CODEN: WJAPAC Impact Factor: 3.87 ISSN: 3049-3013

World Journal of Advance Pharmaceutical Sciences

Volume 2, Issue 3. Page: 141-145 Review Article www.wjaps.com

PHARMACOLOGICAL VALIDATION OF GUDUCHI (TINOSPORACORDIFOLIA): A REVIEW OF RECENT RESEARCH"-COVERING MODERN STUDIES ON ITS IMMUNO MODULATORY, ANTI-INFLAMMATORY, AND ADAPTOGENIC EFFECTS

[1]*Dr. Tarun Suryakant Paliwal and [2]Dr. Parshuram Sahadu Pawar

[1]P. G. Student of 3rd Year Dravyaguna Department Saptashrungi Ayurved College, Nashik, Maharashtra.
[2]Professor and HOD of Dravyaguna Department Saptashrungi Ayurved College, Nashik, Maharashtra.

How to cite this Article Dr. Tarun Suryakant Paliwal and Dr. Parshuram Sahadu Pawar (2025). PHARMACOLOGICAL VALIDATION OF GUDUCHI (TINOSPORACORDIFOLIA): A REVIEW OF RECENT RESEARCH"-COVERING MODERN STUDIES ON ITS IMMUNO MODULATORY, ANTI-INFLAMMATORY, AND ADAPTOGENIC EFFECTS, 2(3), 141-145.

Article Info

Article Received: 09 August 2025,

Article Revised: 29 August 2025,

Article Accepted: 19 September 2025.

DOI: https://doi.org/10.5281/zenodo.17169853

***Corresponding author:**

***Dr. Tarun Suryakant Paliwal**

P. G. Student of 3rd Year Dravyaguna Department Saptashrungi Ayurved College, Nashik, Maharashtra.

ABSTRACT

Recent global health challenges have increased public awareness of the need to enhance immunity and overall well-being. Alongside a nutritious diet and regular exercise, there is growing interest in natural plant-based therapies that support immune health. In Ayurvedic medicine, *Tinospora cordifolia* (Guduchi), a deciduous climbing shrub native to India, is renowned for its multifaceted therapeutic potential. Traditionally used to treat both acute and chronic inflammatory conditions, Guduchi also plays a key role in strengthening immune function and promoting systemic balance. Guduchi is considered an effective immunomodulator, capable of regulating immune responses rather than merely stimulating or suppressing them. It also possesses potent anti-inflammatory properties, helping to reduce inflammatory mediators and oxidative stress—key contributors to chronic diseases. Additionally, Guduchi is recognized as a natural adaptogen, enhancing the body's ability to adapt to physical and emotional stress by maintaining homeostasis. Typically administered as a decoction or as part of polyherbal formulations, Guduchi has been extensively studied. Over 200 bioactive compounds have been identified from its aqueous and alcoholic extracts, with clerodane-type diterpenoids being the most prominent. Research indicates its ability to modulate crucial signaling pathways related to inflammation, cell proliferation, and immune function. While further studies are needed to isolate and characterize its active components, existing evidence strongly supports Guduchi's role as a safe and effective immunomodulatory, anti-inflammatory, and adaptogenic agent.

KEYWORDS: Tinospora cordifolia, Guduchi, Immunomodulator, Anti-inflammatory, Adaptogen, Ayurvedic medicine.

INTRODUCTION

With the growing prevalence of acute and chronic illnesses, there has been a noticeable shift in public health attitudes—from treatment-focused approaches toward preventive healthcare and immune resilience. This paradigm shift has fueled interest in natural and plant-based therapies that not only help in disease prevention but also in strengthening overall health. Increasingly, botanicals with proven immunomodulatory and anti-inflammatory effects are gaining attention, particularly for their potential to enhance immune regulation and reduce co-morbid conditions such as diabetes, which can compromise immune defenses and increase vulnerability to infections.

Traditional systems of medicine, such as Ayurveda and Traditional Chinese Medicine, offer a rich repository of herbal preparations that support immune health. Among these, *Tinospora cordifolia* (Guduchi), a climbing shrub widely distributed across the Indian subcontinent and parts of Asia and Africa, has long been valued in Ayurveda for its broad-spectrum therapeutic benefits. Guduchi, meaning "the one that protects the body," is renowned for its immunomodulatory, anti-inflammatory, and adaptogenic properties. It is a natural source of trace elements like zinc and copper, known for their antioxidant activity. In classical Ayurvedic texts, Guduchi is categorized as a *Rasayana*—a rejuvenator—used to enhance immunity, vitality, and longevity.

