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Review Article

A Review on Pharmacological Properties of Indian Innate Plants

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ABSTRACT

India's vast biodiversity includes a myriad of medicinal plants that have been utilized in traditional medicine for millennia. Plants have been integral to human health and medicine since ancient times, offering a vast array of pharmacologically active compounds with diverse therapeutic potentials. This review explores the broad spectrum of pharmacological properties exhibited by plants, encompassing antioxidant, antimicrobial, anti-inflammatory, anticancer, and other bioactive activities. These properties stem from a rich chemical diversity present in plant extracts, including alkaloids, flavonoids, terpenoids, phenolics, and essential oils. The review discusses the importance of these compounds in modern pharmacology, highlighting their roles in drug discovery, and development, and as natural alternatives to synthetic medications. Moreover, it addresses current trends, challenges, and future directions in utilizing plant-derived compounds for pharmaceutical and nutraceutical applications, emphasizing their significance in both traditional and modern medicinal practices. The integration of traditional knowledge with modern scientific approaches could lead to the development of novel treatments and improved health outcomes.

Keywords: Easily available plants, Herbs, Medicinal plants, Pharmacological properties.

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INTRODUCTION

India's rich and diverse flora has long served as a cornerstone of traditional medicine, providing a vast array of plants renowned for their significant medicinal properties. These indigenous plants have played integral roles in Ayurveda, Siddha, and other traditional Indian medical systems, offering remedies for various ailments while promoting overall health. Recent scientific advancements have begun to validate these traditional uses, shedding light on the pharmacological potential of these plants in modern medicine.

This review aims to explore the pharmacological properties of these key Indian plants, highlighting their traditional uses and the growing body of scientific evidence supporting their medicinal benefits. By bridging traditional knowledge with modern research, this review underscores the potential of these plants in addressing contemporary health challenges and advancing therapeutic developments. Traditional medicine, rooted in plants' therapeutic potential and deeply embedded in global cultures, relies on India's rich biodiversity. India boasts approximately 17,000 higher plant species, with 7,500 recognized for their medicinal properties, positioning it among the world's top biodiverse nations. These plants play crucial roles in village communities and traditional medical systems like Ayurveda, particularly benefiting marginalized groups and regions lacking robust healthcare infrastructure. Globally, over 3.3 billion people rely on medicinal plants for primary healthcare needs, highlighting their foundational role in traditional medicine.[1]

The chemical diversity of medicinal plants continues to shape global pharmacology, providing essential compounds for drug synthesis and development. Despite the historical shift towards synthetic drugs, the resurgence of natural products research underscores the enduring value of botanical resources. Approximately 25% of prescribed medications originate from higher plants, underscoring their significance in modern pharmacotherapy.[2]

Amid challenges such as drug availability, rising healthcare costs, and drug resistance, interest in plant-based remedies has surged. India, steeped in a tradition of medicinal flora, supports a robust herbal industry through knowledge systems like Ayurveda and Unani Medicine. Herbal medicines, known for their minimal side

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effects and natural compatibility, cater to diverse healthcare needs across demographics.[3]

The exploration of medicinal plants not only bolsters local economies but also addresses gaps in public healthcare, particularly in rural and low-income urban settings. The World Health Organization identifies around 21,000 plant species with medicinal properties, emphasizing their broad acceptance and safety profile among global populations.[4] This widespread use reaffirms the harmonious relationship between humans and nature, affirming plants' role as essential therapeutic resources.

The burgeoning bio-industry around medicinal plants in developing nations requires infrastructure and expertise in bioprocessing and industrial utilization. Yet, the potential of indigenous and non-indigenous flora remains largely untapped, promising further discoveries in medicine, agriculture, and environmental sustainability.[5] Rooted in ethnopharmacology, medicinal plants continue to yield novel bioactive compounds crucial for advancing pharmaceutical research and addressing contemporary health challenges.[6]

This review aims to explore the pharmacological properties of key Indian medicinal plants, highlighting their traditional uses and the growing body of scientific evidence supporting their medicinal benefits. By bridging traditional knowledge with modern research, this review underscores the potential of these plants in addressing contemporary health challenges and advancing therapeutic developments.

METHODOLOGY

For this study, an electronic review of literature was conducted to assess the pharmacological attributes of readily accessible medicinal plants, sourced from multiple online databases. Additionally, an ethnomedicinal survey was undertaken to document the utilization of medicinal plants for various treatments, particularly those found along roadside areas. Information on plants employed in traditional medicine to combat diverse diseases was compiled through interviews with practitioners of traditional herbal medicine.

RESULTS AND DISCUSSION

Indian indigenous plants have been extensively studied for their pharmacological properties, revealing a diverse range of bioactive compounds and therapeutic potentials.

Antimicrobial Activity

Indian traditional medicine showcases numerous plants renowned for their potent antimicrobial properties, which have been utilized for centuries to combat infections and promote overall health. Modern scientific research corroborates these traditional uses, highlighting the significant antimicrobial activities of key plants. Neem (*Azadirachta indica*) stands out as a powerful antimicrobial in Indian medicine, with its leaves, bark, and seeds containing nimbidin, nimbin, and azadirachtin, effective against bacteria like *Staphylococcus aureus* and *Escherichia coli*, and fungi including *Candida albicans*.[7,8] Tulsi (*Ocimum sanctum*), or holy basil, exhibits broad-spectrum antimicrobial activity through essential oils rich in compounds like eugenol, thymol, and carvacrol, effective against bacteria such as *Bacillus subtilis* and *Pseudomonas aeruginosa*, and fungi like *Aspergillus niger*.[9,10] Turmeric (*Curcuma longa*) features curcumin, extensively studied for its antimicrobial effects against Methicillin-resistant *Staphylococcus aureus* (MRSA), *Helicobacter pylori*, and various fungi, disrupting microbial membranes and inhibiting protein synthesis (Table 1).[11,12] Garlic (*Allium sativum*) contains allicin, combating bacteria like *Salmonella typhimurium* and *Vibrio cholerae*, and fungi such as Candida species, while also displaying antiviral activity against influenza and herpes viruses.[13,14] Ginger (*Zingiber officinale*) showcases gingerol and shogaol as bioactive compounds effective against bacteria including *E. coli* and *Salmonella typhi*, and fungi like *Candida albicans* and Aspergillus species, disrupting microbial membranes and inhibiting growth.[15,16] Aloe vera (*Aloe barbadensis* miller.) utilizes anthraquinones in its gel to combat bacteria such as *Staphylococcus aureus* and *Escherichia coli*, and fungi like *Candida albicans*.[17] Indian gooseberry (*Emblica officinalis*), known as Amla, features vitamin C and tannins in its fruit, effective against bacteria such as *Staphylococcus aureus* and *Escherichia coli*, and fungi like *Candida albicans*.[18] Clove (*Syzygium aromaticum*) relies on eugenol for its antimicrobial prowess against pathogens including *Staphylococcus aureus, Escherichia coli*, and *Candida albicans*.[19]

Antibacterial Activity

Indian traditional medicine encompasses a rich diversity of plants known for their antibacterial properties, utilized for centuries to treat infections and enhance overall health. Contemporary scientific studies validate these traditional uses, demonstrating their efficacy against various bacterial pathogens. Andrographis (*Andrographis paniculata*), commonly known as Kalmegh, contains andrographolide, which disrupts bacterial cell wall synthesis and inhibits the growth of *Staphylococcus aureus, Escherichia coli*, and *Pseudomonas aeruginosa*.[20] *Butea monosperma* (*Butea monosperma*), known as Flame of the Forest, possesses antibacterial properties due to flavonoids and tannins that disrupt bacterial cell walls and inhibit nucleic acid synthesis, effective against *Staphylococcus aureus* and *Escherichia coli*.[21] Cumin (*Cuminum cyminum*) seeds contain essential oils with compounds such as cumin aldehyde and thymol, which disrupt bacterial cell membranes and interfere with metabolic pathways, exhibiting strong antibacterial effects against *Escherichia coli, Salmonella typhimurium*, and *Bacillus subtilis*.[22] Fenugreek (*Trigonella foenum-graecum*) seeds, containing trigonelline and diosgenin, disrupt bacterial cell walls and inhibit biofilm

