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PHYTOCHEMICAL PROFILING OF *GUDUCHI* (*TINOSPORA CORDIFOLIA*): LINKING AYURVEDIC PERSPECTIVES TO MOLECULAR MECHANISMS OF INFLAMMATION: A NARRATIVE REVIEW

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Abstract

Tinospora cordifolia (Willd.) Hook. f. & Thomson, commonly known in Ayurveda as *Guduchi* or *Amrita*, is a renowned *Rasayana* medicinal plant traditionally valued for its *Shothahara* (anti-inflammatory), *Jwarahara* (antipyretic), and immunomodulatory properties. This review integrates phytochemical data curated from the IMPPAT database and verified using PubChem with evidence from published pharmacological studies to evaluate the extent to which these classical therapeutic attributes can be explained in molecular terms. The major bioactive constituents examined include the alkaloids berberine, magnoflorine, and palmatine; the diterpenoid lactones tinosporide, cordifolide, and columbin; the glycosides cordifolioside A and syringin; arabinogalactan polysaccharides; and the phytosterols β-sitosterol and stigmasterol. These phytoconstituents have been investigated for their reported ability to modulate key inflammatory signaling pathways, including NF-κB, MAPK, JAK-STAT, the NLRP3 inflammasome, and the COX-2/LOX axis. Collectively, the available evidence indicates that *Guduchi* exerts its

anti-inflammatory effects through the coordinated regulation of multiple interconnected molecular pathways rather than a single pharmacological target. This multitarget mode of action provides a scientifically plausible explanation for its classical Ayurvedic designation as a *Tridoshahara*, *Shothahara*, and *Rasayana* drug. However, the majority of current evidence is derived from preclinical investigations, while robust, well-designed clinical trials remain limited. A database-informed, literature-validated approach such as this offers a reproducible framework for bridging traditional Ayurvedic pharmacology with contemporary molecular pharmacology and drug discovery, while also highlighting critical gaps requiring further mechanistic and clinical investigation.

Keywords

Tinospora cordifolia; *Guduchi*; phytochemicals; inflammation; NF-κB; IMPPAT; *Rasayana*

1. Introduction

Inflammation is a complex, tightly regulated biological response of the immune system to infection, tissue injury, and other harmful stimuli. In its acute phase, inflammation is a protective process that eliminates pathogenic threats, promotes tissue repair, and restores physiological homeostasis. However, when the inflammatory response becomes persistent or dysregulated, it contributes to the initiation and progression of numerous chronic diseases, including rheumatoid arthritis, cardiovascular disease, diabetes mellitus, neurodegenerative disorders, and several forms of cancer [3],[4]. Although nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroids remain the cornerstone of anti-inflammatory therapy, their long-term use is frequently associated with significant adverse effects, including gastrointestinal complications, renal dysfunction, immunosuppression, and metabolic disturbances [5]. These limitations have intensified the search for safer and more effective therapeutic agents, particularly those derived from medicinal plants.

Ayurveda, the traditional system of Indian medicine, describes a wide range of medicinal plants possessing *Shothahara* (anti-inflammatory) activity for the management of inflammatory disorders. Among these, *Tinospora cordifolia* (Willd.) Hook. f. & Thomson, commonly known as *Guduchi* or *Amrita*, occupies a prominent position owing to its broad spectrum of therapeutic applications. Classical Ayurvedic texts describe *Guduchi* as a *Rasayana* (rejuvenative), *Jwarahara* (antipyretic), *Deepana* (digestive stimulant), *Tridoshahara* (balancer of all three *Doshas*), and a potent immunomodulatory drug [1]. Contemporary pharmacological investigations have increasingly substantiated these traditional claims, demonstrating that *Guduchi* exhibits

antioxidant, anti-inflammatory, immunomodulatory, hepatoprotective, antidiabetic, antimicrobial, and several other pharmacological activities [1],[2].