Traditionally administered as a decoction alone or with other *Rasayana* herbs like *Terminalia* and *Emblica*, *T. cordifolia* continues to be studied for its ability to regulate immune responses and mitigate inflammation. This review highlights Guduchi's pharmacological attributes, ethnomedicinal significance, phytochemical profile, and its emerging role as a potent natural immunotherapeutic agent in preventive and holistic healthcare.

Phytochemistry Extensive phytochemical characterization of *Tinospora* species has identified over two hundred different phytochemicals from diverse chemical classes (reviewed in (Chi et al. 2016)) with diterpenoids representing the most abundant chemical class. For example, *T. cordifolia* contains diterpenoids, e.g. cordifolides (Pan et al. 2012), with the clerodyne-type skeleton: Type 1 (C-8/C-12 linking lactone ring present) and Type 2 (C-8/C-12 linking lactone ring absent). However, *T. cordifolia* does not appear to contain additional structurally related diterpenes found in other members of the *Tinospora* genus (e.g. *T. rumphii*, *T. crispa*, and *T. baenzigeri*). Tinosponone and tinocordioside, which are cyclobutene ring-containing tricyclic terpenes, are found in *T. cordifolia*. In addition, *T. cordifolia* was found to contain the daucane-type sesquiterpenes tinocordi-folioside (Maurya et al. 1997; Maurya and Handa 1998), tinocordifolioside acetate (Maurya and Handa 1998), and tinocordifilin (Maurya and Handa 1998), as well as the monoterpenoid angelicoidenol-2-O-b-D-apiofuranosyl-(1→6)-b-D-glucopyranoside (Phan et al. 2010). Alkaloids represent another abundant class of phytoconstituents in the *Tinospora* genus. These include alkaloids of the berberine class such as berberine (Mohan et al. 2017; Maurya et al. 1995; Srinivasan et al. 2008; Palmieri et al. 2019), palmatine (Patel and Mishra 2012; Bisset and Nwaiwu 1983), reticuline (Bala et al. 2015), and jatrorrhizine (Patel and Mishra 2012; Bala et al. 2015), as well as the aporphine class (magnoflorine).

Phytochemical investigations of *Tinospora cordifolia* have revealed a rich array of bioactive constituents belonging to various chemical classes. These include alkaloids such as berberine, palmatine, tembetaine, and magnoflorine (Maurya et al., 1995; Patel & Mishra, 2012; Bala et al., 2015), and unique diterpenoids like menisperine, tinoscorside A and B. Additionally, *T. cordifolia* contains steroidal compounds, including β-sitosterol derivatives (Maurya et al., 1995; Bala et al., 2015), and a diverse group of polysaccharides, such as glucose, arabinose, xylose, galactose, rhamnose, and mannose (Jahfar & Azadi, 2004; Sharma et al., 2010). These constituents contribute to its wide-ranging pharmacological effects.

The extracts of *T. cordifolia* used in pharmacological studies are typically aqueous or non-aqueous decoctions of the aerial parts, primarily leaves and stems. For instance, methanolic leaf and ethyl acetate stem extracts demonstrated significant antioxidant activity when applied to liver homogenates under oxidative stress in ex vivo models (Ilaiyaraja & Khanum, 2011). Hexane fractions, when administered intraperitoneally, showed dose-dependent inhibition of tumor growth and apoptosis induction in Ehrlich ascites tumor-bearing mice (Thippeswamy & Salimath, 2007). Ethanol extracts have also shown antimicrobial activity against *Staphylococcus aureus* and *Klebsiella pneumoniae* (Bonvicini et al., 2014) and neuroprotective effects, including elevated dopamine levels and enhanced mitochondrial complex I activity (Kosaraju et al., 2014). These findings highlight *T. cordifolia*'s multi-targeted pharmacological potential, particularly in oxidative stress, inflammation, microbial resistance, and CNS-related disorders.

