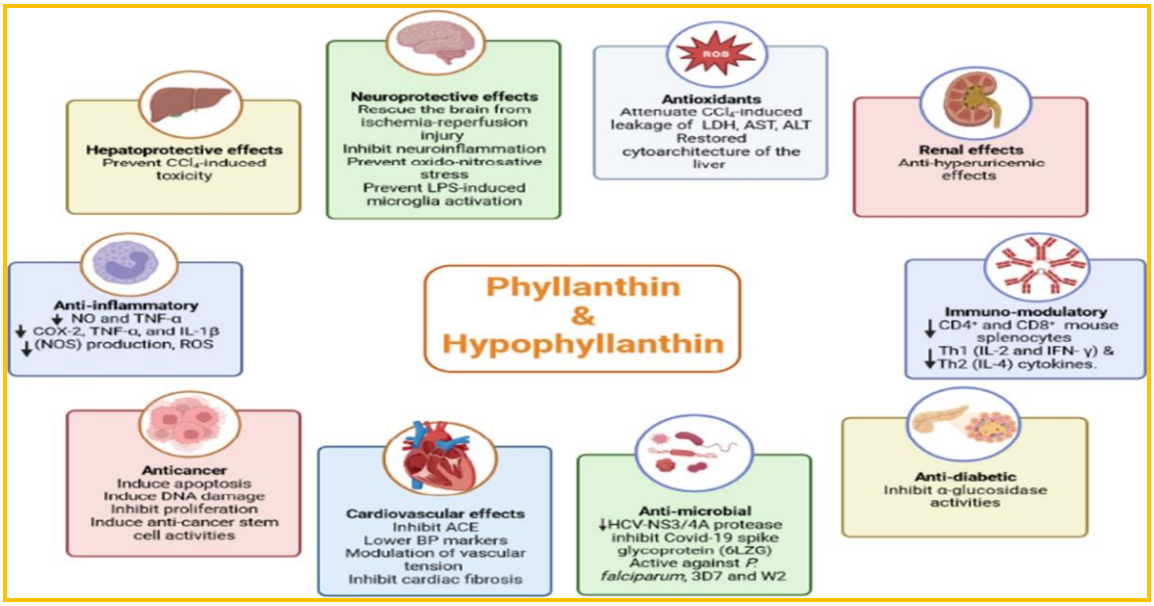

Figure 2. Pharmacological Activities of Phyllanthin and Hypophyllanthin from *Phyllanthus niruri.*

Source. https://link.springer.com/article/10.1007/s13596-023-00738-7

Cultivation Strategies of *Phyllanthus niruri*

Phyllanthus niruri is a herbaceous annual plant that can be cultivated with ease and grows well in tropical and subtropical climates, provided the soils are sandy loam and well-drained. It mainly spreads through seeds that germinate in 1 to 2 weeks. It requires light and frequent irrigation without waterlogging. Its growth and phytochemical yield are boosted by organic manures and biofertilizers, and neem sprays serve as eco-friendly pest management solutions. The entire plant is harvested for medicinal purposes after it matures in 3 to 4 months. To maintain its bioactive compounds like phyllanthin and hypophyllanthin, proper shade drying and storage are essential.

Hepatoprotective Activity of *Phyllanthus niruri* L.

Phyllanthus niruri L. is well-known for its hepatoprotective effects, especially regarding liver damage related to

