

PHYTOCHEMICAL TREASURES AND PHARMACOLOGICAL INSIGHTS: A REVIEW OF *ERYTHRINA INDICA*

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Abstract

Erythrina indica (syn. *Erythrina variegata*) is a medicinal plant widely used in Ayurveda and other traditional systems, attracting growing scientific interest for its therapeutic potential. This review synthesizes existing research on its phytochemical composition and pharmacological activities, highlighting its promise as a source of natural therapeutics. Phytochemical investigations reveal that *Erythrina indica* is rich in alkaloids, flavonoids, and pterocarpanes, which are responsible for its broad spectrum of bioactivity. Scientific studies validate its potent antioxidant capacity and demonstrate significant anti-inflammatory effects. Notably, extracts and isolated compounds exhibit dose-dependent anticancer activity against breast, lung, and liver cancer cell lines by inducing apoptosis and showing cytotoxicity with defined IC₅₀ values. Antimicrobial efficacy has been observed against pathogens such as *Staphylococcus aureus* and *Pseudomonas aeruginosa*, with specific compounds demonstrating the ability to disrupt biofilm formation. *Erythrina indica* also possesses marked antidiabetic potential, significantly reducing blood glucose and glycosylated hemoglobin levels in diabetic models while preserving pancreatic β -cell integrity. Collectively, these findings strongly corroborate the plant's traditional uses and underscore its promise for the development of novel treatments for oxidative stress, inflammation, cancer, microbial infections, and diabetes. Future research should prioritize clinical trials, mechanistic studies, and the development of standardized formulations.

Keywords: *Erythrina indica*; Phytochemical; Antioxidant; Anticancer; Antimicrobial

Introduction

Erythrina indica, also known as *Erythrina variegata* is a medium-sized, fast-growing tree from the *Papilionaceae* family (Kumar *et al.*, 2010b; Avhad *et al.*, 2019). Various parts of the plant have traditionally been used for medicinal purposes, such

as calming the nervous system, treating eye ailments, asthma, and epilepsy, and serving as antiseptics. The leaves are especially noted for their laxative, diuretic, antiseptic, and anti-inflammatory properties. *Erythrina indica*, a spiny shrub found in

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Indian forests, possesses notable medicinal properties. It is used in Ayurveda, Siddha, Unani, and Homeopathic medicine, with its bark, roots, leaves, and fruits applied in the treatment of fever, skin ailments, and as natural astringents (Uzgare, 2025). Phytochemical investigations have led to the isolation, purification, and characterization of lectins from both seeds and leaves of *Erythrina indica* (Uzgare & Bhide, 2021). Compounds isolated from *Erythrina indica*, particularly isoflavonoids, have shown notable antibacterial and anthelmintic activities. The plant also demonstrates multiple pharmacological effects, including relaxation of smooth muscles, neuromuscular inhibition, pain relief, and stimulation of bile secretion. These properties align with its traditional use in indigenous medicine, and studies suggest potential benefits in managing convulsions, fever, inflammation, bacterial infections, insomnia, parasitic infestations, respiratory issues, and wound healing (Ghosal *et al.*, 1972; Haque *et al.*, 2007; Pandya *et al.*, 2012).

This review aims to summarize current research on *Erythrina indica* as a natural source of antioxidant, anti-inflammatory, anticancer, antimicrobial, and antidiabetic agents, emphasizing its phytochemical composition and therapeutic relevance. The literature survey includes studies published from 1972 to 2025, retrieved from Scopus, ResearchGate, Google Scholar, and the Directory of Open Access Journals (DOAJ). The search encompassed peer-reviewed articles reporting phytochemical analyses, in vitro assays, in vivo animal studies, and selected reviews related to the biological activities of *Erythrina indica*. Publications lacking sufficient methodological detail, experimental evidence, or direct relevance to the review scope were excluded to maintain rigor and comprehensiveness.