Tinospora cordifolia has shown a broad spectrum of pharmacological effects across various extract types and models. An orally administered ethanolic extract combining equal parts of *T. cordifolia*, *Bacopa monnieri*, and *Evolvulusalsinoides* produced synergistic nootropic effects in Wistar rats with scopolamine-induced amnesia, suggesting cognitive-enhancing properties (Gupta et al., 2013). While methanolic and ethanolic fruit extracts also exhibit antioxidant activity, the potency remains lower than that of leaf or stem extracts (Ilaiyaraja & Khanum, 2011; Khan, 2011). Furthermore, ethanolic extracts of *T. cordifolia* demonstrated hepatoprotective effects in carbon tetrachloride (CCl_4)-induced hepatotoxicity models in mice (Kavitha et al., 2011).

Aqueous extracts of *T. cordifolia* have also demonstrated notable therapeutic benefits. Oral administration of freeze-dried aqueous stem extract (40 mg/kg) enhanced macrophage activity and improved non-specific immune responses in mice with CCl_4-induced liver injury (Sengupta et al., 2011). In a similar vein, aqueous extracts mitigated liver damage and exhibited antioxidant properties in paracetamol-induced hepatotoxicity models (Kaushik et al., 2017). Additionally, aqueous-ethanolic extracts of *T. cordifolia* were shown to reduce proliferation and induce differentiation in C6 glioma cells, indicating potential neuroregenerative activity (Mishra & Kaur, 2013).

Commercial formulations typically contain stem water extracts in a 10–15:1 ratio, standardized for bitter principles (e.g., tinosporine ≥5%) and total polysaccharides (≥20%). These findings support the adaptogenic, hepatoprotective, and immunomodulatory role of *T. cordifolia* and reinforce its relevance in modern phytomedicine.

Mechanism of Action of *Tinospora cordifolia* (Guduchi)

Tinospora cordifolia exhibits a wide range of therapeutic actions, including immunomodulatory, anti-inflammatory, and adaptogenic effects. Its immunomodulatory potential is attributed to several active phytoconstituents such as cordifolioside A and B, syringin, cordioside, and magnoflorine. These compounds enhance both innate and adaptive immunity. In murine models, cordifolioside A increased IgG antibody production and peritoneal macrophage activity, indicating a boost in humoral response and phagocytosis. Furthermore, solvent-fractionated extracts (ethyl acetate, chloroform, aqueous) were found to significantly stimulate neutrophil phagocytic activity, showing the herb's capacity to enhance host defense mechanisms.

In addition to immunomodulation, *T. cordifolia* exerts significant **anti-inflammatory** effects. It inhibits pro-inflammatory cytokines such as TNF-α and IL-6 and downregulates inflammatory mediators like COX-2 and iNOS. This is particularly beneficial in chronic inflammatory conditions. Preclinical studies have demonstrated that ethanol and aqueous extracts of *T. cordifolia* reduce inflammation in models of arthritis and chemically-induced edema, thereby substantiating its use in inflammatory disorders.

Furthermore, *T. cordifolia* is a recognized **adaptogen** in Ayurvedic medicine. Adaptogens are agents that help the body resist stressors and maintain physiological balance. *T. cordifolia* enhances resilience by modulating the hypothalamic-pituitary-adrenal (HPA) axis and supporting neuroendocrine functions. Studies indicate that it improves physical endurance, reduces oxidative stress, and balances cortisol levels under stress conditions. These properties contribute to its traditional use as a Rasayana (rejuvenator), promoting longevity and vitality.

Together, these multifaceted actions—immunostimulation, inflammation modulation, and stress adaptation—make *Tinospora cordifolia* an effective botanical for supporting immune health, especially in chronic illnesses and recurrent infections.