The diverse therapeutic potential of *Tinospora cordifolia* is largely attributed to its rich and chemically diverse phytoconstituent profile. Phytochemical investigations have identified numerous classes of bioactive compounds, including alkaloids, diterpenoid lactones, glycosides, steroids, sesquiterpenoids, polysaccharides, and phenolic compounds [2]. Many of these constituents have been reported to modulate key inflammatory signaling pathways, including nuclear factor-kappa B (NF-κB), mitogen-activated protein kinase (MAPK), Janus kinase/signal transducer and activator of transcription (JAK-STAT), cyclooxygenase (COX), lipoxygenase (LOX), and pro-inflammatory cytokine networks. These findings suggest that *Guduchi* exerts its pharmacological effects through a multitarget mechanism rather than acting on a single molecular pathway.

The availability of comprehensive phytochemical databases, such as the Indian Medicinal Plants, Phytochemistry and Therapeutics (IMPPAT) database, has further facilitated the systematic identification and evaluation of phytoconstituents present in medicinal plants [6]. Integrating curated phytochemical information from IMPPAT with data from PubChem and evidence from contemporary pharmacological studies provides a robust framework for correlating traditional Ayurvedic knowledge with modern molecular pharmacology.

Accordingly, this review adopts a database-informed and literature-validated approach to comprehensively examine the phytoconstituents of *Tinospora cordifolia*, with particular emphasis on their anti-inflammatory mechanisms and molecular targets. By critically evaluating the available experimental evidence, this review aims to elucidate the scientific basis underlying *Guduchi*'s classical Ayurvedic designation as a *Shothahara* and *Rasayana* drug while also identifying existing gaps that warrant further mechanistic and clinical investigation.

2. Methodology

2.1 Data source and retrieval

Phytochemical data for *Tinospora cordifolia* were drawn from the IMPPAT database, a manually curated repository of phytoconstituents, plant-part associations, therapeutic applications and unique phytochemical (IMPHY) identifiers for Indian medicinal plants [6]. Constituents reported from stem, root, leaf, bark and whole plant were compiled for analysis.

2.2 Standardization

Each retrieved phytoconstituent was then cross-checked against PubChem to obtain a standardized Compound Identifier (CID), structure and chemical classification [7], a step that helped avoid duplication arising from synonymous nomenclature across sources.

2.3 Literature validation

A parallel literature search was carried out across PubMed, Scopus, ScienceDirect, Web of Science and Google Scholar, combining "*Tinospora cordifolia* phytoconstituents" with terms such as "anti-inflammatory activity", "NF-κB inhibition", "cytokine modulation", "COX-2 inhibition" and "immunomodulatory activity". The literature search strategy was structured in accordance with PRISMA 2020 principles to improve transparency [8]; however, this review was conducted as a narrative review rather than a systematic review, and no formal PRISMA flow diagram or quantitative synthesis was undertaken. Experimental, review, in-silico and clinical studies reporting anti-inflammatory, antioxidant or immunomodulatory activity of *Guduchi*-derived phytoconstituents were included.

2.4 Data compilation

The validated phytochemicals were tabulated against compound name, plant part, phytochemical class, molecular target and documented anti-inflammatory activity, and cross-correlated with the principal inflammatory signalling pathways discussed in Section 5.

3. Ayurvedic Perspective of *Guduchi*

3.1 Synonyms

Classical texts refer to *Guduchi* under several synonyms, each pointing to a facet of its therapeutic character. *Amrita*, "nectar of immortality", is the most widely used; *Chinnaruha* and *Chinnodbhava* allude to its capacity to regenerate from a cut stem; and *Madhuparni*, *Tantrika*, *Vatsadani* and *Jivanti* extend this theme of vitality and sustained life [11–16]. Together, these names encode the plant's reputed ability to regenerate, sustain strength and promote longevity.

3.2 Rasa Panchaka

Ayurveda explains *Guduchi*'s pharmacodynamics through its *Rasa Panchaka*: *Tikta* (bitter) and *Kashaya* (astringent) *Rasa*, *Laghu* (light) and *Snigdha* (unctuous) *Guna*, *Ushna Veerya* (hot potency), and *Madhura Vipaka* (sweet post-digestive effect). This combination allows it to pacify all three *Doshas* — Pitta and Vata in particular — earning it classification as a *Tridoshahara Dravya* [11–16]. The *Tikta Rasa* is thought to drive detoxification and metabolic correction, while the *Madhura Vipaka* supports nourishment and tissue rejuvenation, a combination that underlies much of its wide therapeutic use.

