

Pharmacological Activities Of *Azadirachta Indica* (Neem) And *Mangifera Indica* (Mango): A Comparative Review

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Abstract: Medicinal plants remain critical to healthcare worldwide and continue to inspire modern drug discovery. *Azadirachta indica* (neem) and *Mangifera indica* (mango) are two tropical species with long histories of use in traditional medicine across Asia and Africa. Both are pharmacologically versatile, supported by extensive phytochemical diversity. This review provides a comprehensive comparative analysis of their bioactive constituents and therapeutic activities. The discussion highlights four key compounds: nimbolide and azadirachtin from neem, and mangiferin and 3 β -taraxerol from mango. Pharmacological activities considered include antidiabetic, anticancer, antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, cardioprotective, and neuroprotective effects. Neem demonstrates pronounced efficacy in antimicrobial and cytotoxic applications, while mango excels in oxidative stress modulation, metabolic regulation, and cardiovascular protection. The review also examines evidence for polyherbal formulations that combine neem and mango extracts, emphasizing potential synergistic interactions in managing chronic and infectious diseases. Challenges in standardization, safety evaluation, bioavailability, and clinical translation are highlighted. Neem and mango emerge not only as traditional remedies but also as promising contributors to modern integrative medicine and future drug discovery.

Keywords: Neem, Mango, Phytochemistry, Pharmacological activity, Synergism, Polyherbal formulations

1. Introduction

Plants have always been central to human healthcare, serving as primary remedies for a wide variety of illnesses and also providing inspiration for the development of modern pharmaceuticals. For centuries, indigenous

communities have relied on medicinal plants not only to manage disease but also to maintain general well-being. In contemporary times, although synthetic drugs dominate medical practice, traditional medicine continues to be indispensable, particularly in regions where access to conventional healthcare is limited. This reliance is most evident in Africa and Asia, where a majority of people still depend on herbal preparations as their first line of treatment. Within this context, *Azadirachta indica* (neem) and *Mangifera indica* (mango) have earned a distinguished place. Both species are widely distributed across tropical and subtropical regions, and they hold deep cultural as well as medicinal significance.

Neem, a member of the Meliaceae family, is popularly called the “village pharmacy” because nearly every part of the tree is used in traditional medicine. The plant is highly valued for its wide array of bioactive compounds, particularly limonoids such as nimbolide and azadirachtin, which have demonstrated anticancer, antimicrobial, and antiparasitic activities (Rajendran, 2024; Koul et al., 2020). In ethnomedicine, neem extracts are prescribed for a spectrum of conditions, including fever, malaria, skin disorders, diabetes, and inflammatory diseases. Such versatility has made neem a cornerstone of herbal therapeutics in both Ayurveda and African traditional systems.

Mango, belonging to the Anacardiaceae family, is primarily celebrated as one of the world’s most popular tropical fruits. However, its medicinal importance extends well beyond its nutritional value. Traditional healers employ the leaves, bark, seeds, and kernels for the treatment of diabetes, hypertension, gastrointestinal disorders, and various inflammatory conditions. Mango contains diverse phytochemicals, with xanthenes, triterpenes, and polyphenolic compounds dominating its profile. Mangiferin, the most studied xanthone, has been consistently reported for its antioxidant, anti-inflammatory, and antidiabetic properties (Yarasvam, 2023). Another notable compound is 3 β -taraxerol, a pentacyclic triterpene that has shown promise in regulating glucose metabolism and improving lipid balance (Karigidi et al., 2025).

The present review provides a comparative evaluation of neem and mango with emphasis on phytochemistry, pharmacological applications, and therapeutic potential. By linking traditional uses with modern pharmacological evidence, this paper highlights their role in integrative medicine and examines the prospects of synergistic activity when used together in polyherbal formulations.

2. Methodology of Review

A systematic literature search was conducted using databases including PubMed, Scopus, and Web of Science. Search terms included *Azadirachta indica*, neem, *Mangifera indica*, mango, phytochemistry, pharmacological activity, antidiabetic, anticancer, antioxidant, anti-inflammatory, hepatoprotective, cardioprotective, and polyherbal formulations. Preference was given to peer-reviewed studies published between 2016 and 2025 to ensure current coverage. Both experimental and clinical studies were included,

as well as systematic reviews and ethnopharmacological surveys. Data were extracted and synthesized to highlight the phytochemical diversity, pharmacological activities, and comparative strengths of neem and mango.