Phytochemical Insights into the Antioxidant Properties of *Erythrina indica*

Phytochemicals are plant-derived bioactive compounds that, although not classified as nutrients, play a crucial role in health promotion and disease prevention due to their antioxidant, anti-inflammatory, antiviral, and anticancer properties (Yang & Ling, 2025). These compounds, including polyphenols, terpenes, and sulfur- or nitrogen-containing molecules, are responsible for the color, aroma, and taste of plant-based foods. *Erythrina indica* (Indian coral tree) is particularly rich in diverse phytochemicals such as alkaloids (e.g., N-norprotosinomenine, protosinomenine, erythraline), phenolic compounds (pterocarpanes, isoflavones, flavanones, chalcones), sterols, flavonoids, triterpenoids, saponins, tannins, and

fatty acids, which collectively contribute to its wide range of medicinal properties, especially antioxidant and antimicrobial activities (Suryawanshi & Patel, 2011). Across multiple studies, a consistent trend emerges indicating that *Erythrina indica* exhibits strong antioxidant potential regardless of plant part (leaves, bark, roots) or extraction solvent, though polar solvents such as methanol, ethanol, and water generally yield higher activity due to their efficiency in extracting phenolic and flavonoid compounds. For instance, Kumar *et al.* (2010a) demonstrated that methanol, aqueous, and ethanol extracts from various plant parts showed effective free radical scavenging, nitric oxide neutralization, and reducing power in vitro. Similarly, Sakat and Juvekar (2010) reported significant DPPH and nitric oxide scavenging activity in both aqueous and methanolic leaf extracts, with the aqueous extract exhibiting comparatively greater efficacy, suggesting that water-soluble phenolics may play a dominant role. Comparable antioxidant trends were observed in root and bark extracts. Sre *et al.* (2012) found methanolic root extracts rich in flavonoids, tannins, terpenoids, and saponins to exhibit strong activity across multiple antioxidant assays, including DPPH, nitric oxide, superoxide dismutase, and ferric reducing power tests. Devaki (2016) further corroborated these findings by demonstrating a strong correlation between the presence of secondary metabolites in aqueous bark extracts and their free radical scavenging capacity, supported by HPTLC analysis. Collectively, these studies highlight phenolics and flavonoids as the primary contributors to antioxidant activity across different plant tissues. Leaf extracts have also been extensively studied, not only for antioxidant potential but also for antimicrobial activity. Kaushal *et al.* (2018) showed that methanolic leaf extracts possessed moderate antibacterial and antifungal effects alongside notable antioxidant activity, reinforcing the plant's traditional medicinal use. Patil *et al.* (2011) further compared different solvents and plant parts, revealing that ethanol extracts of leaves and stems exhibited the strongest antioxidant activity in DPPH assays, emphasizing the importance of solvent selection in maximizing bioactivity. Despite strong and consistent preclinical evidence supporting the antioxidant and anti-inflammatory potential of *Erythrina indica*, most studies remain limited to in vitro models. As noted by Jiménez-Cabrera *et al.* (2020), while flavonoid-rich species within the *Erythrina* genus can modulate oxidative stress and inflammatory pathways, the precise molecular mechanisms and in vivo relevance remain insufficiently explored. Therefore, future research should focus on

mechanistic studies, bioavailability assessments, and well-designed in vivo and clinical investigations to fully validate the therapeutic potential of *Erythrina indica*-derived phytochemicals.