Table 1. *Rasa Panchaka* of *Guduchi*

Rasa	*Tikta*, *Kashaya*
Guna	*Laghu*, *Snigdha*
Veerya	*Ushna*
Vipaka	*Madhura*
Doshaghnata	*Tridoshahara*
Pradhana Karma	*Rasayana*, *Jwarahara*, *Shothahara*, *Deepana*, *Balya*, *Medhya*

3.3 Classical references

Guduchi appears across the major Ayurvedic compendia — *Charaka Samhita*, *Sushruta Samhita*, *Ashtanga Hridaya*, *Bhavaprakasha Nighantu*, *Dhanvantari Nighantu*, *Raja Nighantu* and *Kaiyyadeva Nighantu* [10–16] — with each text highlighting distinct therapeutic indications and pharmacological attributes. *Charaka Samhita* places *Guduchi* among the foremost *Rasayana* drugs, recommending it in Jwara, *Prameha*, *Kushtha* and *Pandu*. *Sushruta Samhita* highlights its usefulness in inflammatory conditions linked to deranged Pitta, and *Bhavaprakasha Nighantu* foregrounds its *Rasayana*, *Balya*, *Deepana* and *Tridoshahara* properties. The consistency of this description across independent classical sources, spanning different eras and schools, is itself notable.

3.4 Karma and Rogaghnata

Classical Nighantus describe *Guduchi* as possessing approximately fourteen distinct *Karma* and recommend its use in nearly twenty-one disease conditions involving nine Srotasa [11–16]. Its principal therapeutic actions include *Rasayana* (rejuvenative), *Samgrahi* (absorbent), *Balya* (strength-promoting), *Deepana*/*Vahnikrita* (digestive stimulant), *Amahara* (elimination of *Ama*), and *Medhya* (cognitive enhancer). Among its classical indications, Jvara is the most frequently cited, followed by *Trishna*, Pitta (jaundice), *Daha*, *Prameha*, *Pandu*, *Chardi*, *Kushtha*, *Krimi*, *Kasa*, *Bhrama*, *Vataroga*, *Kandu*, *Shwasa*, *Raktarsha*, and *Visarpa*. The therapeutic action of *Guduchi* is also influenced by the choice of *Anupana* (vehicle). When administered with *Erandataila*, it is traditionally indicated for *Vatarakta*; with Sunthi, for *Amavata*; and with *Guda*, for *Vibandha*. Similarly, the use of *Ghrita*, Sita, or *Madhu* as *Anupana* is believed to direct its therapeutic effects toward pacifying *Vata*, Pitta, and *Kapha*, respectively. This context-

dependent application reflects a fundamental principle of Ayurveda, whereby the therapeutic actions of a single *Dravya* can be modified and targeted toward specific Doshic imbalances through the appropriate selection of *Anupana*, rather than by the drug alone.

3.5 Guduchi as Rasayana

Rasayana therapy in Ayurveda is primarily aimed at promoting longevity, enhancing immunity, preserving cognitive function, and maintaining tissue integrity through the optimization of Dhatus [11–16]. Contemporary scientific evidence provides a plausible biological basis for several of these classical concepts. Experimental studies have demonstrated that *Guduchi* possesses immunomodulatory, antioxidant, adaptogenic, hepatoprotective, and cytoprotective properties [1,2]. Furthermore, a 25 kDa immunomodulatory protein isolated from the stem of *Guduchi* has been shown to stimulate macrophage activation and lymphocyte proliferation [18], while its arabinogalactan polysaccharide fractions exhibit immune-adjuvant activity by enhancing both innate and adaptive immune responses [31]. Preliminary clinical studies have also suggested a potential supportive role for *Guduchi* in improving immune function in immunocompromised individuals. However, the available clinical evidence remains limited, and adequately powered, well-designed randomized controlled trials are required to establish its efficacy and safety conclusively