3. Phytochemistry of Neem and Mango

3.1 Neem phytochemistry

Neem produces a remarkably wide range of secondary metabolites that are responsible for its diverse pharmacological actions. Among the most investigated are the limonoids, a group of highly oxygenated triterpenoid derivatives that are largely unique to members of the Meliaceae family. The best characterized limonoids from neem include azadirachtin, nimbolide, and gedunin, all of which have been the subject of extensive pharmacological research (Islas et al., 2020; Rajendran, 2024). Azadirachtin is perhaps the most well-known compound because of its powerful insecticidal activity, which has made it an important agent in eco-friendly pest management. Beyond its agricultural significance, azadirachtin also exhibits antiviral and anticancer effects, reflecting the broader therapeutic scope of neem. Nimbolide has attracted considerable attention as an anticancer compound due to its ability to induce apoptosis, inhibit angiogenesis, and modulate multiple signaling pathways involved in tumor growth. Gedunin has emerged as another promising metabolite with distinct pharmacological relevance. It acts as an inhibitor of the molecular chaperone Hsp90, thereby disrupting protein folding processes in cancer cells, and has also been linked with neuroprotective effects.

In addition to limonoids, neem synthesizes a variety of other bioactive compounds. These include flavonoids such as quercetin and kaempferol, which are well known for their antioxidant and anti-inflammatory activities. The tree also produces triterpenoids like nimbin and nimbidin that contribute to antimicrobial and immunomodulatory functions, as well as sterols such as beta sitosterol that support hepatoprotective and cholesterol lowering actions. Collectively, this diverse phytochemical repertoire underscores neem's reputation as a multi-purpose medicinal plant with both preventive and therapeutic potential (Patil & Savadi, 2022).

3.2 Mango phytochemistry

Mango is equally rich in phytochemicals, with xanthenes, flavonoids, triterpenes, and gallotannins dominating its profile. Mangiferin, a unique C-glucosyl xanthone, is the signature compound most frequently associated with mango's medicinal benefits. Mangiferin has been widely investigated for its antioxidant, antidiabetic, and anti-inflammatory actions (Gold-Smith et al., 2016). Mechanistically, it acts as a potent free radical scavenger, modulates redox sensitive transcription factors such as NF- κ B, and enhances glucose utilization and homeostasis.

Another major compound is 3β -taraxerol, a pentacyclic triterpene that has demonstrated antidiabetic and hepatoprotective properties in preclinical studies (Karigidi et al., 2025). Mango also contains ursolic and oleanolic acids, both of which contribute to anticancer, cardioprotective, and anti-obesity effects. The plant is further enriched with polyphenols such as gallic acid, catechins, and quercetin. These compounds have been associated with antimicrobial activity, antioxidant defense, and modulation of metabolic pathways (Torres-León et al., 2018). Together, the chemical complexity of mango positions it as both a nutritional and pharmacological resource, bridging dietary health promotion with therapeutic potential.

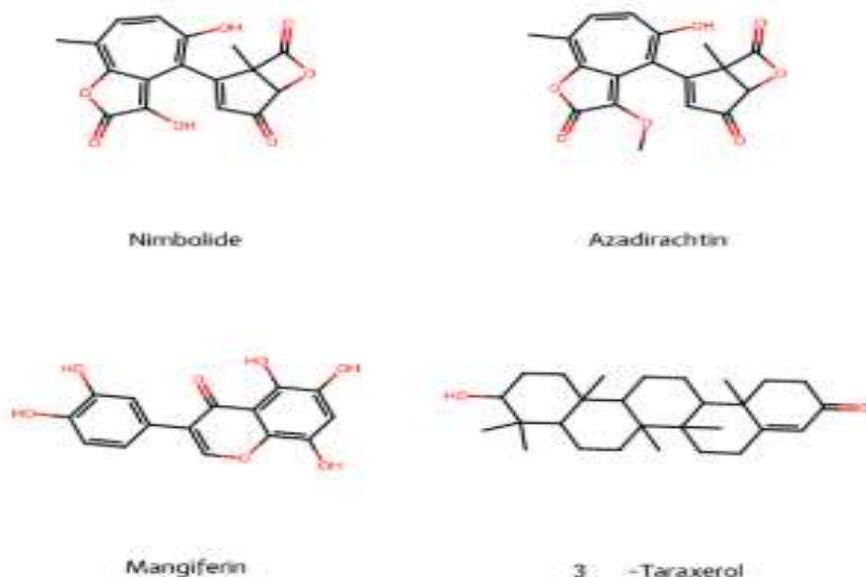


Figure 1. Key bioactive compounds of neem and mango (Nimbolide, azadirachtin, mangiferin, and 3β -taraxerol)