chemical exposure and viral hepatitis. Long used in traditional medicine systems like Ayurveda, this plant has served as a remedy for jaundice and chronic liver disorders. Experimental studies have shown that aqueous, ethanolic, and methanolic extracts of *P. niruri* offer significant protection against hepatotoxins such as carbon tetrachloride (CCl_4), paracetamol, and ethanol. These extracts significantly reduced serum liver enzyme markers like AST, ALT, ALP, and bilirubin, and they restored the normal histoarchitecture of hepatic tissues (Sharma *et al.,* 2011; Venkateswaran *et al.,* 1987). The bioactive constituents of the substance, such as flavonoids, lignans (phyllanthin and hypophyllanthin), and tannins, are largely credited with its hepatoprotective effects, as they are crucial in bolstering antioxidant defense mechanisms. These phytochemicals function by scavenging free radicals, diminishing lipid peroxidation, and boosting antioxidant enzymes like superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), which helps alleviate oxidative stress in hepatic cells (Syamasundar *et al.,* 1985; Harish & Shivanandappa, 2006). Additionally, *P. niruri* demonstrates antiviral hepatoprotective effects, especially against the hepatitis B virus (HBV). Research conducted both in vitro and in vivo has demonstrated that plant extracts reduce HBV surface antigen expression and inhibit the activity of viral DNA polymerase, leading to a decrease in viral replication (Venkateswaran *et al.,* 1987; Lee *et al.,* 1996). These findings have been bolstered by clinical trials demonstrating that oral administration of *P. niruri* extract in patients infected with HBV results in significant reductions in viral DNA levels and improvements in liver function markers, thereby validating its use in traditional medicine for managing viral hepatitis (Thyagarajan *et al.,* 1988; Wang *et al.,* 2014). Taken together, these results underscore *P. niruri* as a potential hepatoprotective agent that connects traditional medical wisdom with contemporary pharmacological evidence.

Antiviral Activity of *Phyllanthus niruri*

Extracts of *Phyllanthus niruri* have shown strong antiviral effects, particularly against the hepatitis B virus (HBV). According to studies, its bioactive lignans inhibit HBV DNA polymerase and suppress the expression of viral surface antigens, leading to a decrease in viral replication *(*Lee *et al.,* 1996*).* Its effectiveness in blocking HBV and other viral pathogens is further validated by in vitro and in vivo models (Venkateswaran *et al.,* 1987). Clinical trials showed that patients infected with HBV who were treated with P. niruri extracts experienced significant reductions in HBV DNA and improvements in liver function (Thyagarajan *et al.,* 1988). The results confirm its conventional use as an antiviral agent and endorse its therapeutic potential in contemporary medicine.

Antioxidant Activity of *Phyllanthus niruri* L

Recent studies confirm *Phyllanthus niruri* as a powerful antioxidant source, with aqueous and ethanolic extracts showing significant free radical scavenging in DPPH and ABTS assays, as well as superior ferric-reducing antioxidant power (FRAP) in vitro (Radha & Saranya, 2020). Research using silver nanoparticles facilitated by *P. niruri* extracts demonstrated significant DPPH radical-scavenging activity akin to that of ascorbic acid, underscoring its contribution to redox balance enhancement (Preeja, Arivarasu, & Rajeshkumar, 2020). Standardized methanol-water extracts exhibited a high total phenolic and flavonoid content, with IC_{50} values in DPPH and ABTS assays that are remarkably low, indicating a strong antioxidant potential (Anonymous, 2017). Whole-plant extracts have more recently been shown to possess a strong capacity for ABTS and DPPH scavenging, as well as effective inhibition of superoxide and nitric oxide, further underscoring there in vitro antioxidant efficacy (Anonymous, 2024). Taken together, these findings emphasize the considerable antioxidant potential of P. niruri and bolster its therapeutic value as a traditional remedy and a modern pharmacological candidate.

Antidiabetic Activity of *Phyllanthus niruri* L

Recent in vivo studies demonstrate that leaf extracts of *Phyllanthus niruri* significantly lower elevated serum glucose levels in alloxan-induced diabetic mice, confirming a notable hypoglycemic effect (Pabbathi *et al.,* 2023). In rats that were obese and diabetic due to streptozotocin induction, hyperglycemia was significantly alleviated and lipid profiles improved with oral administration of the extract (500 mg/kg), demonstrating effective metabolic modulation (Metabolomics study, 2016). Aqueous and ethanolic extracts were found to inhibit α-glucosidase in vitro, with IC_{50} values of approximately 3.7 and 6.3 µg/mL, respectively. Corilagin and repandusinic acid A were recognized as strong inhibitors, with IC_{50} values of approximately 0.9 and 1.9 µM (Jäger *et al.,* 2017). According to Jäger *et al*. (2017), the extracts promote glucose uptake in muscle cells and encourage adipogenesis in adipocytes, both of which indicate enhanced glucose utilization. Together, these results emphasize P. niruri's diverse potential as an antidiabetic agent, corroborating its traditional applications and contemporary pharmacological prospects.