3.6 Guduchi in Shotha and Jwara

Shotha (inflammation) and *Jwara* (fever) are the two conditions most frequently associated with *Guduchi* in the classical Ayurvedic literature [17]. According to Ayurveda, *Shotha* arises from the vitiation of *Doshas* accompanied by the accumulation of *Ama*, whereas *Jwara* is attributed to impaired Agni and Doshic imbalance. *Guduchi* is traditionally considered effective in both conditions owing to its *Tikta Rasa*, *Ushna Veerya*, and *Tridoshahara* properties, which are believed to facilitate the elimination of *Ama*, restore *Agni*, and re-establish physiological balance [11–16]. Contemporary pharmacological evidence provides a plausible mechanistic basis for these classical therapeutic claims. Experimental studies have demonstrated that phytoconstituents of *Guduchi* suppress the production of pro-inflammatory cytokines, including TNF-α, IL-1β, and IL-6, modulate NF-κB signaling, downregulate COX-2 and inducible nitric oxide synthase (iNOS), and attenuate oxidative stress [36,40,46]. Collectively, these findings offer a biologically plausible molecular explanation for the classical *Shothahara* and *Jwarahara* properties of *Guduchi*, while recognizing that modern molecular mechanisms should not be interpreted as direct equivalents of Ayurvedic concepts.

4. Phytochemical Landscape of *Guduchi*

The breadth of *Guduchi*'s pharmacology is mirrored in its phytochemistry. Secondary metabolites are distributed across stem, root, leaf and whole plant, and span several structurally distinct classes — alkaloids, diterpenoid lactones, glycosides, polysaccharides, steroids, sesquiterpenoids and phenolics [1],[2],[19],[20]. No single constituent is thought to account for the plant's therapeutic effect; rather, the prevailing view is that these classes act synergistically.

4.1 Alkaloids

The principal alkaloids — berberine, magnoflorine, palmatine, jatrorrhizine, tembetarine, choline and isocolumbin [2] — are also the most pharmacologically characterised class in the plant. Berberine, in particular, has shown consistent anti-inflammatory, antioxidant, antimicrobial and immunomodulatory activity, acting in part by suppressing NF-κB activation and reducing TNF-α, IL-1β and IL-6 output [23]. Magnoflorine contributes antioxidant and immunoregulatory effects through modulation of cytokine signalling [24], while palmatine adds anti-inflammatory and cytoprotective activity of its own [25].

4.2 Diterpenoids

A second, chemically distinct group — the diterpenoid lactones tinosporide, cordifolide, cordifol, columbin, tinosporon and tinocordifolin — are generally treated as chemotaxonomic markers of *Guduchi* [26]. These compounds exhibit anti-inflammatory, antioxidant and cytoprotective activity, largely through modulation of inflammatory mediators and limitation of oxidative tissue damage.

4.3 Glycosides

Among the glycosides — cordifolioside A, cordioside, tinocordiside and syringin — cordifolioside A stands out for its potent free-radical scavenging activity and protection against oxidative damage [29], while syringin acts more directly on inflammatory mediators and immune regulation [30].

4.4 Polysaccharides

The arabinogalactan polysaccharides isolated from *Guduchi* are of particular interest because their action is broadly immune-supportive rather than simply suppressive: they stimulate macrophage activation and phagocytosis and help regulate cytokine secretion [31],[32], supporting both humoral and cellular immunity while maintaining overall immune balance.

4.5 Phytosterols

β-Sitosterol and stigmasterol are the principal phytosterols reported in the plant. β-Sitosterol inhibits NF-κB activation and downstream cytokine production, in part by increasing the activity of the tyrosine phosphatase SHP-1 [34], and stigmasterol contributes complementary antioxidant and anti-inflammatory activity [33].

4.6 Phenolic and aliphatic constituents

Rounding out the profile, phenylpropanoids and flavonoids, together with fatty-acid esters and other aliphatic compounds, are reported as notable constituents of *Guduchi* stem and leaf essential oil, contributing further to its antioxidant and antimicrobial activity [1],[2].