formation, showing antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*.[23] Lemongrass (*Cymbopogon citratus*) is potent due to essential oils like citral and limonene, which disrupt bacterial cell membranes and inhibit enzyme activity, effective against *Escherichia coli, Salmonella typhi*, and *Staphylococcus aureus*.[24] Moringa (*Moringa oleifera*), also known as the drumstick tree, contains bioactive compounds such as pterygospermin and benzyl isothiocyanate, which disrupt bacterial cell walls and inhibit protein synthesis, showing antibacterial activity against *Escherichia coli, Staphylococcus aureus*, and *Pseudomonas aeruginosa*.[25] Holy Fig (*Ficus religiosa*), or Peepal tree, contains tannins and flavonoids that disrupt bacterial cell walls and interfere with nucleic acid synthesis, effective against *Staphylococcus aureus* and *Escherichia coli*.[26] Indian Bael (*Aegle marmelos*), or Bilva, contains marmelosin and tannins that disrupt bacterial cell walls and inhibit bacterial enzymes, effective against *Staphylococcus aureus* and *Escherichia coli*.[27] Indian Sandalwood (*Santalum album*) contains santalol and other sesquiterpenes, which disrupt bacterial cell membranes and inhibit growth, effective against *Staphylococcus aureus* and *Escherichia coli*.[28] Indian Blackberry (*Syzygiumcumini*), or Jamun, contains ellagic acid and anthocyanins that inhibit bacterial cell wall synthesis and disrupt membrane integrity, effective against *Staphylococcus aureus* and *Escherichia coli*.[29] Ashwagandha (*Withania somnifera*) contains withanolides that disrupt bacterial cell membranes and inhibit growth, showing antibacterial activity against *Staphylococcus aureus* and *Escherichia coli*.[30] Bacopa (*Bacopa monnieri*), known as Brahmi, contains bacosides and flavonoids that inhibit bacterial enzyme activity and disrupt cell walls, effective against *Staphylococcus aureus* and *Escherichia coli*.[31] Licorice (*Glycyrrhiza glabra*) contains glycyrrhizin and flavonoids that disrupt bacterial cell walls and inhibit enzymes, showing antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* (Table 2).[32]

Antiviral Activity

Indian traditional medicine includes a diverse array of plants known for their antiviral properties, which have been used for centuries to combat viral infections, and modern scientific research has validated many of these traditional uses. Indian Gooseberry (*Phyllanthus emblica*), also known as Amla, is rich in vitamin C and polyphenols, inhibiting viruses such as Hepatitis B and HIV by enhancing the host's immune response and directly inhibiting viral replication.[33] Turmeric (*Curcuma longa*) contains curcumin, which inhibits the replication of viruses including Influenza, Hepatitis C, and HIV by blocking viral entry into host cells and suppressing viral replication.[34] Neem (*Azadirachta indica*) is renowned for its therapeutic properties, with compounds like azadirachtin and nimbolide inhibiting viruses such as Dengue, Herpes Simplex Virus (HSV), and HIV by disrupting viral envelope proteins and preventing viral entry.[35] Tulsi (*Ocimum sanctum*), or holy basil, contains essential oils with eugenol and ursolic acid, showing activity against Influenza, HSV, and Hepatitis B by inhibiting viral replication and modulating the immune response.[36] Ginger (*Zingiber officinale*) has compounds like gingerol and zingerone that inhibit viruses including Influenza, Human Respiratory Syncytial Virus (HRSV), and Norovirus by blocking viral attachment and penetration.[37] Andrographis (*Andrographis paniculata*), known as Kalmegh, features andrographolide, which has shown antiviral activity against Influenza, Hepatitis C, and Dengue by interfering with viral RNA synthesis and enhancing immune response.[38] Licorice (*Glycyrrhiza glabra*) contains glycyrrhizin, inhibiting viruses such as Hepatitis C, HIV, and HSV by preventing viral gene expression and replication.[39] Indian Mulberry (*Morinda citrifolia*), or Noni, has compounds like scopoletin and damnacanthal that show activity against Hepatitis B and HSV by enhancing immune response and disrupting viral RNA and protein synthesis.[40] Ashwagandha (*Withania somnifera*) contains withanolides that inhibit Influenza and HSV by modulating the immune response and inhibiting viral entry.[41] Bitter Melon (*Momordica charantia*) features momordicin and charantin, which disrupt viral RNA and protein synthesis, inhibiting viruses like HIV and Hepatitis C.[42] Phyllanthus (*Phyllanthus amarus*) has compounds like phyllanthin and hypophyllanthin that inhibit Hepatitis B and C viruses by blocking viral DNA polymerase and enhancing immune response.[43] Holy Basil (*Ocimum tenuiflorum*), also known as Tulsi, has essential oils with eugenol and ursolic acid that inhibit Influenza and HSV by modulating the immune response and preventing viral replication.[44] Garlic (*Allium sativum*) contains allicin and ajoene, inhibiting Influenza and HIV by blocking viral entry and disrupting replication processes.[45] Bael (*Aegle marmelos*), or Bengal quince, has compounds like marmelosin and psoralen that inhibit HSV and Influenza by enhancing immune response and preventing viral replication.[46] Indian Sarsaparilla (*Hemidesmus indicus*), or Anantamul, features hemidesmine and saponins that inhibit Hepatitis B and HIV by blocking viral DNA polymerase and enhancing immune response.[47] Karanj (*Pongamia pinnata*), or Indian beech, has compounds like karanjin and pongamol that inhibit Hepatitis B and HIV by preventing viral replication and entry.[48] Clove (*Syzygium aromaticum*) contains eugenol, which disrupts viral envelope integrity and inhibits HSV and Hepatitis C replication.[49] Adhatoda (*Adhatodavasica*), or Malabar nut, has vasicine and vasicinone that inhibit Influenza and HSV by enhancing immune response and preventing viral replication.[50] Tinospora (*Tinospora cordifolia*), also known as Guduchi or Giloy, contains tinosporide and cordifolioside that inhibit Hepatitis C and Dengue by modulating immune response and preventing replication.[51] Indian Lilac (*Azadirachta indica*), or Neem, has compounds like azadirachtin and nimbolide that inhibit HSV and Hepatitis B by preventing viral entry and disrupting envelope proteins.[52] Moringa (*Moringa oleifera*), or drumstick tree, has pterygospermin and benzyl isothiocyanate that inhibit HSV

Table 1: Comparative Analysis of Antimicrobial Plants in Indian Traditional Medicine.

Plant Name	Active Compounds	Target Bacteria	Target Fungi	Additional Notes	References
Neem (*Azadirachta indica*)	Nimbidin, Nimbin, Azadirachtin	*Staphylococcus aureus, Escherichia coli*	*Candida albicans*	Effective parts: leaves, bark, seeds	[7-8]
Tulsi (*Ocimum sanctum*)	Eugenol, Thymol, Carvacrol	*Bacillus subtilis, Pseudomonas aeruginosa*	*Aspergillus niger*	Essential oils are key	[9,10]
Turmeric (*Curcuma longa*)	Curcumin	MRSA, *Helicobacter pylori*	Various fungi	Disrupts microbial membranes inhibit protein synthesis	[11,12]
Garlic (*Allium sativum*)	Allicin	*Salmonella typhimurium, Vibrio cholerae*	Candida species	Also antiviral against influenza and herpes	[13,14]
Ginger (*Zingiber officinale*)	Gingerol, Shogaol	*Escherichia coli, Salmonella typhi*	*Candida albicans*, Aspergillus species	Disrupts microbial membranes	[15,16]
Aloe vera (*Aloe barbadensis* Miller.)	Anthraquinones	*Staphylococcus aureus, Escherichia coli*	*Candida albicans*	Effective part: gel	[17]
Indian gooseberry (*Emblica officinalis*)	Vitamin C, Tannins	*Staphylococcus aureus, Escherichia coli*	*Candida albicans*	Known as Amla	[18]
Clove (*Syzygium aromaticum*)	Eugenol	*Staphylococcus aureus, Escherichia coli*	*Candida albicans*	-	[19]

and Influenza by disrupting replication and enhancing immune response.[53] Peppermint (*Mentha piperita*) contains menthol and menthone that inhibit HSV and Influenza by preventing viral attachment and entry.[54] Indian Bdellium (*Commiphora wightii*), or Guggul, has guggulsterones that inhibit Hepatitis C and HSV by preventing replication and enhancing immune response.[55] Pomegranate (*Punica granatum*) contains punicalagins and ellagic acid that inhibit Influenza and HSV by modulating immune response and preventing replication.[56] Indian Cork Tree (*Millingtonia hortensis*) has lapachol and β-sitosterol that inhibit Influenza and HSV by enhancing immune response and preventing replication.[57] Indian Kino Tree (*Pterocarpus marsupium*), or Malabar Kino, has pterostilbene and marsupin that inhibit Hepatitis B and HSV by preventing viral DNA polymerase activity and replication.[58] Banyan Tree (*Ficus benghalensis*) has flavonoids and triterpenoids that inhibit Hepatitis B and HSV by modulating immune response and preventing replication.[59] Indian Tulip Tree (*Thespesia populnea*) contains gossypol and thespesone that inhibit HSV and Hepatitis B by disrupting viral envelope integrity and preventing replication (Table 3).[60] This comprehensive review underscores the potential of Indian plants in developing antiviral therapies, necessitating further research to fully harness their therapeutic benefits.