4. Pharmacological Activities of Neem and Mango

Table 1. Pharmacological activities of key phytochemicals in neem

Phytochemical	Pharmacological Activities	References
Azadirachtin	Antifeedant, antiviral, anticancer	Islas et al., 2020
Nimbolide	Anticancer (pro-apoptotic, anti-angiogenic), antidiabetic	Rajendran, 2024; Shu & Ma, 2021
Gedunin	Hsp90 inhibition, anticancer, neuroprotection	Koul et al., 2020
Nimbin, Nimbidin	Anti-inflammatory, antimicrobial	Patil & Savadi, 2022
Quercetin, Kaempferol	Antioxidant, anti-inflammatory, hepatoprotective	Patil & Savadi, 2022

Table 2. Pharmacological activities of key phytochemicals in mango

Phytochemical	Pharmacological Activities	References
Mangiferin	Antioxidant, antidiabetic, anti-inflammatory, anticancer	Gold-Smith et al., 2016; Yarasvam, 2023
3 β -Taraxerol	Glucose-lowering, lipid regulation, hepatoprotective	Karigidi et al., 2025
Ursolic acid, Oleanolic acid	Anticancer, cardioprotective, hepatoprotective	Ediriweera et al., 2017
Gallic acid, Catechins, Quercetin	Antioxidant, antimicrobial, neuroprotective	Torres-León et al., 2018
Gallotannins, Benzophenones	Antimicrobial, immunomodulatory, antioxidant	Torres-León et al., 2018

5. Expanded Pharmacological Insights

5.1 Antidiabetic effects

Both neem (*Azadirachta indica*) and mango (*Mangifera indica*) are extensively studied for their antidiabetic potential, and each contributes unique bioactive compounds that modulate glucose and lipid metabolism. Neem extracts, particularly those containing nimbolide, nimbidin, and quercetin, have been reported to improve insulin sensitivity, stimulate peripheral glucose uptake, and reduce hyperglycemia in animal and cellular models (Shu & Ma, 2021). The mechanisms are multifaceted. Nimbolide protects against diabetic cardiomyopathy by suppressing oxidative stress, reducing lipid peroxidation, and inhibiting apoptosis in cardiomyocytes. Quercetin, another neem constituent, has been shown to enhance GLUT4 translocation, thereby promoting glucose uptake in skeletal muscle cells.

Mango leaves and seeds are rich in mangiferin and 3 β -taraxerol, two compounds that contribute significantly to antidiabetic effects. Mangiferin is a potent antioxidant that reduces advanced glycation end product formation, modulates NF- κ B signaling, and improves pancreatic beta-cell function (Yarasvam, 2023). 3 β -Taraxerol enhances insulin signaling pathways, reduces adipogenesis, and regulates lipid metabolism, resulting in lower plasma cholesterol and triglyceride levels (Karigidi et al., 2025). Clinical trials using mango leaf teas have reported improvements in fasting blood glucose, glycated hemoglobin (HbA1c), and serum lipid profiles in type 2 diabetic patients. Together, these findings demonstrate that both neem and mango act at multiple points in the pathophysiology of diabetes, ranging from pancreatic protection to improved insulin sensitivity and lipid regulation.

5.2 Anticancer properties

Neem and mango also display promising anticancer activities, though their mechanisms of action differ according to their dominant phytochemical classes. Neem-derived limonoids, especially nimbolide, exert anticancer effects by inducing apoptosis in cancer cells through caspase activation, mitochondrial membrane depolarization, and inhibition of angiogenesis (Rajendran, 2024). Nimbolide suppresses cancer cell proliferation by downregulating PI3K/AKT/mTOR signaling, a key pathway in tumor survival. Azadirachtin interferes with multiple cell signaling cascades and has shown the ability to sensitize cancer cells to chemotherapeutic agents, thereby enhancing treatment efficacy. Gedunin, another neem metabolite, targets the molecular chaperone Hsp90, destabilizing oncogenic proteins and impairing cancer cell survival.