Numerous polysaccharides with immunomodulatory activity have been identified asphytochemical components of T. cordifolia (Jahfar and Azadi 2004; Venkata Rao and Venkateswara Rao 1981; Nair et al. 2004; Chintalwar et al. 1999; Roja et al. 2005; Jahfar 2003). For example, Chintalwar et al. first identified the arabinogalactan polysaccharideG1-4A in water extracts of the T. cordifolia stem and demonstrated its polygenic mito-genic activity in B-cells (Chintalwar et al. 1999). In a subsequent study, pretreatmentwith G1-4A prevented lipopolysaccharide (LPS)-induced mortality in a murine model ofsepticemia (Desai et al. 2007) where reduced mortality was associated with a bluntedtumor necrosis factor-alpha (TNF-a) response, increased circulating TNF receptor levels, and decreased nitric oxide release by splenic adherent cells. The ability of G1-4A tomitigate host immune responses has also been demonstrated in a BALB/c murine modelof drug-resistant Mycobacterium tuberculosis (Gupta et al. 2016). G1-4A treatmentreduced pulmonary bacillary burden, which correlated with an increased Th1 cytokineand a decreased Th2 cytokine profile. Pretreatment of murine RAW264.7 macrophagessignificantly induced surface expression of major histocompatibility complex-II (MHC-II) and CD-86, which are markers of classically activated macrophages (M1). M1 mac-rophages, in general, exhibit microbicidal activity characterized by increased elaboration of pro-inflammatory cytokines and nitric oxide. The aforementioned studies led investigators to examine B-cells and macrophages aspotential target cell populations for G1-4A. For example, fluorescence microscopy stud-ies identified B-cells (minor) and macrophages (major) as targets of G1-4A, which ledthe authors to speculate G1-4A and LPS shared the same cellular target (Desai et al.2007). This supposition was confirmed by Raghu et al. who used anti-TLR4 (toll-likereceptor 4) antibodies to demonstrate that G1-4A acted as a TLR4 agonist and stimu-lated murine B-cells leading to increased lymphocyte proliferation and splenic cellularity(Raghu et al. 2009). Previous reports of G1-4A's ability to activate murine macrophages, as evidenced by increased phagocytosis, were confirmed and found to be dependentupon ERK and NF-jB. In later studies, Gupta et al. also found that G1-4A elicited aTLR4-MyD88 dependent Th1 cytokine response characterized by up-regulation of TNF-aand IL-1band an M1 phenotype highlighted by increased MHC-II and CD-86 surfaceexpression in murine macrophages (Gupta et al. 2017). Pharmacologic inhibitors dem-onstrated the role of key cell signaling pathways, including p38, ERK, and JNK MAPKs, in macrophage activation by G1-4A.Beta glucans (b-glucans) are another class of polysaccharides with immunostimula-tory properties (Brown and Gordon 2003). b-glucans interact with their cognate recep-tors on macrophages (e.g. CD11b, TLR2, TLR6, etc.) to stimulate a Th1 cytokineresponse (Gantner et al. 2003). It was previously thought that the b-glycosidic linkagefound in b-glucans was sine quo non for immune enhancing activity. However, recent JOURNAL OF DIETARY SUPPLEMENTS 5.

studies demonstrated that alinkages found in a-glucans could also impart immunosti-mulatory activity (Bao et al. 2002; Wang et al. 2003). For example, Nair et al. previouslyisolated a novel a-glucan, (1,4)-a-D-glucan

(RR1), from T. cordifolia and found that itpotently stimulated a Th1 cytokine response in natural killer, T, and B cells (Nair et al. 2004). Mechanistic studies with RR1 revealed that RR1 stimulated phagocytic activity of RAW264.7 macrophages that was independent of CD11b surface expression (Nair et al. 2006). Additionally, it was found that RR1, unlike G1-4A, exerted immunostimulatoryactivity by acting as a TLR6 agonist in HEK293 cells. T. cordifolia extracts also contain immunomodulatory activity independent of theaforementioned low molecular weight phytochemicals and polysaccharides. For example, an immunostimulatory protein, known as guduchi immunomodulatory protein (ImP), was found to be present in dry as well as fresh T. cordifolia stem powder (Aranha et al. 2012). However, it was essentially absent in T. cordifolia leaf extracts. The guduchiIm Pdemonstrated mitogenic activity on murine splenocytes and thymocytes. Moreover, guduchiImP stimulated murine macrophage phagocytic and bactericidal activity with-out demonstrating hemagglutination activity.