5. Molecular Understanding of Inflammation

Before mapping *Guduchi*'s constituents onto specific molecular targets, it is useful to set out the inflammatory pathways themselves. Acute inflammation depends on host defence and tissue repair, but when its signalling persists beyond what is physiologically useful, it becomes a driver of chronic disease in its own right [3]. Five pathways are of particular relevance here.

5.1 NF-κB pathway

NF-κB is a transcription factor that sits at the centre of the inflammatory response, controlling genes involved in immunity, inflammation, cell survival and stress adaptation [36]. At rest, it is held inactive in the cytoplasm by IκB proteins; stimuli such as TNF-α, IL-1β, bacterial LPS or oxidative stress trigger IκB degradation, freeing NF-κB to translocate to the nucleus and activate TNF-α, IL-6, IL-1β, COX-2, iNOS and chemokine genes [37]. Because this cascade sits upstream of so many downstream mediators, excessive NF-κB activation is implicated across a wide range of inflammatory and autoimmune disorders.

5.2 MAPK pathway

The MAPK family — ERK, JNK and p38 — forms a second major relay, transmitting extracellular inflammatory signals inward and regulating leukocyte recruitment, cytokine secretion and tissue remodelling [38]; its dysregulation is similarly linked to chronic inflammatory and autoimmune disease [39]. Relevant to *Guduchi* specifically, a chloroform extract of *Tinospora cordifolia* has been reported to lower phosphorylated p38 MAPK levels in LPS-stimulated macrophages while keeping NF-κB sequestered in the cytoplasm, and to significantly reduce paw oedema in rats without affecting constitutively expressed COX-1 [40] — a dual-pathway effect that, if confirmed further, would be pharmacologically noteworthy.

5.3 JAK-STAT pathway

A third route runs through the Janus kinases: cytokine, growth-factor or interferon binding activates receptor-associated JAKs, which phosphorylate STAT proteins that then dimerise and move to the nucleus to regulate immune, inflammatory and proliferative gene expression [41]. Persistent activation of this pathway is associated with rheumatoid arthritis, inflammatory bowel disease and psoriasis [42]. In experimental models of arthritis, *Tinospora cordifolia* has been reported to reduce joint inflammation alongside measurable changes in JAK/STAT signalling [43], suggesting this pathway may also be relevant to its traditional use in *Vatarakta* and related joint conditions.

5.4 NLRP3 inflammasome

The NLRP3 inflammasome adds a further, more acute layer of regulation: assembled in response to microbial infection, cellular stress, reactive oxygen species or metabolic disturbance, it recruits caspase-1 to convert pro-IL-1β and pro-IL-18 into their active, secreted forms [44]. Overactivation of this complex has been linked to gout, atherosclerosis, diabetes and neurodegenerative disease [45].

5.5 COX-2 and LOX pathways

Finally, arachidonic acid released by phospholipase A2 is metabolised along two parallel routes — cyclooxygenase and lipoxygenase [46]. The inducible COX-2 isoform drives prostaglandin E2 production during inflammation and remains the principal target of conventional NSAIDs [5]. *Tinospora cordifolia* has been reported to inhibit COX-2 selectively, sparing constitutive COX-1 [40], and dihydroxy berberine isolated from the plant has shown in-silico dual inhibition of 5-LOX and COX-2 [9] — a combined action on both arms of the arachidonic-acid cascade that is uncommon among single natural compounds. The lipoxygenase route itself generates leukotrienes, including LTB4, a potent leukocyte chemoattractant relevant to asthma, allergy and chronic inflammatory disease [47].

6. Mapping *Guduchi* Phytoconstituents to Inflammatory Pathways

Read together, these five pathways and the constituent-level evidence above point to a consistent picture: *Guduchi* does not appear to act through any single inflammatory target but across several nodes of the network at once — NF-κB, MAPK, JAK-STAT, the NLRP3 inflammasome, and the COX-2/LOX and oxidative-stress axes [23],[24],[25],[29],[30],[34]. This multi-target profile, summarised in Table 2, is one plausible explanation for the unusually broad range of conditions in which *Guduchi* is traditionally indicated.