Natural Anti-inflammatory Agents: The Role of *Erythrina indica*

Medicinal plants are an important source of structurally diverse bioactive compounds, many of which show promise as anti-inflammatory agents (Latif & Nawaz, 2026). Collectively, studies indicate that *Erythrina indica* exhibits consistent anti-inflammatory activity across different plant parts, extraction methods, and experimental models, suggesting a broad pharmacological profile. Aqueous and alcoholic extracts of *Erythrina indica* leaves and bark demonstrate dose-dependent inhibition of key inflammatory processes, including protein denaturation, membrane destabilization, proteinase activity, and paw edema formation in animal models (Wankhede *et al.*, 2009; Rajeev *et al.*, 2010; Vrunda *et al.*, 2017). These effects are often accompanied by antioxidant activity, implying that suppression of oxidative stress may contribute to the anti-inflammatory response. Bark extracts additionally show hepatoprotective effects in chemically induced liver injury, with efficacy comparable to standard drugs (Vrunda *et al.*, 2017). Similar anti-inflammatory trends are reported in *Erythrina variegata*. Ethanolic and methanolic bark extracts inhibit COX-2-mediated prostaglandin synthesis and nitric oxide production, while showing membrane-stabilizing effects linked to high levels of alkaloids, phenolics, and flavonoids (Thongmee & Itharat, 2016; Santhiya *et al.*, 2016). However, limited effects on TNF- α release suggest greater relevance to acute rather than chronic inflammatory pathways. Comparative in vitro studies further highlight the potency of *Erythrina indica*, which showed the strongest inhibition of protein denaturation among several medicinal plants, though moderate proteinase inhibition compared with *Mukia maderaspatana* (Kousalya *et al.*, 2020). Overall, while preclinical evidence strongly supports the anti-inflammatory potential of *Erythrina* species, most findings are derived from in vitro and animal studies. Variability in extraction methods and experimental models remains a limitation, underscoring the need for mechanistic studies and clinical validation.

Insight into the Anticancer Activities of *Erythrina indica*

Many medicinal plants show promising anticancer potential, mainly because of their antioxidant and tumor-suppressing properties

(Shaikh & Uzgare, 2026). *Erythrina indica* is a significant medicinal plant well-documented in traditional medical systems, the seeds are used for treating cancer, while the bark is traditionally employed for managing fever, hepatitis, malaria, rheumatism, toothache, boils, and bone fractures. With the increasing demand for safer and more effective anticancer agents, research has intensified on plants traditionally recognized for their medicinal properties (Karthick *et al.*, 2016). Kumaran *et al.* (2021) described breast cancer as a malignancy arising from breast cells, commonly originating in the ducts or lobules and potentially involving surrounding fatty or fibrous tissues. The cytotoxic effect of *Erythrina indica* leaf aqueous extract was evaluated using an MTT assay, where breast cancer cells were treated with 50-300 $\mu\text{g/ml}$ concentrations for 24 hours and assessed for viability and morphological changes. The extract exhibited dose-dependent inhibition of cell proliferation and induced apoptotic morphological alterations observed under phase-contrast microscopy as confirmed by morphological changes, suggesting the extract's potential as a novel anticancer agent. Vijaya Bharathi and Srivastava (2019) evaluated the anticancer activity of *Erythrina indica* flower extracts using MTT assays on HepG2 and MG-63 cell lines, with microscopy confirming morphological changes. The ethanol extract showed strong cytotoxicity (71.26% and 67.11% inhibition, respectively), and essential oil was further isolated by steam distillation for chemical and pharmaceutical analysis. Ramesh *et al.* (2021) evaluated the antitumor potential of *Erythrina indica* leaf extract against human lung cancer cells. The extract exhibited significant cytotoxicity, achieving 50% growth inhibition (IC_{50}) at 100 $\mu\text{g/mL}$, indicating strong anticancer activity. Further studies are needed to explore its therapeutic potential and safety as a natural anticancer agent. Umarani and Nethaji (2021) explored the anticancer potential of *Erythrina variegata* leaf ethanolic extract. GC-MS analysis identified bioactive compounds, and in silico docking showed that 3-eicosyne strongly interacts with the colorectal cancer oncogene KRAS G12D and tumor suppressor p53 R249S, indicating potent activity against colorectal adenocarcinoma-related targets. Priya *et al.* (2017) aimed to isolate a potential anticancer compound from *Erythrina indica* leaves. Ethanol extracts were fractionated using High-Performance Liquid Chromatography (HPLC), and the bioactive fraction was tested against Adenocarcinomic Human Alveolar Basal Epithelial (A549) cells. Structural characterization using Fourier Transform Infrared Spectroscopy (FT-IR), Nuclear Magnetic

Resonance (NMR), Gas Chromatography (GC), and Tandem Mass Spectrometry (MS/MS) identified the compound as 13-docosenamide (Z), suggesting its promising potential as an anticancer agent and its feasibility for laboratory production. Herlina *et al.* (2011) investigated the anticancer potential of *Erythrina variegata* leaves and stem bark against T47D human breast cancer cells. Methanol extracts were tested in vitro using the Sulforhodamine B (SRB) assay, demonstrating significant cytotoxicity. Bioactive compounds were isolated via column chromatography and characterized using spectroscopic methods, identifying an erythrina alkaloid and an isoflavonoid. These compounds exhibited IC₅₀ values of 1.0 µg/mL and 3.3 µg/mL, respectively, indicating strong anticancer activity and highlighting *Erythrina indica* as a promising source of natural anticancer agents.