Anti-Fungal activity

Antifungal plants and trees play a pivotal role in traditional and modern medicine by providing natural alternatives to synthetic antifungal agents. These plants produce a variety of bioactive compounds that inhibit the growth of fungi, making them valuable for treating fungal infections. This review highlights several plants known for their antifungal properties, supported by recent high-impact journal research. Tea Tree (*Melaleuca alternifolia*) oil is renowned for its potent antifungal activity. Terpinen-4-ol, the main active component of tea tree oil, exhibits significant antifungal effects against Candida species and dermatophytes.[61] Neem (*Azadirachta indica*) extracts, rich in azadirachtin and nimbin, have been shown to possess strong antifungal properties. Neem oil effectively inhibits the growth of *Candida albicans* and Aspergillus species.[62] Garlic (*Allium sativum*) is well-known for its broad-spectrum antimicrobial properties, including antifungal effects. Allicin, the main bioactive compound in garlic, has been shown to inhibit the growth of Candida and other fungal pathogens.[63] Turmeric (*Curcuma longa*) contains curcumin, which has demonstrated antifungal activity against various fungal strains. Curcumin's potential to inhibit the growth of Candida species and dermatophytes has been highlighted.[64] Thyme (*Thymus vulgaris*) essential oil, particularly rich in thymol and carvacrol, exhibits strong antifungal properties.

Its efficacy against Candida and Aspergillus species has been demonstrated.[65] Eucalyptus (*Eucalyptus globulus*) oil contains eucalyptol (1,8-cineole), which has been shown to have antifungal properties. Eucalyptus oil effectively inhibits the growth of Trichophyton and Candida species.[66] Lavender (*Lavandula angustifolia*) essential oil has antifungal properties, attributed to its high linalool and linalyl acetate content. Lavender oil was effective against various fungal pathogens, including Candida and Aspergillus species.[67] Cinnamon (*Cinnamomum verum*) bark and oil, containing cinnamaldehyde, have potent antifungal activity. Its effectiveness against Candida and dermatophyte infections has been demonstrated.[68] Clove (*Syzygium aromaticum*) oil, rich in eugenol, has significant antifungal properties. Its efficacy against Candida species and dermatophytes has been highlighted.[69] Oregano (*Origanum vulgare*) essential oil contains carvacrol and thymol, which exhibit strong antifungal activity. Its effectiveness against *Candida albicans* and Aspergillus species has been reported.[70] Aloe Vera (*Aloe barbadensis*) gel contains anthraquinones and polysaccharides that exhibit antifungal activity. Its efficacy against Candida species and other fungal pathogens has been demonstrated.[71] Peppermint (*Mentha piperita*) oil, rich in menthol and menthone, has shown significant antifungal activity. Its effectiveness against various Candida species has been confirmed.[72] Rosemary (*Rosmarinus officinalis*) essential oil contains compounds such as rosmarinic acid and camphor, known for their antifungal properties. Its activity against Aspergillus and Penicillium species has been highlighted.[73] Ginger (*Zingiber officinale*) contains gingerol and shogaol, which exhibit strong antifungal activity. Its effectiveness against *Candida albicans* and other fungal pathogens has been

Table 2: Antibacterial Properties of Plants in Indian Traditional Medicine.

Plant Name	Active Compounds	Target Bacteria	Mechanism of Action	References
Andrographis (*Andrographis paniculata*)	Andrographolide	*Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa*	Disrupts bacterial cell wall synthesis, inhibits growth	[20]
Flame of the Forest (*Butea monosperma*)	Flavonoids, Tannins	*Staphylococcus aureus, Escherichia coli*	Disrupts cell walls inhibit nucleic acid synthesis	[21]
Cumin (*Cuminum cyminum*)	Cumin aldehyde, Thymol	*Escherichia coli, Salmonella typhimurium, Bacillus subtilis*	Disrupts cell membranes and interferes with metabolic pathways	[22]
Fenugreek (*Trigonella foenum-graecum*)	Trigonelline, Diosgenin	*Staphylococcus aureus, Escherichia coli*	Disrupts cell walls, inhibits biofilm formation	[23]
Lemongrass (*Cymbopogon citratus*)	Citral, Limonene	*Escherichia coli, Salmonella typhi, Staphylococcus aureus*	Disrupts cell membranes, inhibits enzyme activity	[24]
Moringa (*Moringa oleifera*)	Pterygospermin, Benzyl isothiocyanate	*Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa*	Disrupts cell walls, inhibits protein synthesis	[25]
Holy Fig (*Ficus religiosa*)	Tannins, Flavonoids	*Staphylococcus aureus, Escherichia coli*	Disrupts cell walls, interferes with nucleic acid synthesis	[26]
Indian Bael (*Aegle marmelos*)	Marmelosin, Tannins	*Staphylococcus aureus, Escherichia coli*	Disrupts cell walls, inhibits bacterial enzymes	[27]
Indian Sandalwood (*Santalum album*)	Santalol, Sesquiterpenes	*Staphylococcus aureus, Escherichia coli*	Disrupts cell membranes, inhibits growth	[28]
Indian Blackberry (*Syzygiumcumini*)	Ellagic acid, Anthocyanins	*Staphylococcus aureus, Escherichia coli*	Inhibits cell wall synthesis, disrupts membrane integrity	[29]
Ashwagandha (*Withania somnifera*)	Withanolides	*Staphylococcus aureus, Escherichia coli*	Disrupts cell membranes, inhibits growth	[30]
Bacopa (*Bacopa monnieri*)	Bacosides, Flavonoids	*Staphylococcus aureus, Escherichia coli*	Inhibits enzyme activity, disrupts cell walls	[31]
Licorice (*Glycyrrhiza glabra*)	Glycyrrhizin, Flavonoids	*Staphylococcus aureus, Escherichia coli*	Disrupts cell walls, inhibits enzymes	[32]

Table 3: Antiviral Properties of Plants in Indian Traditional Medicine.

Plant Name	Active Compounds	Target Viruses	Mechanism of Action	References
Indian Gooseberry (*Phyllanthus emblica*)	Vitamin C, Polyphenols	Hepatitis B, HIV	Enhances immune response, inhibits viral replication	[33]
Turmeric (*Curcuma longa*)	Curcumin	Influenza, Hepatitis C, HIV	Blocks viral entry, suppresses viral replication	[34]
Neem (*Azadirachta indica*)	Azadirachtin, Nimbolide	Dengue, HSV, HIV	Disrupts viral envelope proteins, prevents viral entry	[35]
Tulsi (*Ocimum sanctum*)	Eugenol, Ursolic acid	Influenza, HSV, Hepatitis B	Inhibits viral replication, modulates the immune response	[36]
Ginger (*Zingiber officinale*)	Gingerol, Zingerone	Influenza, HRSV, Norovirus	Blocks viral attachment and penetration	[37]
Andrographis (*Andrographis paniculata*)	Andrographolide	Influenza, Hepatitis C, Dengue	Interferes with viral RNA synthesis, enhances immune response	[38]
Licorice (*Glycyrrhiza glabra*)	Glycyrrhizin	Hepatitis C, HIV, HSV	Prevents viral gene expression and replication	[39]
Indian Mulberry (*Morindacitrifolia*)	Scopoletin, Damnacanthal	Hepatitis B, HSV	Enhances immune response, disrupts viral RNA and protein synthesis	[40]
Ashwagandha (*Withania somnifera*)	Withanolides	Influenza, HSV	Modulates immune response and inhibits viral entry	[41]
Bitter Melon (*Momordica charantia*)	Momordicin, Charantin	HIV, Hepatitis C	Disrupts viral RNA and protein synthesis	[42]
Phyllanthus (*Phyllanthus amarus*)	Phyllanthin, Hypophyllanthin	Hepatitis B, Hepatitis C	Blocks viral DNA polymerase, enhances immune response	[43]
Holy Basil (*Ocimum tenuiflorum*)	Eugenol, Ursolic acid	Influenza, HSV	Modulates immune response, prevents viral replication	[44]
Garlic (*Allium sativum*)	Allicin, Ajoene	Influenza, HIV	Blocks viral entry, disrupts replication processes	[45]
Bael (*Aegle marmelos*)	Marmelosin, Psoralen	HSV, Influenza	Enhances immune response, prevents viral replication	[46]
Indian Sarsaparilla (*Hemidesmus indicus*)	Hemidesmine, Saponins	Hepatitis B, HIV	Blocks viral DNA polymerase, enhances immune response	[47]
Karanj (*Pongamia pinnata*)	Karanjin, Pongamol	Hepatitis B, HIV	Prevents viral replication and entry	[48]
Clove (*Syzygium aromaticum*)	Eugenol	HSV, Hepatitis C	Disrupts viral envelope integrity, inhibits replication	[49]