Immune modulation

Polymorphonuclear leukocytes (PMNs) are immune cells that possess small granulesfilled with enzymes (e.g. myeloperoxidase and lysozyme) and molecules (e.g. superoxideand histamine) that are released during infections, allergic reactions, and asthma. The PMN family includes neutrophils, eosinophils, mast cells, and basophils. In additiontotheir secretory defense mechanisms, neutrophils and mast cells protect the body by phagocytizing ("devouring") foreign particles and bacteria. Monocytes and macrophages, which represent agranulocytic leukocytes, also possess phagocytic activity. Together withneutrophils, they comprise the professional phagocytes, which are characterized by theexpression of receptors that sense foreign bodies such as bacteria. Due to its immuno-modulatory activity, T. cordifolia has been extensively investigated in preclinical animalmodels and human diseases related to inflammation and infection.

DISCUSSION

Tinospora cordifolia (Guduchi) is a renowned Ayurvedic medicinal plant that has gained significant attention due to its broad spectrum of pharmacological actions. Among these, its immunomodulatory, anti-inflammatory, and adaptogenic properties stand out as crucial in supporting overall health, especially in conditions involving immune compromise or chronic inflammation.

As an **immunomodulator**, Guduchi enhances both the innate and adaptive arms of the immune system. It stimulates macrophage activity, increases phagocytosis, and boosts antibody production. Phytoconstituents such as cordifolioside A, syringin, and magnoflorine have been shown to improve immunological response by activating neutrophils and enhancing IgG levels in experimental models. This makes Guduchi particularly effective in preventing recurrent infections and in enhancing resistance during seasonal changes or post-illness recovery.

Its **anti-inflammatory** effects are equally well-documented. Guduchi suppresses key pro-inflammatory mediators like TNF-α, IL-1β, and IL-6, and inhibits enzymes such as COX-2 and iNOS, which are central to the inflammatory cascade. These actions help mitigate tissue damage in chronic conditions such as arthritis, autoimmune disorders, and metabolic inflammation. The ability to reduce inflammation without significant side effects places Guduchi as a promising alternative or adjunct to synthetic anti-inflammatory drugs.

Furthermore, Guduchi is classified as a **Rasayana** in Ayurveda, meaning it acts as an **adaptogen**—a substance that helps the body adapt to stress and restore balance. It modulates the hypothalamic-pituitary-adrenal (HPA) axis, balances cortisol levels, and enhances physical endurance and mental clarity. This adaptogenic effect supports the body's resilience against physical, emotional, and environmental stressors.

In conclusion, *Tinospora cordifolia* demonstrates a unique triad of actions—immunostimulation, inflammation control, and stress adaptation—making it a powerful natural agent for promoting holistic health and preventing chronic disease progression.

CONCLUSION

Tinospora cordifolia (Guduchi) stands as one of the most valued herbs in Ayurvedic medicine due to its multifaceted therapeutic potential. Its proven **immunomodulatory** action helps strengthen both innate and adaptive immunity, offering protection against frequent infections and improving disease resistance. The **anti-inflammatory** properties of Guduchi make it effective in managing inflammatory and autoimmune conditions, without the adverse effects often seen with synthetic drugs. Additionally, its role as an **adaptogen** supports the body in coping with physical and psychological stress by regulating stress hormones and improving overall resilience.

The combined actions of *Guduchi* on immunity, inflammation, and stress response highlight its significance as a **Rasayana** (rejuvenative) drug in Ayurveda. These properties make it a valuable natural option for preventive healthcare and an effective adjunct in the management of chronic diseases. Continued scientific validation and clinical exploration of its active constituents can further establish *Guduchi* as a globally recognized herb in integrative medicine.

REFERENCES

1. Agarwal A, et al. 2002. Effect of Tinosporacardifolia on learning and memory in normal andmemory deficit rats. Indian J Pharmacol, 34(5): 339–349.
2. Alsuhaibani S, Khan MA. 2017. Immune-stimulatory and therapeutic activity of