Mango's anticancer potential is largely attributed to mangiferin and related polyphenols. Mangiferin inhibits tumor progression by suppressing NF- κ B and MAPK signaling, reducing the expression of pro-inflammatory cytokines, and enhancing apoptosis in cancer cells (Gold-Smith et al., 2016). In vivo studies have demonstrated mangiferin's ability to reduce tumor volume in colon and breast cancer models. Additional mango compounds such as gallotannins and triterpenes contribute cytotoxic effects, often through pro-oxidant activity within tumor cells. Mango extracts have also demonstrated chemopreventive activity by inhibiting carcinogen-induced DNA damage.

While neem shows greater potency in preclinical oncology studies, mango offers chemopreventive potential and functional food applications. The integration of these plants may provide synergistic benefits, particularly in targeting both early carcinogenic processes and established tumors.

5.3 Antioxidant and anti-inflammatory effects

The pharmacological versatility of neem and mango is strongly underpinned by their antioxidant and anti-inflammatory capacities. Oxidative stress plays a central role in the development of chronic diseases such as diabetes, cancer, neurodegeneration, and cardiovascular disorders. Both plants contain polyphenols and flavonoids that scavenge reactive oxygen species, enhance endogenous antioxidant defense systems, and reduce lipid peroxidation.

In neem, flavonoids such as quercetin and kaempferol enhance the activity of antioxidant enzymes including superoxide dismutase, catalase, and glutathione peroxidase. Nimbidin, a triterpenoid, suppresses nitric oxide production in activated macrophages, thereby reducing inflammation. Mango polyphenols, particularly mangiferin, act as free radical scavengers and metal chelators. Mangiferin also modulates the expression of Nrf2, a transcription factor regulating antioxidant enzyme genes.

The anti-inflammatory properties of both plants are linked to the downregulation of pro-inflammatory cytokines such as TNF- α , IL-6, and IL-1 β (Islas et al., 2020; Yarasvam, 2023). By interfering with cyclooxygenase and lipoxygenase pathways, neem and mango extracts reduce the synthesis of prostaglandins and leukotrienes, thereby attenuating inflammation. These dual antioxidant and anti-inflammatory actions serve as the foundation for the broad pharmacological effects attributed to both plants.

5.4 Antimicrobial activities

Neem is particularly well documented for its antimicrobial effects. Compounds such as azadirachtin, nimbidin, and gedunin disrupt microbial membranes, inhibit spore germination, and interfere with quorum sensing in pathogenic bacteria. Neem leaf extracts demonstrate activity against multidrug resistant bacteria, including *Staphylococcus aureus* and *Escherichia coli*. Fungal pathogens such as *Candida albicans* are also sensitive to neem derived compounds, which disrupt ergosterol synthesis and compromise membrane integrity.

Mango extracts also possess antimicrobial activity, though their potency is comparatively lower than neem. Mango polyphenols such as gallic acid and catechins exert antibacterial effects by causing protein precipitation and interfering with microbial enzyme systems (Torres-León et al., 2018). Mangiferin has shown activity against influenza and herpes viruses in vitro. While neem is a stronger candidate for direct antimicrobial therapies, mango's antimicrobial role may be more relevant in the context of dietary prevention and supportive care.

5.5 Hepatoprotective and cardioprotective roles

Neem and mango also contribute significantly to liver and heart health. Neem extracts protect against chemically induced liver injury by reducing oxidative stress and improving glutathione levels. Nimbidin and nimbolide have been shown to restore serum markers of hepatic function such as ALT, AST, and bilirubin, as well as histological integrity of hepatocytes.

Mango triterpenes and mangiferin offer hepatoprotective benefits by stabilizing cell membranes, reducing lipid peroxidation, and enhancing mitochondrial function. In diabetic and high fat diet models, mangiferin significantly improves antioxidant defense in liver tissue, reduces steatosis, and restores hepatic enzyme activity.

Cardioprotective effects are particularly evident in mango, where mangiferin improves endothelial function, lowers LDL cholesterol, and prevents atherosclerotic plaque formation (Ediriweera et al., 2017). Ursolic and oleanolic acids from mango further support cardioprotection by reducing myocardial oxidative stress and enhancing nitric oxide bioavailability. Neem's cardiovascular effects are less well studied but include antihypertensive and antithrombotic actions.