Plant Name	Active Compounds	Target Viruses	Mechanism of Action	References
Adhatoda (*Adhatoda vasica*)	Vasicine, Vasicinone	Influenza, HSV	Enhances immune response, prevents viral replication	[50]
Tinospora (*Tinospora cordifolia*)	Tinosporide, Cordifolioside	Hepatitis C, Dengue	Modulates immune response, prevents replication	[51]
Indian Lilac (*Azadirachta indica*)	Azadirachtin, Nimbolide	HSV, Hepatitis B	Prevents viral entry, disrupts envelope proteins	[52]
Moringa (*Moringa oleifera*)	Pterygospermin, Benzyl isothiocyanate	HSV, Influenza	Disrupts replication, enhances immune response	[53]
Peppermint (*Mentha piperita*)	Menthol, Menthone	HSV, Influenza	Prevents viral attachment and entry	[54]
Indian Bdellium (*Commiphora wightii*)	Guggulsterones	Hepatitis C, HSV	Prevents replication, enhances immune response	[55]
Pomegranate (*Punica granatum*)	Punicalagins, Ellagic acid	Influenza, HSV	Modulates immune response, prevents replication	[56]
Indian Cork Tree (*Millingtonia hortensis*)	Lapachol, β-Sitosterol	Influenza, HSV	Enhances immune response, prevents replication	[57]
Indian Kino Tree (*Pterocarpus marsupium*)	Pterostilbene, Marsupin	Hepatitis B, HSV	Prevents viral DNA polymerase activity, inhibits replication	[58]
Banyan Tree (*Ficus benghalensis*)	Flavonoids, Triterpenoids	Hepatitis B, HSV	Modulates immune response, prevents replication	[59]
Indian Tulip Tree (*Thespesia populnea*)	Gossypol, Thespesone	HSV, Hepatitis B	Disrupts viral envelope integrity, prevents replication	[60]

demonstrated.[74] Lemongrass (*Cymbopogon citratus*) oil, high in citral, has potent antifungal properties. Its effectiveness against Candida and Aspergillus species has been shown.[75] Basil (*Ocimum basilicum*) essential oil contains eugenol and linalool, which have demonstrated antifungal activity. Its effectiveness against fungal pathogens, including Candida species, has been confirmed.[76] Grapefruit (*Citrus paradisi*) seed extract, rich in polyphenols and flavonoids, has shown antifungal activity. Its effectiveness against Candida species and dermatophytes has been highlighted.[77] Licorice (*Glycyrrhiza glabra*) root extract contains glycyrrhizin and flavonoids that exhibit antifungal properties. Its efficacy against Candida and Aspergillus species has been demonstrated.[78] Chamomile (*Matricaria chamomilla*) extracts have mild antifungal properties, particularly useful in soothing skin irritations and minor fungal infections. Its activity against fungal pathogens has been confirmed.[79] St. John's Wort (*Hypericum perforatum*) oil contains hypericin and flavonoids with antifungal properties. Its effectiveness against Candida species has been highlighted.[80] Sage (*Salvia officinalis*) essential oil contains thujone and camphor, which exhibit antifungal properties. Its activity against Aspergillus and Candida species has been highlighted.[81] Bergamot (*Citrus bergamia*) essential oil contains limonene and linalool, known for their antifungal properties. Its effectiveness against Candida and Aspergillus species has been highlighted.[82] Black Cumin (*Nigella sativa*) oil contains thymoquinone, which exhibits significant antifungal properties. Its effectiveness against *Candida albicans* and other fungi has been shown.[83] Rosemary (*Rosmarinus officinalis*) essential oil contains rosmarinic acid and camphor, which have demonstrated antifungal activity. Its efficacy against various fungal pathogens has been confirmed.[84] Geranium (*Pelargonium graveolens*) essential oil, rich in citronellol and geraniol, has shown antifungal activity. Its effectiveness against Candida species has been highlighted (Table 4).[85]

Antioxidant property

Indian traditional medicine recognizes several plants and trees celebrated for their potent antioxidant properties. These natural antioxidants play a crucial role in neutralizing harmful free radicals, thereby protecting cells from oxidative stress and potential damage. Indian Gooseberry (*Phyllanthus emblica*), commonly known as Amla, is renowned for its high vitamin C content and bioactive compounds like polyphenols, tannins, and flavonoids, which inhibit lipid peroxidation and have demonstrated significant antioxidant activity.[86,87] Turmeric (*Curcuma longa*) is revered for its curcumin content, exhibiting strong antioxidant effects by scavenging free radicals and enhancing enzymatic antioxidant defenses.[88,89] Holy Basil (*Ocimum sanctum*), or Tulsi, contains essential oils rich in eugenol and rosmarinic acid, which possess significant antioxidant activity, protecting cells from damage caused by reactive oxygen species.[90,91] Green Tea (*Camellia sinensis*) is celebrated for its high antioxidant content, particularly Epigallocatechin Gallate (EGCG), which enhances antioxidant enzyme activity and protects cells from oxidative stress.[92,93] Aloe Vera (*Aloe barbadensis* miller.) contains vitamins A, C, and E, along with flavonoids and polyphenols, contributing to its antioxidant properties, both topically and orally.[94,95] Ginger (*Zingiber officinale*) is known for its bioactive compounds like gingerol and shogaol, which neutralize free radicals and reduce oxidative stress.[96,97] Ashwagandha (*Withania somnifera*) contains withanolides that exhibit significant antioxidant activity, enhancing cellular defenses.[98,99] Pomegranate (*Punica granatum*) is rich in polyphenols such as punicalagins and anthocyanins, which reduce oxidative stress and enhance antioxidant enzyme activities.[100,101] Moringa (*Moringa oleifera*) contains polyphenols, flavonoids, and vitamins A, C, and E, known for scavenging free radicals and protecting against cellular damage.[102,103] *Ginkgo biloba* (*Ginkgo biloba*) contains flavonoids and terpenoids that neutralize free radicals and protect against oxidative stress.[104,105] Grape Seed (*Vitis vinifera*) is rich in proanthocyanidins, which protect cells by scavenging free radicals and inhibiting lipid peroxidation.[106,107] Rosemary (*Rosmarinus officinalis*) contains phenolic compounds like rosmarinic acid and carnosic acid, which exhibit significant antioxidant activity.[108,109] Blueberries (*Vaccinium corymbosum*) are rich in anthocyanins, which neutralize free radicals and reduce oxidative stress.[110,111] Olives (*Olea europaea*) contain polyphenols like oleuropein and hydroxytyrosol, which reduce oxidative stress and protect cells from damage.[112,113] Acai Berries (*Euterpe oleracea*) are high in anthocyanins and flavonoids, enhancing antioxidant defenses and reducing oxidative damage.[114,115] Goji Berries (*Lyciumbarbarum*) contain carotenoids and flavonoids, which scavenge free radicals and protect against cellular damage (Table 5).[116,117] These plants and trees are recognized for their significant antioxidant activities, contributing to their health benefits and therapeutic potential in traditional and modern medicine.

Table 4: Antifungal Properties of Plants and Trees in Traditional and Modern Medicine.

Plant Name	Active Compounds	Target Fungi	Mechanism of Action	References
Tea Tree (*Melaleuca alternifolia*)	Terpinen-4-ol	Candida species, Dermatophytes	Inhibits fungal growth	[61]
Neem (*Azadirachta indica*)	Azadirachtin, Nimbin	*Candida albicans*, Aspergillus species	Inhibits fungal growth	[62]
Garlic (*Allium sativum*)	Allicin	Candida, and other fungal pathogens	Inhibits fungal growth	[63]
Turmeric (*Curcuma longa*)	Curcumin	Candida species, Dermatophytes	Inhibits fungal growth	[64]
Thyme (*Thymus vulgaris*)	Thymol, Carvacrol	Candida, Aspergillus species	Inhibits fungal growth	[65]
Eucalyptus (*Eucalyptus globulus*)	Eucalyptol (1,8-cineole)	Trichophyton, Candida species	Inhibits fungal growth	[66]
Lavender (*Lavandula angustifolia*)	Linalool, Linalyl acetate	Candida, Aspergillus species	Inhibits fungal growth	[67]
Cinnamon (*Cinnamomum verum*)	Cinnamaldehyde	Candida, Dermatophytes	Inhibits fungal growth	[68]
Clove (*Syzygium aromaticum*)	Eugenol	Candida species, Dermatophytes	Inhibits fungal growth	[69]
Oregano (*Origanum vulgare*)	Carvacrol, Thymol	*Candida albicans*, Aspergillus species	Inhibits fungal growth	[70]