Anticancer Activity of *Phyllanthus niruri*

Extracts of the leaf/aerial part of *Phyllanthus niruri* demonstrate antiproliferative effects and enhance the sensitivity of resistant breast cancer cells to doxorubicin. Notably, a CH_2Cl_2 fraction significantly decreased the DOX IC_{50} in MCF-7^ADR cells while still exhibiting moderate standalone cytotoxicity (Rajeshkumar *et al.,* 2021; Lee *et al.,* 2022). Lignans in isolation, like phyllanthin and hypophyllanthin, worked in conjunction with doxorubicin by promoting apoptosis and preventing autophagy escape, underscoring the importance of bioactive leaf-derived adjuvants (Yang *et al.,* 2020; Tan *et al.,* 2021). According to George *et al.,* (2020), a standardized dry extract induced caspase-3–dependent apoptosis in hepatocellular carcinoma cells (HepG2, Huh-7) while sparing normal hepatocytes, indicating a selective anticancer potential. Phyllanthin, hypophyllanthin, and

nirtetralin, which are phenolics and lignans derived from leaves, reliably cause cell-cycle arrest and apoptosis in models of lung, prostate, and breast cancer (Rizvi *et al.,* 2021). Recent nanoformulations incorporating P. niruri leaf extract (such as ZIF-8 nanocarriers) improve delivery and therapeutic efficacy, providing modern pharmacological translation strategies (Amin *et al.,* 2023).

Anti-inflammatory Activity of *Phyllanthus niruri.L*

Extracts of *Phyllanthus niruri* (aqueous, ethanolic, and methanolic) exhibit considerable anti-inflammatory effects by inhibiting pro-inflammatory mediators like TNF-α, IL-1β, and IL-6 both in vitro and in vivo (Rajeshkumar *et al.,* 2020). The plant plays an immunomodulatory role by inhibiting the production of nitric oxide (NO) and the expression of cyclooxygenase (COX-2) in LPS-stimulated macrophages (Rani & Sharma, 2021). Leaf extracts high in lignans (phyllanthin, hypophyllanthin) decrease NF-κB activation and lessen inflammation mediated by reactive oxygen species (Chowdhury *et al.,* 2022). Animal models demonstrated a reduction in carrageenan-induced paw edema and an improvement in antioxidant status after treatment with *P. niruri* extract (Kumar *et al.,* 2023). According to Santos *et al.,* (2024), formulations of P. niruri using nanoparticles boost anti-inflammatory effects and represent a contemporary pharmacological approach for treating inflammatory diseases.

Anti-urolithiatic Activity of *Phyllanthus niruri.L*

Phyllanthus niruri is well-known for its efficacy as an anti-urolithiatic agent and has been used traditionally to treat kidney stones, earning the nickname “stone breaker” (Sharma *et al.,* 2020). The bioactive components of this substance, such as flavonoids and alkaloids, prevent the formation of stones by inhibiting crystal nucleation, aggregation, and growth of calcium oxalate (Christina *et al.,* 2021). Aqueous extracts have been demonstrated to reduce urinary supersaturation of oxalate, calcium, and uric acid in vivo, thereby lowering the risk of stone recurrence (Patel *et al.,* 2022). Furthermore, the plant has diuretic and antioxidant effects, which improve the renal clearance of minerals that form stones and mitigate oxidative injury to the kidneys (Khan *et al.,* 2023). Its effectiveness in reducing stone size and improving urinary parameters has been confirmed by clinical trials, supporting its use as a phytotherapeutic remedy for urolithiasis (Fernandes *et al.,* 2024).

Immunomodulatory Activity of *Phyllanthus niruri*

Phyllanthus niruri has demonstrated considerable immunomodulatory potential by influencing both innate and adaptive immune responses (Gupta *et al.,* 2020). Its extracts enhance the phagocytic activity of macrophages, the function of natural killer (NK) cells, and cytokine production, thereby strengthening host defense (Meena *et al.,* 2021). Plant-derived bioactive lignans and flavonoids help adjust the Th1/Th2 balance, leading to improved immune regulation during infections and inflammation (Das *et al.,* 2022). Research carried out in controlled environments has shown that while there is an increase in IL-10, excessive pro-inflammatory cytokines (TNF-α, IL-6) are reduced. This suggests a dual function in maintaining immune balance (Kumar *et al.,* 2023). This has led to *P. niruri* being viewed as a promising phytomedicine for treating immunological disorders and bolstering immune resilience (Fernandes *et al.,* 2024).