5.6 Neuroprotection

Neurodegenerative diseases are increasingly linked to oxidative stress, inflammation, and protein misfolding. Neem and mango provide protective mechanisms that target these processes. Neem limonoids, particularly gedunin, inhibit the molecular chaperone Hsp90, reducing the accumulation of misfolded proteins associated with diseases such as Alzheimer's. Experimental models suggest that neem extracts reduce neuronal apoptosis and improve memory function.

Mango polyphenols, led by mangiferin, offer neuroprotection through multiple mechanisms. Mangiferin scavenges free radicals in neuronal tissues, reduces neuroinflammation, and modulates mitochondrial bioenergetics. In animal models of Parkinson's disease, mangiferin protects dopaminergic neurons from oxidative damage. In Alzheimer's models, it reduces amyloid beta aggregation and improves cognitive performance (Yarasvam, 2023). The ability of mango phytochemicals to cross the blood-brain barrier enhances their therapeutic relevance.

6. Comparative Analysis and Discussion

Neem and mango display overlapping pharmacological profiles, yet their distinctive strengths set them apart. Neem demonstrates stronger cytotoxic and antimicrobial effects due to its limonoid content, while mango is superior in metabolic regulation, antioxidant defense, and cardiovascular support through mangiferin and triterpenes. The convergence of both plants lies in their antioxidant and anti-inflammatory capacities, which form the backbone of nearly all other pharmacological actions.

Neem has been more extensively studied in the context of anticancer and antimicrobial therapies, while mango has gained momentum in the field of metabolic disorders and functional foods. Mango extracts are increasingly incorporated into nutraceutical formulations, while neem remains a focus for novel anticancer and antimicrobial agents.

One critical limitation in both plants is the variability of phytochemical content based on geographical origin, cultivation practices, plant part used, and extraction methods. This variation complicates reproducibility and standardization, both of which are essential for clinical translation. Another major challenge is the poor bioavailability of key compounds such as nimbolide and mangiferin. These molecules often suffer from low solubility, poor absorption, and rapid metabolism. Advances in formulation science, including nanoparticles, liposomes, and phytosomes, are being explored to overcome these barriers and enhance pharmacokinetics.

7. Polyherbal Formulations and Synergism

Polyherbalism is a foundational principle of traditional medicine, where combinations of multiple plants are used to enhance therapeutic efficacy and reduce side effects. Neem and mango represent a potentially powerful pair when combined. Neem provides potent antimicrobial and cytotoxic effects, while mango complements these actions through systemic antioxidant, metabolic, and cardiovascular regulation.

Evidence from polyherbal antidiabetic formulations demonstrates superior glycemic control, improved lipid profiles, and enhanced antioxidant capacity compared to single plant treatments (Saleem et al., 2019). For example, neem extracts targeting insulin resistance can be complemented by mango derived mangiferin, which improves beta-cell function and systemic glucose utilization.

Mechanistically, this synergy reflects the multi-target nature of plant derived compounds. Neem limonoids target signaling pathways related to cell proliferation, microbial invasion, and apoptosis. Mango polyphenols act primarily through modulation of redox balance, mitochondrial protection, and regulation of inflammatory cascades. When combined, these compounds address both the primary cause of disease and its systemic consequences.

Future directions in polyherbal research should focus on exploring pharmacokinetic interactions between neem and mango compounds, optimizing formulation ratios, and validating efficacy through controlled preclinical and clinical studies. Advances in omics technologies, molecular docking, and network pharmacology can provide new insights into the mechanisms of synergy. Establishing neem and mango combinations as evidence based therapies could significantly strengthen the role of phytomedicine in integrative healthcare systems.

8. Conclusion

Neem (*Azadirachta indica*) and mango (*Mangifera indica*) are versatile medicinal plants with rich phytochemistry and broad pharmacological potential. Neem is particularly strong in antimicrobial and anticancer domains, while mango demonstrates superiority in antioxidant defense, anti-inflammatory action, and metabolic regulation. Their complementary activities make them promising candidates for polyherbal formulations. The evidence supports the traditional wisdom of combining medicinal plants to achieve synergistic outcomes. Standardization, safety evaluation, and clinical validation remain pressing challenges, yet emerging formulation strategies and systems biology approaches offer promising solutions. Integrating neem and mango into modern pharmacological frameworks may accelerate the discovery of novel therapeutic agents and promote the development of holistic, multimodal therapies for chronic and infectious diseases.

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Conflict of Interest

The author(s) declare that there is no conflict of interest.

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