Antimicrobial Properties of *Erythrina indica*

Plant-derived antimicrobial phytochemicals, including alkaloids, phenolics, terpenoids, saponins, flavonoids, tannins, and sulfides, inhibit microbes by disrupting membranes, interfering with enzymes, or binding cellular components. Their multi-target activity makes them promising alternatives to synthetic drugs in the search for new antimicrobial agents (Vaou *et al.*, 2021). Kumari *et al.* (2017) evaluated various solvent extracts of *Erythrina indica* leaves in hexane, chloroform, dichloromethane, ethyl acetate, methanol, and aqueous for phytochemical content and antibacterial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Proteus vulgaris* using the disc diffusion method. Phytochemical screening revealed phenols, alkaloids, flavonoids, tannins, and saponins. All extracts exhibited antibacterial activity, with chloroform and methanol extracts showing the strongest inhibition, particularly against *Staphylococcus aureus* and *Pseudomonas aeruginosa*, highlighting the plant's potential as a natural antimicrobial agent. Poyil and Shamna (2023) investigated the antibacterial potential of methanolic *Erythrina indica* Lam. extract against *Staphylococcus aureus*, a major pathogen responsible for biofilm-associated catheter-associated urinary tract infections (CAUTIs). The extract exhibited significant antibacterial activity with a minimum inhibitory concentration (MIC) of 4.8 mg/mL and reduced *Staphylococcus aureus* biofilms on catheters by up to 71%. These results suggest that the extract contains bioactive compounds capable of combating biofilm-forming, antibiotic-resistant bacteria, highlighting its

potential for development into antibacterial coatings and clinical applications. Enupe *et al.* (2024) evaluated *Erythrina senegalensis* leaf extracts against multidrug-resistant Gram-negative bacteria. The aqueous extract showed moderate biofilm inhibition against *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Salmonella Enteritidis*, while the ethanol extract was inactive. Phytochemical analysis revealed tannins, flavonoids, alkaloids, and other bioactive compounds, highlighting the extract's potential as a natural antibacterial and antibiofilm agent. Priya and Maneemegalai (2018) evaluated the antimicrobial activity of 13-docosenamide (Z), a bioactive compound isolated from ethanolic leaves of *Erythrina indica*. The compound exhibited dose-dependent antibacterial effects against clinical isolates, completely inhibiting *Salmonella Typhi* and *Salmonella Paratyphi* at 400 µg/mL, while showing over 79% inhibition of *Vibrio parahaemolyticus* and *Vibrio cholerae*. Moderate to low inhibition (<50%) was observed for *Escherichia coli* and *Bacillus subtilis*, and no activity was noted against *Klebsiella pneumoniae*, *Proteus mirabilis*, *Streptococcus pneumoniae*, and *Staphylococcus aureus*. These results confirm the selective antibacterial potential of 13-docosenamide (Z) and support the medicinal value of *Erythrina indica*. Tanaka *et al.* (2002) evaluated 16 isoflavonoids from *Erythrina variegata* roots for activity against methicillin-resistant *Staphylococcus aureus* (MRSA). Fourteen compounds exhibited antibacterial effects, with erycristagallin and orientanol B showing the highest potency (MIC 3.13-6.25 µg/mL). These results suggest that these isoflavonoids are promising leads for developing plant-based therapies against MRSA.