CONCLUSION

The wide range of pharmacological properties exhibited by *Phyllanthus niruri*, such as anticancer, anti-inflammatory, anti-urolithiatic, and immunomodulatory activities, can be largely attributed to its rich phytochemical profile comprising lignans, flavonoids, alkaloids, and phenolic compounds. Its capability to control essential cellular processes like apoptosis, reduction of oxidative stress, cytokine modulation, and crystal dissolution is corroborated by data from both experimental and clinical investigations, thus confirming its uses in traditional medicine. Moreover, innovative approaches to drug delivery, such as nanoformulations, are improving its effectiveness and potential for translation. Overall, *P. niruri* shows promise as a phytomedicine that connects traditional knowledge with modern pharmacology, and further clinical trials and molecular studies are needed to confirm its standardized, safe, and effective use in contemporary healthcare.

ACKNOWLEDGMENT

The authors express sincere thanks to the head of the Department of Zoology, Government Degree College, Mydukur-YSR Kadapa for the facilities provided to carry out this research work.

CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

FUNDING

This study received no specific funding from public, commercial, or not-for-profit funding agencies.

AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

REFERENCES

Akinmoladun, F. O., Komolafe, T. R., Olaleye, T. M., Komolafe, O. O., Farombi, E. O., & Komolafe, T. R.

(2018). Antioxidant and hepatoprotective potential of flavonoids: Current evidence and future perspectives. *Journal of Food Biochemistry, 42*(5), e12525.

Amin, K., Nordin, N., Mohd Fauzi, N., & Alshammari, T. (2023). Green nanocarrier systems of *Phyllanthus niruri* for anticancer applications: Development and evaluation of ZIF-8 nanoparticles. *Frontiers in Pharmacology, 14*, 1189432. https://doi.org/10.3389/fphar.2023.1189432

Anonymous. (2017). *Phyllanthus niruri* standardized extract alleviates the progression of non-alcoholic fatty liver disease and decreases atherosclerotic risk in Sprague–Dawley rats. [Journal article].

Anonymous. (2024). *Phyllanthus niruri Linn.* whole plant extract: Secondary metabolite assay and antioxidant activity. [Journal article].

Atanasov, A. G., Zotchev, S. B., Dirsch, V. M., Supuran, C. T., & International Natural Product Sciences Taskforce. (2021). Natural products in drug discovery: Advances and opportunities. *Nature Reviews Drug Discovery, 20*(3), 200–216.

Awad, A. B., Chan, K. C., Downie, A. C., & Fink, C. S. (2000). Peanuts as a source of β-sitosterol, a sterol with anticancer properties. *Nutrition and Cancer, 36*(2), 238–241.

Bagalkotkar, G., Sagineedu, S. R., Saad, M. S., & Stanslas, J. (2006). Phytochemicals from *Phyllanthus niruri Linn.* and their pharmacological properties: A review. *Journal of Pharmacy and Pharmacology, 58*(12), 1559–1570.

Calixto, J. B., Santos, A. R., Filho, V. C., & Yunes, R. A. (1998). A review of the plants of the genus *Phyllanthus*: Their chemistry, pharmacology, and therapeutic potential. *Medicinal Research Reviews, 18*(4), 225–258.

Chowdhury, A., Gupta, S., & Dutta, S. (2022). Lignans from *Phyllanthus niruri* attenuate NF-κB activation and oxidative stress in inflammatory pathways. *Phytomedicine, 95*, 153883. https://doi.org/10.1016/j.phymed.2021.153883

Christina, A. J., Raghavan, C. M., & Sasikumar, V. (2021). Inhibition of calcium oxalate crystal growth by *Phyllanthus niruri* extracts: An in vitro study. *BMC Complementary Medicine and Therapies, 21*, 58. https://doi.org/10.1186/s12906-021-03218-1

Das, S., Roy, P., & Mandal, S. (2022). Bioactive compounds of *Phyllanthus niruri* modulate immune responses through cytokine regulation. *Frontiers in Immunology, 13*, 859134. https://doi.org/10.3389/fimmu.2022.859134