Plant Name	Active Compounds	Target Fungi	Mechanism of Action	References
Aloe Vera (*Aloe barbadensis*)	Anthraquinones, Polysaccharides	Candida species, other fungal pathogens	Inhibits fungal growth	[71]
Peppermint (*Mentha piperita*)	Menthol, Menthone	Candida species	Inhibits fungal growth	[72]
Rosemary (*Rosmarinus officinalis*)	Rosmarinic acid, Camphor	Aspergillus, Penicillium species	Inhibits fungal growth	[73]
Ginger (*Zingiber officinale*)	Gingerol, Shogaol	*Candida albicans*, other fungal pathogens	Inhibits fungal growth	[74]
Lemongrass (*Cymbopogon citratus*)	Citral	Candida, Aspergillus species	Inhibits fungal growth	[75]
Basil (*Ocimum basilicum*)	Eugenol, Linalool	Candida species	Inhibits fungal growth	[76]
Grapefruit (*Citrus paradisi*)	Polyphenols, Flavonoids	Candida species, Dermatophytes	Inhibits fungal growth	[77]
Licorice (*Glycyrrhiza glabra*)	Glycyrrhizin, Flavonoids	Candida, Aspergillus species	Inhibits fungal growth	[78]
Chamomile (*Matricaria chamomilla*)	Various compounds	Fungal pathogens	Mild antifungal properties, soothes skin irritations	[79]
St. John's Wort (*Hypericum perforatum*)	Hypericin, Flavonoids	Candida species	Inhibits fungal growth	[80]
Sage (*Salvia officinalis*)	Thujone, Camphor	Aspergillus, Candida species	Inhibits fungal growth	[81]
Bergamot (*Citrus bergamia*)	Limonene, Linalool	Candida, Aspergillus species	Inhibits fungal growth	[82]
Black Cumin (*Nigella sativa*)	Thymoquinone	*Candida albicans*, other fungi	Inhibits fungal growth	[83]
Rosemary (*Rosmarinus officinalis*)	Rosmarinic acid, Camphor	Various fungal pathogens	Inhibits fungal growth	[84]
Geranium (*Pelargonium graveolens*)	Citronellol, Geraniol	Candida species	Inhibits fungal growth	[85]

Anti-inflammatory activity

Indian traditional medicine recognizes several plants and trees celebrated for their potent anti-inflammatory properties, crucial in reducing inflammation and treating various inflammatory conditions. Turmeric (*Curcuma longa*) contains curcumin, known for inhibiting inflammatory molecules like COX-2 and cytokines, showing therapeutic potential against arthritis and inflammatory bowel disease.[118,119] Ginger (*Zingiber officinale*) with its gingerols and shogaols inhibits pro-inflammatory cytokines, beneficial for conditions like osteoarthritis.[120,121] Boswellia (*Boswellia serrata*), containing boswellic acids, inhibits 5-lipoxygenase to manage chronic inflammatory diseases like rheumatoid arthritis.[122,123] Ashwagandha (*Withania somnifera*) with its withanolides reduces inflammation by modulating the immune system, beneficial for stress-induced inflammation.[124,125] Holy Basil (*Ocimum sanctum*) contains eugenol and rosmarinic acid, effective in treating inflammatory disorders.[126,127] Aloe Vera (*Aloe barbadensis* miller.) utilizes acemannan to inhibit cytokine production, offering relief for skin and internal inflammations.[128,129] Green Tea (*Camellia sinensis*) rich in EGCG, suppresses inflammation and reduces the risk of inflammatory diseases.[130,131] Cat's Claw (*Uncaria tomentosa*) inhibits TNF-alpha to treat arthritis and inflammatory bowel disease.[132,133] Licorice (*Glycyrrhiza glabra*) with glycyrrhizin reduces inflammation in conditions such as peptic ulcers.[134,135] Rosemary (*Rosmarinus officinalis*) and its rosmarinic acid alleviate arthritis symptoms.[136,137] Pomegranate (*Punica granatum*) with punicalagins combats oxidative stress and inflammation associated with chronic diseases.[138,139] Devil's Claw (*Harpagophytum procumbens*) uses harpagosides to inhibit COX-2, easing pain and inflammation.[140,141] Frankincense (*Boswellia serrata*) treats arthritis by inhibiting 5-lipoxygenase.[142,143] Willow Bark (*Salix alba*) with salicin manages pain and inflammation similar to aspirin.[144,145] *Ginkgo biloba* (*Ginkgo biloba*) reduces inflammation and enhances cognitive function.[146,147] Chamomile (*Matricaria chamomilla*) with apigenin and quercetin treats various inflammatory conditions (Table 6).[148,149] These botanicals illustrate diverse

strategies for managing inflammation, highlighting their therapeutic potential in traditional and modern medicine.

Anticancer activity

Indian traditional medicine has identified several plants and trees renowned for their potent anticancer properties, offering promising avenues for cancer treatment and prevention. Turmeric (*Curcuma longa*) contains curcumin, extensively studied for its anticancer effects, inhibiting cancer cell proliferation, inducing apoptosis, and suppressing tumor growth.[150,151] Green tea (*Camellia sinensis*) is rich in EGCG, known for its antioxidant and anticancer properties, inhibiting cancer cell growth and interfering with tumor-promoting pathways.[152,153] Ginger (*Zingiber officinale*), with its gingerols and paradols, exhibits anticancer activities by modulating carcinogenic pathways and inducing apoptosis.[154,155] Ashwagandha (*Withania somnifera*) contains Withaferin A, showing potential anticancer effects through apoptosis induction and immune modulation.[156,157] Holy Basil (*Ocimum sanctum*) with phytochemicals like ursolic acid and eugenol induces apoptosis and modulates cancer-related pathways.[158,159] Ginseng (*Panax ginseng*), with ginsenosides, inhibits tumor growth and enhances immune responses against cancer cells.[160,161] Garlic (*Allium sativum*) contains allicin, suppressing cancer cell proliferation and angiogenesis.[162,163] Various berries (strawberries, raspberries, and blueberries) rich in anthocyanins and ellagic acid reduce oxidative stress, inhibit tumor growth, and induce apoptosis.[164,165] Moringa (*Moringa oleifera*), with quercetin and beta-sitosterol, inhibits cancer cell proliferation and induces apoptosis.[166,167] Echinacea (*Echinacea purpurea*) stimulates the immune system against cancer cells through its alkamides and polysaccharides.[168,169] Black Raspberry (*Rubus occidentalis*), Grape Seed Extract (*Vitis vinifera*), and

Table 5: Antioxidant Properties of Plants and Trees in Indian Traditional Medicine.

Plant Name	Active Compounds	Mechanism of Action	References
Indian Gooseberry (*Phyllanthus emblica*)	Vitamin C, Polyphenols, Tannins, Flavonoids	Inhibits lipid peroxidation, significant antioxidant activity	[86,87]
Turmeric (*Curcuma longa*)	Curcumin	Scavenges free radicals enhances enzymatic antioxidant defenses	[88,89]
Holy Basil (*Ocimum sanctum*)	Eugenol, Rosmarinic Acid	Protects cells from reactive oxygen species	[90,91]
Green Tea (*Camellia sinensis*)	Epigallocatechin Gallate (EGCG)	Enhances antioxidant enzyme activity, protects from oxidative stress	[92,93]
Aloe Vera (*Aloe barbadensis* miller.)	Vitamins A, C, and E, Flavonoids, Polyphenols	Provides antioxidant properties topically and orally	[94,95]
Ginger (*Zingiber officinale*)	Gingerol, Shogaol	Neutralizes free radicals, reduces oxidative stress	[96,97]
Ashwagandha (*Withania somnifera*)	Withanolides	Enhances cellular defenses	[98,99]
Pomegranate (*Punica granatum*)	Polyphenols (Punicalagins, Anthocyanins)	Reduces oxidative stress, enhances antioxidant enzyme activities	[100,101]
Moringa (*Moringa oleifera*)	Polyphenols, Flavonoids, Vitamins A, C, and E	Scavenges free radicals, protects against cellular damage	[102,103]
Ginkgo biloba (*Ginkgo biloba*)	Flavonoids, Terpenoids	Neutralizes free radicals, protects against oxidative stress	[104,105]
Grape Seed (*Vitis vinifera*)	Proanthocyanidins	Protects cells by scavenging free radicals, inhibits lipid peroxidation	[106,107]
Rosemary (*Rosmarinus officinalis*)	Rosmarinic Acid, Carnosic Acid	Exhibits significant antioxidant activity	[108,109]
Blueberries (*Vaccinium corymbosum*)	Anthocyanins	Neutralizes free radicals, reduces oxidative stress	[110,111]
Olives (*Olea europaea*)	Polyphenols (Oleuropein, Hydroxytyrosol)	Reduces oxidative stress, protects cells from damage	[112,113]
Acai Berries (*Euterpe oleracea*)	Anthocyanins, Flavonoids	Enhances antioxidant defenses, reduces oxidative damage	[114,115]
Goji Berries (*Lycium barbarum*)	Carotenoids, Flavonoids	Scavenges free radicals, protects against cellular damage	[116,117]

Table 6: Anti-Inflammatory Properties of Plants and Trees in Indian Traditional Medicine.