Critical Analysis:

Across these studies, solvent choice, plant species, and target pathogen significantly influence antibacterial and antibiofilm outcomes. Methanolic and chloroform extracts often show stronger activity, likely due to efficient extraction of phenolics, flavonoids, and alkaloids. Crude extracts demonstrate broad-spectrum effects, while isolated compounds (e.g., 13-docosenamide, isoflavonoids) may show selective but highly potent activity. Biofilm inhibition, a clinically relevant aspect, is underexplored in most studies except Poyil and Shamna (2023) and Enupe *et al.* (2024). Future research should standardize extraction methods, directly compare MIC/IC₅₀ values, and evaluate synergistic effects to fully assess therapeutic potential.

Evaluation of the Antidiabetic Potential of *Erythrina indica*

The global prevalence of diabetes mellitus is rising, leading to serious health risks and increased mortality. Poor blood glucose regulation can result in severe complications. Although conventional antidiabetic treatments are effective, they often produce undesirable side effects, making medicinal plants a promising source of safer alternative therapies (Salehi *et al.*, 2019). Kumar *et al.* (2011) investigated the hypoglycaemic and antidiabetic effects of *Erythrina indica* stem bark extracts in normal and alloxan-induced diabetic rats. Phytochemical analysis revealed that the alcoholic extract contained carbohydrates, alkaloids, flavonoids, saponins, phytosterols, phenolics, and tannins, while the aqueous extract contained carbohydrates, alkaloids, flavonoids, glycosides, phytosterols, and triterpenoids. These bioactive compounds are likely responsible for the observed hypoglycaemic activity of *Erythrina indica*. Devaki *et al.* (2016) investigated the antidiabetic effects of aqueous *Erythrina indica* bark extract in streptozotocin-induced diabetic rats. Administration of 400 mg/kg of extract for 30 days significantly reduced blood glucose and

glycosylated hemoglobin (HbA1c) while increasing insulin and hemoglobin levels. Histological analysis showed that the extract preserved and rejuvenated pancreatic islet cells, supporting its hypoglycemic activity and traditional use in diabetes management. Murugan *et al.* (2010) studied the hypoglycemic effects of ethanolic leaf extract of *Erythrina indica* in normal and alloxan-induced diabetic mice. The extract was found safe up to 2000 mg/kg, and the chloroform fraction demonstrated significant blood glucose-lowering activity, comparable to Glibenclamide.

Overall, the antioxidant and anti-inflammatory activities of *Erythrina indica* appear most promising, as they are consistently supported by multiple in vitro and in vivo studies and linked to well-characterized phytochemicals. The antidiabetic activity also shows encouraging in vivo evidence but requires further mechanistic and clinical validation. In contrast, the anticancer and antimicrobial effects, though noteworthy, are largely based on in vitro and in silico studies. Thus, these latter activities are likely to remain mainly experimental until supported by advanced preclinical and clinical investigations.

Table 1. Pharmacological Applications of *Erythrina indica*

Medicinal potential	Plant Part	Test Methods	Pharmacological Application	References
Antioxidant	Leaves, bark, roots (methanol, aqueous, ethanol)	DPPH, NO scavenging, superoxide dismutase, ferric reducing power	Strong free radical scavenging, lipid peroxidation inhibition; activity attributed to flavonoids, phenolics.	Sakat and Juvekar (2010); Devaki (2016); Kaushal <i>et al.</i> (2018); Patil <i>et al.</i> (2011)
Anti-inflammatory	Leaves, bark (aqueous, hydroalcoholic, ethanolic, methanolic)	Protein denaturation, RBC stabilization, paw edema, granuloma, COX-2 & NO inhibition	Dose-dependent inhibition of inflammation, hepatoprotective effects; membrane stabilization; supports traditional use.	Wankhede <i>et al.</i> (2009); Vrunda <i>et al.</i> (2017)
Anticancer	Leaves, flowers, roots, bark (aqueous, ethanol, methanol)	MTT assay, SRB assay, GC-MS, HPLC, in silico docking	Dose-dependent cytotoxicity; IC ₅₀ range: 1–100 µg/mL; induces apoptosis; bioactive compounds: 13-docosenamide, erycristagallin, orientanol B; activity against breast, lung, colorectal, liver, and bone cancer cells.	Herlina <i>et al.</i> (2011); Tanaka <i>et al.</i> (2002)
Antimicrobial	Leaves, bark, aqueous, methanol, ethanol, chloroform	Disc diffusion, MIC, crystal violet, Kirby–Bauer	Effective against <i>S. aureus</i> , <i>P. aeruginosa</i> , <i>Salmonella</i> spp., <i>K. pneumoniae</i> ; inhibits biofilm formation (up to 71%); 13-docosenamide shows selective antibacterial activity; isoflavonoids effective against MRSA.	Kumari <i>et al.</i> (2017); Poyil and Shamna (2023); Enupe <i>et al.</i> (2024); Priya and Maneemagalai (2018); Tanaka <i>et al.</i> (2002)
Antidiabetic	Bark, leaves (aqueous, ethanolic, alcoholic)	STZ-induced diabetic rats, alloxan-induced mice	Reduced blood glucose & HbA1c, increased insulin & hemoglobin; preserved pancreatic islets.	Devaki <i>et al.</i> (2016); Murugan <i>et al.</i> (2010)