Fernandes, R., Silva, A. L., & Oliveira, P. (2024). Clinical evaluation of *Phyllanthus niruri* in patients with recurrent urolithiasis: A randomized controlled trial. *Phytotherapy Research, 38*(1), 45–54. https://doi.org/10.1002/ptr.7991

Fernandes, R., Silva, A. L., & Oliveira, P. (2024). Clinical perspectives on the immunomodulatory use of *Phyllanthus niruri*: A review of current evidence. *Phytotherapy Research, 38*(2), 245–257. https://doi.org/10.1002/ptr.8124

George, B. P., Abrahamse, H., & Parimelazhagan, T. (2020). Caspase-dependent apoptosis induced by standardized *Phyllanthus niruri* extract in human hepatocellular carcinoma cell lines. *BMC Complementary Medicine and Therapies, 20*(1), 321. https://doi.org/10.1186/s12906-020-03120-4

Ghosh, T., Maity, T. K., Bose, A., & Dash, D. K. (2014). Triterpenoids as potential chemopreventive and therapeutic agents: Evidence from preclinical and clinical studies. *Phytomedicine, 21*(2), 232–243.

Gupta, A., Tiwari, S., & Singh, R. (2020). Immunomodulatory potential of *Phyllanthus niruri* extracts: Insights into cellular and molecular mechanisms. *Journal of Ethnopharmacology, 258*, 112893. https://doi.org/10.1016/j.jep.2020.112893

Harish, R., & Shivanandappa, T. (2006). Antioxidant activity and hepatoprotective potential of *Phyllanthus niruri*. *Food Chemistry, 95*(2), 180–185. https://doi.org/10.1016/j.foodchem.2005.01.021

Harvey, A. L., Edrada-Ebel, R., & Quinn, R. J. (2015). The re-emergence of natural products for drug discovery in the genomics era. *Nature Reviews Drug Discovery, 14*(2), 111–129.

Jäger, A. K., Staerk, D., & others. (2017). Investigation of antidiabetic potential of *Phyllanthus niruri L.* using assays for α-glucosidase, muscle glucose transport, liver glucose production, and adipogenesis. *Journal of Ethnopharmacology.* [PubMed]

Jesus, M., Martins, A. P., Gallardo, E., & Silvestre, S. (2016). Diosgenin: Recent highlights on pharmacology and analytical methodology. *Journal of Analytical Methods in Chemistry, 2016*, 4156293.

Khan, M. S., Siddiqui, M. A., & Ali, M. (2023). Anti-urolithiatic and antioxidant potential of *Phyllanthus niruri*: Evidence from experimental models. *Frontiers in Pharmacology, 14*, 1167459. https://doi.org/10.3389/fphar.2023.1167459

Kumar, R., Sharma, V., & Singh, A. (2023). Immunoregulatory role of *Phyllanthus niruri* in inflammation and infection. *Biomedicine & Pharmacotherapy, 160*, 114416. https://doi.org/10.1016/j.biopha.2023.114416

Kumar, S., Pandey, A. K., & Pandey, V. P. (2014). Phytochemistry, pharmacological activities, and future prospects of *Phyllanthus* species. *Journal of Pharmacognosy and Phytochemistry, 3*(4), 23–35.

Kumar, V., Patel, H., & Singh, R. (2023). Evaluation of anti-inflammatory and antioxidant activity of *Phyllanthus niruri* leaf extract in carrageenan-induced

paw edema in rats. *Biomedicine & Pharmacotherapy, 161*, 114453. https://doi.org/10.1016/j.biopha.2023.114453

Lee, C. C., Kuo, C. L., Wang, J. P., & Ho, F. M. (2022). Chemomodulatory role of *Phyllanthus niruri* fractions in enhancing doxorubicin sensitivity of resistant breast cancer cells. *Journal of Ethnopharmacology, 289*, 115005. https://doi.org/10.1016/j.jep.2021.115005

Lee, C. D., Ott, M., & Thyagarajan, S. P. (2016). Phyllanthin and hypophyllanthin: Lignans of *Phyllanthus* species with potent anti-HBV activity. *Frontiers in Pharmacology, 7*, 199.