Table 2. Mapping of *Guduchi* phytoconstituents to molecular inflammatory pathways

Phytoconstituent	Class	Molecular target / pathway	Reported activity	Ref.
Berberine	Alkaloid	NF-κB, COX-2	Suppresses pro-inflammatory cytokines	[23]
Magnoflorine	Alkaloid	MAPK, oxidative stress	Anti-inflammatory, antioxidant	[24]
Palmatine	Alkaloid	Cytokine signalling, JAK-STAT	Immunomodulatory	[25]
Tinosporide	Diterpenoid	MAPK	Anti-inflammatory	[26]
Columbin	Diterpenoid	Cytokine pathways	Reduces inflammatory mediators	[26]
Cordifolide	Diterpenoid	Immune regulation	Immunomodulatory	[26]
Cordifolioside A	Glycoside	Oxidative stress, NLRP3	Antioxidant, anti-inflammatory	[29]
Syringin	Glycoside	COX-2, cytokine pathways	Suppresses inflammatory mediators	[30]
β-Sitosterol	Phytosterol	NF-κB, COX-2	Anti-inflammatory, antioxidant	[34]
Guduchi polysaccharides	Polysaccharide	Innate-immune signalling	Immunomodulatory	[31,32]

7. *Guduchi* as a *Rasayana*: A Modern Interpretation

7.1 Immunomodulation

If *Rasayana* is understood, in modern terms, as the maintenance of physiological resilience, immunomodulation is arguably its clearest correlate in *Guduchi*. Its polysaccharides enhance macrophage activation, phagocytosis and antigen presentation [31],[32], while berberine, magnoflorine and cordifolioside A regulate cytokine production in ways that support immune homeostasis rather than blanket suppression [23],[24],[29]. The 25 kDa immunomodulatory protein isolated from the stem adds a further, more specific mechanism, with demonstrated lymphoproliferative and macrophage-activating activity [18]. Taken together, this profile — modulation without generalised suppression — is consistent with the classical *Rasayana* concept in a way that few conventional immunosuppressive agents can claim.

7.2 Reduction of oxidative stress

A second thread running through *Guduchi*'s *Rasayana* action is antioxidant defence. Cordifolioside A, magnoflorine, syringin and β-sitosterol all show measurable free-radical scavenging activity [29],[24],[30],[34], and because oxidative stress is itself a trigger for NF-κB, MAPK and NLRP3 activation, this antioxidant activity may indirectly dampen redox-sensitive inflammatory signalling — a mechanism that links two of the plant's most consistently reported properties.

7.3 Healthy ageing and longevity

Ageing itself is increasingly understood as accompanied by a state of chronic low-grade inflammation, sometimes termed "inflammaging" [3],[4]. The antioxidant, anti-inflammatory and immunomodulatory activities described above offer a plausible route by which *Guduchi* could counter this process, lending a measure of scientific interpretation to its classical description as *Amrita* — though direct evidence linking the plant to slowed ageing in humans remains to be established.

7.4 Host-defence enhancement

Guduchi's stimulation of macrophage and leukocyte function, and its promotion of protective immune mediators [31],[32], together provide a mechanistic basis for its traditional use in states of recurrent infection and weakened immunity. A clinical report from the COVID-19 pandemic period described *Guduchi* Ghanavati as safe and associated with improved perceived immune status among individuals considered at risk [48], though larger controlled studies would be needed to confirm this observation.

8. Future Perspectives

8.1 Network pharmacology

Because *Guduchi* appears to act through several pathways at once, single-compound, single-target approaches are unlikely to capture its full pharmacology; systems-based network pharmacology is better suited to this kind of multi-target action [50]. A recent metabolomics and network-pharmacology study of the plant identified several hundred enriched human protein targets, with pathway analysis highlighting cAMP, mTOR, MAPK and PI3K-Akt signalling and docking evidence for interaction with BACE1 and MAO-B in the context of Alzheimer's disease [49]. While that particular study addressed neuroprotection rather than inflammation, it illustrates the kind of systems-level analysis that inflammation-focused research on *Guduchi* could usefully adopt.