Pharmacological Applications of *Erythrina indica*

Table 1 summarizes the pharmacological activities of *Erythrina indica*, covering antioxidant, anti-inflammatory, anticancer, antimicrobial, and antidiabetic effects. Extracts from leaves, bark, flowers, and roots showed significant activity in both in vitro and in vivo studies. Key bioactive compounds responsible for anticancer and antimicrobial effects are highlighted where identified, linking chemical composition to biological activity. The table complements the main text by providing a clear, organized overview of the plant's therapeutic potential. Improvements in uniform formatting, clearer descriptions, and explicit connections to the corresponding sections in the text would further enhance clarity and usability.

Conclusion

Erythrina indica is a versatile medicinal plant known for its wide-ranging health benefits, including protection against oxidative damage, inflammation, microbial infections, cancer, and high blood sugar. Its leaves, bark, roots, and flowers are packed with active compounds such as flavonoids, isoflavonoids, alkaloids, pterocarpanes, tannins, saponins, and 13-docosenamide (Z), which largely drive its therapeutic effects. Experimental research using both in vitro and in vivo models has confirmed its traditional use in systems like Ayurveda, Siddha, Unani, and Homeopathy, demonstrating effectiveness in managing infections, inflammatory disorders, diabetes, and degenerative conditions. The plant's diverse bioactive molecules exhibit potent antioxidant, anti-inflammatory, anticancer, antimicrobial, and blood glucose-regulating properties, positioning *Erythrina indica* as a promising candidate for natural drug development.

The novelty of this review lies in its integrated and comprehensive synthesis of phytochemical constituents, traditional medicinal relevance, and experimentally validated pharmacological activities of *Erythrina indica*. By consolidating evidence across multiple therapeutic domains, this review highlights the plant's multitarget potential and underscores its relevance in modern drug discovery. Importantly, it identifies critical limitations in current research and proposes clear future research priorities, including clinical validation, mechanistic elucidation, extract standardization, biotechnological enhancement of bioactive compounds, and investigation of synergistic effects with conventional drugs. Addressing these gaps will

not only strengthen the scientific foundation of *Erythrina indica* based therapies but also accelerate its development as a safe, effective, and evidence-based natural therapeutic agent for chronic and degenerative diseases.

Future research should focus on isolating and characterizing novel bioactive compounds, elucidating molecular mechanisms, and conducting preclinical and clinical trials to ensure efficacy and safety in humans. Development of standardized extracts, nutraceuticals, and plant-based formulations could enhance its therapeutic applications. Additionally, biotechnological approaches such as tissue culture and metabolic engineering may improve bioactive compound production. Investigating synergistic effects with conventional drugs could further expand its role in managing cancer, diabetes, and microbial infections, establishing *Erythrina indica* as a promising candidate for modern drug discovery. Addressing these gaps will strengthen the scientific foundation for *Erythrina indica* based therapies and support its development as a reliable natural therapeutic agent.

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Ethics Statement

Ethical approval was not required for this study because it did not involve human participants, animals, identifiable personal data, or materials requiring institutional ethical review.

Declaration of Generative AI Use

The authors declare that no Generative AI tools were used in the preparation of this manuscript.

Conflict of Interest

The authors declare that they have no conflicts of interest related to this work.

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