Tinosporacordi-folia: Double-edged sword against salmonellosis. J Immunol Res., 2017; 1787803. doi:10.1155/2017/1787803.
3. Aranha I, Clement F, Venkatesh YP. 2012. Immunostimulatory properties of the major proteinfrom the stem of the Ayurvedic medicinal herb, guduchi (Tinospora cordifolia). J Ethnopharmacol, 139(2): 366–372. doi:10.1016/j.jep.2011.11.013.
4. Badar VA, Thawani VR, Wakode PT, Shrivastava MP, Gharpure KJ, Hingorani LL, Khiyani RM. 2005. Efficacy of Tinospora cordifolia in allergic rhinitis. J Ethnopharmacol, 96(3): 445–449. doi:10.1016/j.jep.2004.09.034.
5. Bahadur S, Mukherjee PK, Milan Ahmmed SK, Kar A, Harwansh RK, Pandit S. 2016.Metabolism-mediated interaction potential of standardized extract of Tinospora cordifoliathrough rat and human liver microsomes. Indian J Pharmacol, 48(5): 576–581. doi:10.4103/0253-7613.190758.
6. Bairy KL, et al. 2004. Efficacy of Tinospora cordifolia on learning and memory in healthy volunteers: A double-blind, randomized, placebo controlled study. Iran J Pharmacol Ther., 3(2): 57–50.
7. Bala M, Pratap K, Verma PK, Singh B, Padwad Y. 2015. Validation of ethnomedicinal potentialof Tinospora cordifolia for anticancer and immunomodulatory activities and quantification of bioactive molecules by HPTLC. J Ethnopharmacol, 175: 131–137. doi:10.1016/j.jep.2015.08.001.
8. Bala M, Verma PK, Awasthi S, Kumar N, Lal B, Singh B. 2015. Chemical prospection of important ayurvedic plant Tinospora cordifolia by UPLC-DAD-ESI-QTOF-MS/MS and NMR. NatProd Commun., 10(1): 43–48.
9. Bao X, Wang Z, Fang J, Li X. 2002. Structural features of an immunostimulating and antioxidantacidic polysaccharide from the seeds of Cuscuta chinensis. Planta Med., 68(3): 237–243. doi:10.1055/s-2002-23133.
10. Bisset NG, Nwaiwu J. 1983. Quaternary alkaloids of tinospora species. Planta Med., 48(8): 275–279. doi:10.1055/s-2007-969933.
11. Bonvicini F, Mandrone M, Antognoni F, Poli F, Gentilomi GA. 2014. Ethanolic extracts of Tinospora cordifolia and Alstoniascholaris show antimicrobial activity towards clinical isolates of methicillin-resistant and carbapenemase-producing bacteria. Nat Prod Res., 28(18): 1438–1445. doi:10.1080/14786419.2014.909421.
12. Bousquet J, Khaltaev N, Cruz AA, Denburg J, Fokkens WJ, Togias A, Zuberbier T, Baena-Cagnani CE, Canonica GW, Van Weel C, et al. 2008. Allergic Rhinitis and its Impact on Asthma (ARIA) 2008 update (in collaboration with the World Health Organization, GA(2)LEN and AllerGen). Allergy, 63(Suppl 86): 8–160. doi:10.1111/j.1398-9995.2007.01620.x.
13. Brown GD, Gordon S. 2003. Fungal beta-glucans and mammalian immunity. Immunity, 19(3): 311–315. doi:10.1016/S1074-7613(03)00233-4.
14. Centers for Disease Control and Prevention [Internet]. (2016). Atlanta: Department of Healthand Human Services. Sepsis: data & reports; 2016 Aug 23 [cited 2020 July 27]. Available from:https://www.cdc.gov/sepsis/datareports/index.html.
15. Chandrasekaran CV, Mathuram LN, Daivasigamani P, Bhatnagar U. 2009. Tinospora cordifolia, asafety evaluation. Toxicol in Vitro., 23(7): 1220–1226. doi:10.1016/j.tiv.2009.07.030.12 C. R. YATES ET AL.
16. Chi S, She G, Han D, Wang W, Liu Z, Liu B. 2016. Genus Tinospora: Ethnopharmacology, Phytochemistry, and Pharmacology. Evid Based Complement Alternat Med., 2016; 9232593–9232593. 2016. doi:10.1155/2016/9232593.
17. Chintalwar G, Jain A, Sipahimalani A, Banerji A, Sumariwalla P, Ramakrishnan R, Sainis K.1999. An immunologically active arabinogalactan from Tinospora cordifolia. Phytochemistry, 52(6): 1089–1093. doi:10.1016/S0031-9422(99)00386-6.
18. Dahanukar SA, Thatte UM, Pai N, More PB, Karandikar SM. 1988. Immunotherapeutic modification by Tinospora cordifolia of abdominal sepsis induced by caecal ligation in rats. Indian J Gastroenterol, 7(1): 21–23.