8.2 Molecular docking and in-silico studies

At a more targeted level, berberine, magnoflorine, tinosporide and cordifolioside A would benefit from dedicated docking studies against NF-κB, COX-2, JAK/STAT, NLRP3 and MAPK targets [51], work that could help clarify structure–activity relationships and prioritise candidates for further development.

8.3 Clinical validation

The evidence gap that most limits translation, however, is clinical rather than mechanistic. Well-designed, adequately powered randomized controlled trials evaluating efficacy, safety, dosage standardisation and long-term outcomes in conditions such as rheumatoid arthritis, inflammatory bowel disease, metabolic syndrome and autoimmune disorders remain scarce, and this gap needs to be addressed before therapeutic claims can be made with confidence.

8.4 Drug discovery

Looking further ahead, integrating phytochemical databases such as IMPPAT with AI-assisted drug-discovery platforms, systems biology and pharmacokinetic modelling could meaningfully accelerate the identification of therapeutic leads from *Guduchi* [6],[50], turning what is currently a large but scattered evidence base into a more targeted discovery pipeline.

9. Discussion

This review has drawn together classical Ayurvedic knowledge, phytochemical evidence and modern molecular insight to examine the anti-inflammatory potential of *Tinospora cordifolia*. Ayurveda recognises *Guduchi* as a *Rasayana*, *Shothahara*, *Jwarahara* and *Tridoshahara* drug, and the phytochemical evidence reviewed here — spanning alkaloids, diterpenoid lactones, glycosides, polysaccharides and phytosterols — offers a plausible molecular counterpart to these classical attributions, even where the correspondence is inferred rather than directly demonstrated.

The theme that recurs most consistently across this evidence is multiplicity of target: *Guduchi* constituents appear to act on several nodes of the inflammatory network — NF-κB, MAPK, JAK-STAT, NLRP3, and the COX-2/LOX axis — rather than any single one. This distinguishes the plant from conventional single-target anti-inflammatory drugs and offers a mechanistic rationale for the breadth of its traditional indications. The antioxidant activity documented for several constituents adds a further, connecting thread, since oxidative stress itself feeds back into NF-κB, MAPK and NLRP3 activation — consistent with *Guduchi*'s classical role as a *Rasayana* rather than a narrowly anti-inflammatory drug.

The observed multitarget pharmacological profile supports the holistic therapeutic philosophy of Ayurveda, where medicinal plants are considered to restore systemic homeostasis rather than inhibit a single molecular pathway. Nevertheless, such conceptual parallels should be interpreted cautiously, as modern molecular mechanisms cannot be considered direct equivalents of classical Ayurvedic concepts; the two frameworks describe the plant's action at different levels of abstraction, and correlation between them does not establish that either fully explains the other.

Limitations: most of the mechanistic evidence summarised here derives from in-vitro, animal and in-silico studies rather than controlled clinical trials, and should be read with that caveat in mind. Extraction method, plant part used and dosage also vary considerably across the cited literature and were not standardised in this review, which limits direct comparison between studies. Above all, well-designed, adequately powered clinical trials in specific inflammatory conditions remain scarce, and closing this gap should be the priority for future work before firm therapeutic claims are made.

10. Conclusion

Tinospora cordifolia (*Guduchi*) is a *Rasayana*, *Shothahara*, *Jwarahara* and immunomodulatory drug of Ayurveda whose phytochemical profile — alkaloids, diterpenoid lactones, glycosides, polysaccharides and phytosterols — provides emerging mechanistic evidence supporting its traditional therapeutic applications, acting variously on NF-κB, MAPK, JAK-STAT, the NLRP3 inflammasome and the COX-2/LOX axis. Bringing IMPPAT-derived phytochemical data together with the pharmacological literature, as this review has attempted, offers a useful and reproducible framework for examining traditional Ayurvedic knowledge in molecular terms. Realising the plant's translational potential further will require network-pharmacology and docking studies to prioritise leads, together with well-designed clinical trials, before its role in inflammatory and immune-mediated disease management can be considered established rather than merely plausible.

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Conflict of Interest

The authors declare no conflict of interest.

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