Plant Name	Active Compounds	Mechanism of Action	References
Turmeric (*Curcuma longa*)	Curcumin	Inhibits COX-2 and cytokines, treats arthritis and IBD	[118,119]
Ginger (*Zingiber officinale*)	Gingerols, Shogaols	Inhibits pro-inflammatory cytokines, beneficial for osteoarthritis	[120,121]
Boswellia (*Boswellia serrata*)	Boswellic Acids	Inhibits 5-lipoxygenase, manages rheumatoid arthritis	[122,123]
Ashwagandha (*Withania somnifera*)	Withanolides	Modulates immune system, reduces stress-induced inflammation	[124,125]
Holy Basil (*Ocimum sanctum*)	Eugenol, Rosmarinic Acid	Effective in treating inflammatory disorders	[126,127]
Aloe Vera (*Aloe barbadensis* miller.)	Acemannan	Inhibits cytokine production, relieves skin and internal inflammations	[128,129]
Green Tea (*Camellia sinensis*)	Epigallocatechin Gallate (EGCG)	Suppresses inflammation, reduces the risk of inflammatory diseases	[130,131]
Cat's Claw (*Uncaria tomentosa*)	Unspecified	Inhibits TNF-alpha, treats arthritis and IBD	[132,133]
Licorice (*Glycyrrhiza glabra*)	Glycyrrhizin	Reduces inflammation in peptic ulcers	[134,135]
Rosemary (*Rosmarinus officinalis*)	Rosmarinic Acid	Alleviates arthritis symptoms	[136,137]
Pomegranate (*Punica granatum*)	Punicalagins	Combats oxidative stress and inflammation	[138,139]
Devil's Claw (*Harpagophytum procumbens*)	Harpagosides	Inhibits COX-2, eases pain and inflammation	[140,141]
Frankincense (*Boswellia serrata*)	Boswellic Acids	Inhibits 5-lipoxygenase, treats arthritis	[142,143]
Willow Bark (*Salix alba*)	Salicin	Manages pain and inflammation similar to aspirin	[144,145]
Ginkgo biloba (*Ginkgo biloba*)	Unspecified	Reduces inflammation, enhances cognitive function	[146,147]
Chamomile (*Matricaria chamomilla*)	Apigenin, Quercetin	Treats various inflammatory conditions	[148,149]

Chaga Mushroom (*Inonotus obliquus*), with their respective compounds, exhibit antioxidant properties, inhibit tumor growth, and enhance the immune response against cancer.[170,177] Soursop (*Annona muricata*) contains acetogenins, promising in inhibiting cancer cell growth and inducing apoptosis.[178,179] Reishi Mushroom (*Ganoderma lucidum*) with polysaccharides and triterpenes inhibits tumor growth and enhances the immune response against cancer cells.[180,181] Additionally, Sweet Wormwood (*Artemisia annua*) contains artemisinin, which has shown anticancer effects by inducing apoptosis and inhibiting angiogenesis in various cancer types.[182,183] Graviola (*Annona muricata*) contains acetogenins, which have demonstrated potential in inhibiting cancer cell growth and inducing apoptosis.[184,185] Bitter Melon (*Momordica charantia*) contains compounds like cucurbitacin B and charantin, which have shown anticancer effects by inducing apoptosis and inhibiting cancer cell proliferation.[186,187] *Ginkgo biloba* extracts have been studied for their potential anticancer activities due to their antioxidant properties and ability to modulate cell signaling pathways involved in cancer development.[188,189] Rosemary (*Rosmarinus officinalis*) contains carnosic acid and rosmarinic acid, which exhibit antioxidant and anticancer properties by inhibiting tumor growth and inducing apoptosis in cancer cells.[190,191] Oregano (*Origanum vulgare*) contains carvacrol and thymol, which have shown anticancer effects by inducing cell cycle arrest and apoptosis in cancer cells (Table 7).[192,193] These plants represent diverse sources of bioactive compounds that have been studied for their potential in cancer prevention and therapy, contributing to the growing field of natural products in oncology research. These references should provide comprehensive insights into the anticancer properties of the mentioned plants and their bioactive components.

Antidiabetic activity

Diabetes mellitus is a chronic metabolic disorder characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Managing diabetes is crucial to

preventing complications and improving the quality of life for those affected. In recent years, there has been significant interest in using plant-based remedies for managing diabetes due to their efficacy, lower side effects, and traditional use in various cultures. This review highlights several plants and trees known for their antidiabetic properties, supported by recent research.

Momordica charantia (Bitter Melon) is extensively used in traditional medicine for its antidiabetic effects. It contains bioactive compounds such as charantin, vicine, and polypeptide-p, which have been shown to exert hypoglycemic effects by enhancing glucose uptake and insulin sensitivity.[194] Similarly, *Trigonella foenum-graecum* (Fenugreek) seeds are rich in soluble fiber, which helps manage blood glucose levels. The seeds contain trigonelline, 4-hydroxyisoleucine, and other alkaloids that exhibit antidiabetic properties by enhancing insulin secretion and reducing insulin resistance.[195] *Cinnamomum verum* (Cinnamon) has been traditionally used to treat various ailments, including diabetes. It contains bioactive compounds such as cinnamaldehyde, cinnamic acid, and cinnamate, which enhance insulin receptor activity and glucose uptake.[196] *Gymnemasylvestre* (Gymnema) is known as the "sugar destroyer" due to its ability to suppress the taste of sweetness and reduce sugar absorption in the intestines. Gymnemic acids, the primary bioactive compounds, enhance insulin secretion and regenerate pancreatic beta cells.[197] *Ocimum tenuiflorum* (Holy Basil) is widely revered in Ayurvedic medicine for its therapeutic properties, including antidiabetic effects. It contains compounds such as eugenol, ursolic acid, and rosmarinic acid, which enhance insulin secretion and improve glucose metabolism.[198] Aloe vera is widely recognized for its medicinal properties, including antidiabetic effects. The gel from Aloe vera leaves contains compounds such as aloin and aloe-emodin that have been shown to reduce blood glucose levels and improve insulin sensitivity.[199] *Azadirachta indica* (Neem) has been used in traditional medicine for its various health benefits, including antidiabetic properties. Neem leaves contain bioactive compounds such as nimbidin, nimbin, and quercetin, which help reduce blood glucose levels by enhancing insulin sensitivity and secretion.[200] *Syzygiumcumini* (Jamun) seeds are well-known for their antidiabetic effects. They contain jamboline and ellagic acid, which help regulate blood sugar levels by enhancing insulin activity and inhibiting alpha-glucosidase.[201]

Berberis vulgaris (Barberry) contains berberine, an alkaloid with potent antidiabetic properties. Berberine has been shown to enhance insulin sensitivity, reduce glucose production in

Table 7: Anticancer Properties of Plants and Trees in Indian Traditional Medicine.

Plant	Bioactive Components	Anticancer Effects	References
Turmeric (*Curcuma longa*)	Curcumin	Inhibits cancer cell proliferation, induces apoptosis, suppresses tumor growth	[150,151]
Green tea (*Camellia sinensis*)	EGCG	Inhibits cancer cell growth, interferes with tumor-promoting pathways	[152,153]
Ginger (*Zingiber officinale*)	Gingerols, paradols	Modulates carcinogenic pathways, induces apoptosis	[154,155]
Ashwagandha (*Withania somnifera*)	Withaferin A	Induces apoptosis, modulates immune system	[156,157]
Holy Basil (*Ocimum sanctum*)	Ursolic acid, eugenol	Induces apoptosis, modulates cancer-related pathways	[158,159]
Ginseng (*Panax ginseng*)	Ginsenosides	Inhibits tumor growth, enhances immune responses	[160,161]
Garlic (*Allium sativum*)	Allicin	Suppresses cancer cell proliferation, inhibits angiogenesis	[162,163]
Various berries	Anthocyanins, ellagic acid	Reduces oxidative stress, inhibits tumor growth, induces apoptosis	[164,165]
Moringa (*Moringa oleifera*)	Quercetin, beta-sitosterol	Inhibits cancer cell proliferation, induces apoptosis	[166,167]
Echinacea (*Echinacea purpurea*)	Alkamides, polysaccharides	Stimulates immune system against cancer cells	[168,169]
Black Raspberry (*Rubus occidentalis*)	Various compounds	Exhibits antioxidant properties, inhibits tumor growth, enhances immune response	[170-177]
Grape Seed Extract (*Vitis vinifera*)	Various compounds	Exhibits antioxidant properties, inhibits tumor growth, enhances immune response	[170-177]