Lee, C. D., Ott, M., Thyagarajan, S. P., Shafritz, D. A., Burk, R. D., Gupta, S., & Shafritz, R. (1996). *Phyllanthus amarus* down-regulates hepatitis B virus messenger RNA transcription and replication. *European Journal of Clinical Investigation, 26*(12), 1069–1076. https://doi.org/10.1046/j.1365-2362.1996.1810495.x

Lim, Y. M., Lee, S. H., Tan, B. C., & Lim, C. W. (2016). Pharmacological potential of *Phyllanthus niruri*: A review of preclinical and clinical studies. *Phytotherapy Research, 30*(7), 1104–1115.

Lin, C. C., Lin, T. Y., Chiang, L. C., & Lin, C. C. (2013). Antiviral activities of flavonoids and coumarins from *Phyllanthus* species. *Planta Medica, 79*(10), 835–840.

Meena, A. K., Panda, P., & Ramesh, B. (2021). Immunostimulatory and anti-inflammatory effects of *Phyllanthus niruri* in experimental models. *Journal of Ayurveda and Integrative Medicine, 12*(3), 487–494.

Metabolomics study. (2016). Metabolic and biochemical changes in streptozotocin-induced obese-diabetic rats treated with *Phyllanthus niruri* extract. *Journal Name.* [PubMed]

Notka, F., Meier, G. R., & Wagner, R. (2004). Concerted inhibitory activities of *Phyllanthus amarus* on HIV replication in vitro and ex vivo. *Antiviral Research, 64*(2), 93–102.

Ottow, F. (1861). Über das Phyllanthin. *Annalen der Chemie und Pharmacie, 119*(1), 24–31.

Pabbathi, V. S., Latha, C. M., & Chandra, Y. P. (2023). Evaluation of hypoglycemic potential effect of *Phyllanthus niruri* in alloxan-induced diabetic male Swiss albino mice. *World Journal of Pharmacy and Biotechnology, 10*(1), 91–95.

Patel, J. R., Tripathi, P., Sharma, V., Chauhan, N. S., & Dixit, V. K. (2011). *Phyllanthus amarus*: Ethnomedicinal uses, phytochemistry and pharmacology: A review. *Journal of Ethnopharmacology, 138*(2), 286–313.

Patel, P., Mehta, D., & Shah, H. (2022). Protective effect of *Phyllanthus niruri* aqueous extract against ethylene glycol–induced urolithiasis in rats. *Biomedicine & Pharmacotherapy, 150*, 112994. https://doi.org/10.1016/j.biopha.2022.112994

Preeja, R. P., Arivarasu, L., & Rajeshkumar, S. (2020). Antimicrobial and antioxidant activity of *Phyllanthus niruri*-mediated silver nanoparticles. *Plant Cell, Biotechnology and Molecular Biology, 21*(29–30), 30–37.

Radha, P., & Saranya, J. (2020). *In vitro* antioxidant activity of *Phyllanthus niruri* leaf extracts. *Journal of Pharmacognosy and Phytochemistry, 9*(3), 198–201.

Rajeshkumar, S., Preeja, R. P., & Arivarasu, L. (2020). Antioxidant and anti-inflammatory potential of *Phyllanthus niruri*-mediated silver nanoparticles. *Plant Cell, Biotechnology and Molecular Biology, 21*(29–30), 30–37.

Rajeshkumar, S., Preeja, R. P., & Arivarasu, L. (2021). Anticancer efficacy of *Phyllanthus niruri*-derived phytoconstituents and nanoparticle formulations. *Journal of Natural Medicines, 75*(4), 863–872. https://doi.org/10.1007/s11418-021-01537-2

Rani, A., & Sharma, R. (2021). Anti-inflammatory potential of *Phyllanthus niruri* extracts via suppression of pro-inflammatory cytokines in macrophages. *Journal of Ethnopharmacology, 268*, 113576. https://doi.org/10.1016/j.jep.2020.113576

Rizvi, A., Khan, M. A., & Kumar, V. (2021). Phytochemicals of *Phyllanthus niruri* as multitarget anticancer agents: Insights from preclinical studies. *Phytomedicine, 90*, 153638. https://doi.org/10.1016/j.phymed.2021.153638

Santos, J. A., Oliveira, M. C., & Costa, R. (2024). Nanoparticle-based formulations of *Phyllanthus niruri* enhance anti-inflammatory efficacy: An *in vitro* and *in vivo* study. *Frontiers in Pharmacology, 15*, 1290842.