Plant	Bioactive Components	Anticancer Effects	References
Chaga Mushroom (*Inonotus obliquus*)	Various compounds	Exhibits antioxidant properties, inhibits tumor growth, enhances immune response	[170-177]
Soursop (*Annona muricata*)	Acetogenins	Inhibits cancer cell growth, induces apoptosis	[178,179]
Reishi Mushroom (*Ganoderma lucidum*)	Polysaccharides, triterpenes	Inhibits tumor growth, enhances immune response	[180,181]
Sweet Wormwood (*Artemisia annua*)	Artemisinin	Induces apoptosis, inhibits angiogenesis	[182,183]
Graviola (*Annona muricata*)	Acetogenins	Inhibits cancer cell growth, induces apoptosis	[184,185]
Bitter Melon (*Momordica charantia*)	Cucurbitacin B, charantin	Induces apoptosis, inhibits cancer cell proliferation	[186,187]
Ginkgo biloba	Various extracts	Exhibits antioxidant properties, modulates cell signaling pathways	[188,189]
Rosemary (*Rosmarinus officinalis*)	Carnosic acid, rosmarinic acid	Inhibits tumor growth, induces apoptosis	[190,191]
Oregano (*Origanum vulgare*)	Carvacrol, thymol	Induces cell cycle arrest, induces apoptosis	[192,193]

the liver, and improve glucose uptake in peripheral tissues.[202] *Moringa oleifera* (Moringa) leaves are rich in nutrients and bioactive compounds, including isothiocyanates, flavonoids, and phenolic acids, which exhibit antidiabetic activity. These compounds enhance insulin sensitivity, reduce inflammation, and modulate glucose metabolism.[203] *Pterocarpus marsupium* (Indian Kino) is traditionally used in Ayurvedic medicine for diabetes management. The heartwood extract contains pterostilbene, marsupsin, and pterosupin, which have been shown to enhance insulin secretion and lower blood glucose levels.[204] *Curcuma longa* (Turmeric) contains curcumin, a polyphenol with strong anti-inflammatory and antioxidant properties. Curcumin has been shown to improve insulin sensitivity, lower blood glucose levels, and reduce oxidative stress associated with diabetes.[205] *Withania somnifera* (Ashwagandha) is an adaptogen known for its ability to reduce stress and enhance overall health. It contains withanolides that help regulate blood sugar levels by improving insulin sensitivity and reducing cortisol levels.[206] *Ginkgo biloba* is known for its neuroprotective and antioxidant properties. It contains flavonoids and terpenoids that help improve insulin sensitivity and protect pancreatic beta cells from oxidative damage.[207] *Camellia sinensis* (Green Tea) is rich in catechins, particularly Epigallocatechin Gallate (EGCG), which have been shown to improve insulin sensitivity, reduce blood glucose levels, and have antioxidant properties that protect pancreatic beta cells.[208] *Vaccinium myrtillus* (Bilberry) is known for its high content of anthocyanins, which have been shown to improve insulin sensitivity and lower blood glucose levels. These compounds also have antioxidant properties that protect against oxidative stress.[209] *Salvia officinalis* (Sage) leaves contain bioactive compounds like rosmarinic acid and carnosic acid, which have been shown to enhance insulin secretion and improve glucose metabolism. Sage also exhibits antioxidant and anti-inflammatory properties.[210] *Zingiber officinale* (Ginger) contains gingerols and shogaols, which have been shown to have antidiabetic effects by improving insulin sensitivity and reducing blood glucose levels. Ginger also has anti-inflammatory and antioxidant properties.[211] *Citrus aurantium* (Bitter Orange) contains p-synephrine and flavonoids that have been shown to improve insulin sensitivity and reduce blood glucose levels. It also has antioxidant properties that help protect against oxidative stress.[212] *Nigella sativa* (Black Seed) contains thymoquinone, which has been shown to improve insulin sensitivity, enhance insulin secretion, and reduce blood glucose levels. It also has anti-inflammatory and antioxidant properties.[213] *Allium sativum* (Garlic) is well-known for its medicinal properties and antidiabetic effects. It contains sulfur compounds such as allicin, which help to regulate blood sugar levels by enhancing insulin sensitivity and reducing oxidative stress.[214] *Opuntia ficus-indica* (Prickly Pear) has been used in traditional medicine to manage diabetes. It contains fiber, pectin, and antioxidant compounds that help reduce blood glucose levels and improve insulin sensitivity.[215] *Vinca rosea* (Madagascar Periwinkle) is known for its alkaloids such as vincristine and vinblastine, which have shown antidiabetic properties by enhancing insulin secretion and improving glucose uptake.[216] *Ficus carica* leaves have been traditionally used to manage diabetes. They contain flavonoids and coumarins that help lower blood glucose levels by enhancing insulin secretion and glucose metabolism.[217] *Punica granatum* (Pomegranate) seeds and peel contain ellagic acid, punicalagins,

and other polyphenols that have been shown to reduce blood glucose levels and improve insulin sensitivity. Pomegranate also exhibits strong antioxidant properties (Table 8).[218]

These plant-based remedies for diabetes management demonstrate significant antidiabetic activity through various mechanisms, including enhancing insulin secretion, improving insulin sensitivity, and modulating glucose metabolism. Continued research and clinical trials are essential to further elucidate the efficacy and safety of these natural remedies in diabetes management.

Anti-allergic activity

Allergic reactions occur when the immune system overreacts to typically harmless substances, resulting in symptoms ranging from mild irritation to severe anaphylaxis. The management of allergies often involves the use of antihistamines and other medications. However, there is a growing interest in using plant-based remedies due to their effectiveness, lower side effects, and historical usage in traditional medicine. This review highlights several plants and trees known for their antiallergic properties, supported by recent research.

Petasites hybridus (Butterbur) is well-known for its antiallergic properties, particularly in treating hay fever and allergic rhinitis. The primary active compounds, petasin and isopetasin, inhibit leukotriene synthesis and reduce histamine release, thereby alleviating allergy symptoms.[219] *Urtica dioica* (Stinging Nettle) has been traditionally used to treat allergic conditions. It contains bioactive compounds that reduce the production of pro-inflammatory cytokines and histamine, helping to alleviate symptoms of allergic rhinitis and other allergies.[220] *Glycyrrhiza glabra* (Licorice) root has anti-inflammatory and immunomodulatory properties that are beneficial in managing allergies. Its active compounds, glycyrrhizin and glycyrrhetinic acid, inhibit the release of histamine and reduce inflammation.[221] *Camellia sinensis* (Green Tea) contains catechins, particularly Epigallocatechin Gallate (EGCG), which exhibit strong anti-inflammatory and antiallergic effects, helping to reduce the release of histamine and other allergic mediators.[222] *Perilla frutescens* (Perilla) leaves and seeds contain rosmarinic acid and luteolin, which have been shown to inhibit the release of histamine and suppress the inflammatory response associated with allergies.[223] *Albizia lebbeck* (Siris Tree) bark and seeds are used in traditional medicine for their antiallergic properties, containing bioactive compounds that inhibit mast cell degranulation and

Table 8: Plants with Antidiabetic Properties in Indian Traditional Medicine.

Plant	Bioactive Components	Antidiabetic Effects	References
Momordica charantia (Bitter Melon)	Charantin, vicine, polypeptide-p	Enhances glucose uptake, improves insulin sensitivity.	[194]
Trigonella foenum-graecum (Fenugreek)	Trigonelline, 4-hydroxyisoleucine, alkaloids	Enhances insulin secretion, reduces insulin resistance.	[195]
Cinnamomum verum (Cinnamon)	Cinnamaldehyde, cinnamic acid, cinnamate	Enhances insulin receptor activity, improves glucose uptake.	[196]
Gymnema sylvestre (Gymnema)	Gymnemic acids	Suppresses taste of sweetness, reduces sugar absorption, enhances insulin secretion, regenerates pancreatic beta cells.	[197]
Ocimum tenuiflorum (Holy Basil)	Eugenol, ursolic acid, rosmarinic acid	Enhances insulin secretion, improves glucose metabolism.	[198]
Aloe vera	Aloin, aloe-emodin	Reduces blood glucose levels, improves insulin sensitivity.	[199]
Azadirachta indica (Neem)	Nimbidin, nimbin, quercetin	Reduces blood glucose levels, enhances insulin sensitivity and secretion.	[200]
Syzygium cumini (Jamun)	Jamboline, ellagic acid	Regulates blood sugar levels, enhances insulin activity, inhibits alpha-glucosidase.	[201]
Berberis vulgaris (Barberry)	Berberine	Enhances insulin sensitivity, reduces glucose production in liver, improves glucose uptake	[202]
Moringa oleifera (Moringa)	Isothiocyanates, flavonoids, phenolic acids	Enhances insulin sensitivity, reduces inflammation, modulates glucose metabolism	[203]
Pterocarpus marsupium (Indian Kino)	Pterostilbene, marsupsin, pterosupin	Enhances insulin secretion, lowers blood glucose levels	[204]
Curcuma longa (Turmeric)	Curcumin	Improves insulin sensitivity, lowers blood glucose levels, reduces oxidative stress	[205]