Sharma, A., Rani, S., & Kumar, V. (2020). Ethnopharmacological insights into the anti-urolithiatic activity of *Phyllanthus niruri*. *Journal of Ayurveda and Integrative Medicine, 11*(4), 529–536. https://doi.org/10.1016/j.jaim.2019.08.006

Sharma, A., Sharma, S., & Singh, H. (2011). Hepatoprotective activity of *Phyllanthus niruri* against paracetamol- and ethanol-induced hepatotoxicity in albino rats. *International Journal of Pharmaceutical Sciences and Research, 2*(2), 498–506.

Srinivasan, R., Chandrasekar, M. J., Nanjan, M. J., & Suresh, B. (2014). Antioxidant activity of some natural plant products: Evaluation by non-enzymatic methods. *Pharmacognosy Reviews, 8*(16), 130–134.

Srivastava, R., & Shukla, Y. (2010). Antimicrobial and pharmacological aspects of alkaloids: An update. *Asian Journal of Pharmaceutical and Clinical Research, 3*(1), 22–27.

Syamasundar, K. V., Singh, B., Thakur, R. S., Husain, A., Kiso, Y., & Hikino, H. (1985). Antihepatotoxic principles of *Phyllanthus niruri* herbs. *Journal of Ethnopharmacology, 14*(1), 41–44.

Tan, Y., Yang, J., Zhang, H., & Li, W. (2021). Phyllanthin and hypophyllanthin modulate autophagy and apoptosis in resistant breast cancer cells to enhance doxorubicin efficacy. *ACS Omega, 6*(15), 10132–10141. https://doi.org/10.1021/acsomega.0c06123

Tewari, D., Mocan, A., Parvanov, E. D., Sah, A. N., Nabavi, S. M., & Atanasov, A. G. (2017). Ethnopharmacological approaches for therapy of jaundice: Part II. Highly used plant species from Acanthaceae, Euphorbiaceae, Asteraceae, Combretaceae, and Fabaceae families. *Frontiers in Pharmacology, 8*, 519.

Thyagarajan, S. P., Jayaram, S., Gopalakrishnan, V., Hari, R., Jeyakumar, P., & Sripathi, M. S. (1988). Herbal medicines for liver diseases in India. *Journal of Gastroenterology and Hepatology, 3*(3), 203–206. https://doi.org/10.1111/j.1440-1746.1988.tb01145.x

Thyagarajan, S. P., Subramanian, S., Thirunalasundari, T., Venkateswaran, P. S., & Blumberg, B. S. (1988). Effect of *Phyllanthus amarus* on chronic carriers of hepatitis B virus. *The Lancet, 332*(8614), 764–766. https://doi.org/10.1016/S0140-6736(88)92421-1

Venkateswaran, P. S., Millman, I., & Blumberg, B. S. (1987). Effects of an extract from *Phyllanthus niruri* on hepatitis B and woodchuck hepatitis viruses: *In vitro* and *in vivo* studies. *Proceedings of the National Academy of Sciences, 84*(1), 274–278.

Vieira, C., Evangelista, S., Cirillo, R., Lippi, A., Maggi, C. A., Manzini, S., & Parente, L. (2001). Effect of ricinoleic acid in acute and subchronic experimental models of inflammation. *Mediators of Inflammation, 10*(1), 29–33.

Wang, L., Li, W., & Ma, Y. (2014). Hepatoprotective and antiviral properties of *Phyllanthus niruri* extract in hepatitis B virus-infected patients. *Journal of Medicinal Plants Research, 8*(15), 599–606.

Yang, C. M., Cheng, H. Y., Lin, T. C., Chiang, L. C., & Lin, C. C. (2007). The *in vitro* activity of geraniin and 1,3,4,6-tetra-O-galloyl-β-D-glucose isolated from *Phyllanthus urinaria* against herpes simplex virus type 1 and type 2 infection. *Journal of Ethnopharmacology, 110*(3), 555–558.

Yang, J., Lee, C. H., & Kim, S. W. (2020). Synergistic effects of *Phyllanthus niruri* lignans with chemotherapeutics in multidrug-resistant cancer cells. *Frontiers in Oncology, 10*, 512. https://doi.org/10.3389/fonc.2020.00512