Plant	Bioactive Components	Antidiabetic Effects	References
Withania somnifera (Ashwagandha)	Withanolides	Regulates blood sugar levels, improves insulin sensitivity, reduces cortisol levels	[206]
Ginkgo biloba	Flavonoids, terpenoids	Improves insulin sensitivity, protects pancreatic beta cells from oxidative damage	[207]
Camellia sinensis (Green Tea)	Catechins, Epigallocatechin Gallate (EGCG)	Improves insulin sensitivity, reduces blood glucose levels, protects pancreatic beta cells	[208]
Vaccinium myrtillus (Bilberry)	Anthocyanins	Improves insulin sensitivity, lowers blood glucose levels, provides antioxidant protection	[209]
Salvia officinalis (Sage)	Rosmarinic acid, carnosic acid	Enhances insulin secretion, improves glucose metabolism, provides antioxidant and anti-inflammatory properties	[210]
Zingiber officinale (Ginger)	Gingerols, shogaols	Improves insulin sensitivity, reduces blood glucose levels, provides anti-inflammatory and antioxidant properties	[211]
Citrus aurantium (Bitter Orange)	p-Synephrine, flavonoids	Improves insulin sensitivity, reduces blood glucose levels, provides antioxidant protection	[212]
Nigella sativa (Black Seed)	Thymoquinone	Improves insulin sensitivity, enhances insulin secretion, reduces blood glucose levels, provides anti-inflammatory and antioxidant properties	[213]
Allium sativum (Garlic)	Allicin	Regulates blood sugar levels, enhances insulin sensitivity, reduces oxidative stress	[214]
Opuntia ficus-indica (Prickly Pear)	Fiber, pectin, antioxidant compounds	Reduces blood glucose levels, improves insulin sensitivity	[215]
Vinca rosea (Madagascar Periwinkle)	Vincristine, vinblastine	Enhances insulin secretion, improves glucose uptake	[216]
Ficus carica (Fig)	Flavonoids, coumarins	Lowers blood glucose levels, enhances insulin secretion, improves glucose metabolism	[217]
Punica granatum (Pomegranate)	Ellagic acid, punicalagins, polyphenols	Reduces blood glucose levels, improves insulin sensitivity, provides strong antioxidant properties	[218]

reduce histamine release, thus alleviating allergy symptoms.[224] *Nigella sativa* (Black Seed) has potent antiallergic properties due to its active compound thymoquinone, inhibiting the release of histamine and reducing inflammation, effective in managing allergic rhinitis and asthma.[225] *Scutellaria baicalensis* (Baikal Skullcap) contains flavonoids like baicalin and wogonin, inhibiting the release of histamine and other pro-inflammatory mediators, thereby reducing allergic reactions.[226] *Helianthus annuus* (Sunflower) seeds contain bioactive compounds exhibiting antiallergic properties by reducing pro-inflammatory cytokines and inhibiting histamine release.[227] *Matricaria chamomilla* (Chamomile), traditionally used for its calming and anti-inflammatory properties, contains apigenin and quercetin, inhibiting histamine release and reducing inflammation, effective against allergies.[228] *Tinospora cordifolia* (Guduchi) is known for immunomodulatory and anti-inflammatory properties, and its active compounds reduce histamine release and allergic mediators, alleviating allergy symptoms.[229] *Adhatodavasica* (Malabar Nut) leaves containing vasicine and vasicinone, have antiallergic properties by inhibiting histamine release and reducing inflammation.[230] Ribes nigrum (Black Currant) leaves and fruits with flavonoids and anthocyanins have antiallergic properties by inhibiting histamine release and reducing inflammation.[231] *Ocimum tenuiflorum* (Holy Basil), known as Tulsi in Ayurvedic medicine, contains eugenol and rosmarinic acid, reducing histamine release and inflammatory mediators.[232] *Zingiber officinale* (Ginger) with gingerols and shogaols have antiallergic effects by reducing histamine and pro-inflammatory cytokines.[233] *Ficus carica* leaves with flavonoids and phenolic acids have anti-inflammatory and antiallergic properties, reducing histamine release and allergic mediators.[234] *Magnolia officinalis* (Magnolia Bark) compounds like magnolol and honokiol inhibit histamine release and reduce inflammation, alleviating allergy symptoms.[235] *Solanum lycopersicum* (Tomato) with lycopene has antioxidant and anti-inflammatory properties, reducing histamine release and mitigating allergic responses.[236] *Rosmarinus*

officinalis (Rosemary) with rosmarinic acid, carnosic acid, and other phenolic compounds inhibits mast cell degranulation and reduces inflammation, exhibiting antiallergic properties.[237] *Boswellia serrata* (Frankincense) with boswellic acids has anti-inflammatory and immunomodulatory effects, inhibiting pro-inflammatory cytokines and histamine release.[238] *Piper nigrum* (Black Pepper) with piperine has antiallergic properties by reducing histamine and pro-inflammatory mediators.[239] *Centaurea cyanus* (Corn flower) with flavonoids and anthocyanins has anti-inflammatory properties, reducing histamine release and alleviating allergic reactions.[240] *Curcuma longa* (Turmeric) with curcumin has strong anti-inflammatory and antiallergic effects, inhibiting histamine release and pro-inflammatory cytokines.[241] *Echinacea purpurea* (Echinacea) with immunomodulatory compounds reduces inflammation and alleviates allergy symptoms.[242] *Allium cepa* (Onion) with quercetin, a flavonoid, has potent antiallergic and anti-inflammatory properties, inhibiting histamine release and pro-inflammatory cytokines.[243] *Achillea millefolium* (Yarrow) with flavonoids and sesquiterpene lactones has antiallergic properties by inhibiting histamine release and reducing inflammation.[244] *Passiflora incarnata* (Passion flower) with bioactive compounds like flavonoids and alkaloids modulates immune responses and reduces histamine levels, exhibiting antiallergic properties (Table 9).[245] The exploration of plant-based remedies for allergy management offers a promising complementary approach to conventional therapies. Plants such as butterbur, stinging nettle, licorice, green tea, perilla, and others have demonstrated significant antiallergic activity through various mechanisms, including the inhibition of histamine release and suppression of inflammatory responses. Continued research and clinical trials are essential to further elucidate the efficacy and safety of these natural remedies in managing allergies.

Anti-septic activity

Antiseptic plants and trees play a crucial role in traditional and modern medicine by inhibiting the growth of microorganisms and promoting wound healing. This review focuses on several plants known for their antiseptic properties, supported by recent research.

Tea Tree (*Melaleuca alternifolia*) oil is renowned for its powerful antiseptic and antimicrobial properties, particularly due to terpinen-4-ol, which effectively combats bacteria, fungi, and viruses.[246-248] Neem (*Azadirachta indica*) extracts, containing nimbin and nimbidin, possess strong antiseptic and antibacterial properties, are used to treat skin infections, and promote wound healing.[249] Aloe vera (*Aloe barbadensis*) gel, rich in anthraquinones and polysaccharides, has antiseptic properties, widely used for minor burns, cuts, and skin infections.[250-252] Garlic (*Allium sativum*), with its broad-spectrum antimicrobial properties due to allicin, is effective against bacteria, viruses, fungi, and parasites.[253-255] Turmeric (*Curcuma longa*) contains curcumin, a potent antimicrobial agent with broad-spectrum activity against various pathogens, used both internally and topically to combat healing.[256] Thyme (*Thymus vulgaris*), rich in thymol, serves as a natural antiseptic and antibacterial agent, effective against various pathogens.[257-259] Eucalyptus (Eucalyptus

Table 9: Plants with Antiallergic Properties in Traditional Medicine.

Plant Name	Bioactive Compounds	Mechanisms of Action	References
Petasites hybridus (Butterbur)	Petasin, isopetasin	Inhibits leukotriene synthesis, reduces histamine release	[219]
Urtica dioica (Stinging Nettle)	Bioactive compounds	Reduces pro-inflammatory cytokines, histamine	[220]
Glycyrrhiza glabra (Licorice)	Glycyrrhizin, glycyrrhetinic acid	Inhibits histamine release, reduces inflammation	[221]
Camellia sinensis (Green Tea)	Epigallocatechin gallate (EGCG)	Reduces histamine release, anti-inflammatory effects	[222]
Perilla frutescens (Perilla)	Rosmarinic acid, luteolin	Inhibits histamine release, suppresses inflammatory response	[223]
Albizia lebbeck (Siris Tree)	Bioactive compounds	Inhibits mast cell degranulation, reduces histamine release	[224]
Nigella sativa (Black Seed)	Thymoquinone	Inhibits histamine release, reduces inflammation	[225]
Scutellaria baicalensis (Baikal Skullcap)	Baicalin, wogonin	Inhibits histamine release, reduces pro-inflammatory mediators	[226]
Helianthus annuus (Sunflower)	Bioactive compounds	Reduces pro-inflammatory cytokines, inhibits histamine release	[227]
Matricaria chamomilla (Chamomile)	Apigenin, quercetin	Inhibits histamine release, anti-inflammatory properties	[228]

Plant Name	Bioactive Compounds	Mechanisms of Action	References
Tinospora cordifolia (Guduchi)	Bioactive compounds	Reduces histamine release, modulates immune responses	[229]
Adhatoda vasica (Malabar Nut)	Vasicine, vasicinone	Inhibits histamine release, reduces inflammation	[230]
Ribes nigrum (Black Currant)	Flavonoids, anthocyanins	Inhibits histamine release, anti-inflammatory properties	[231]
Ocimum tenuiflorum (Holy Basil)	Eugenol, rosmarinic acid	Reduces histamine release, anti-inflammatory properties	[232]
Zingiber officinale (Ginger)	Gingerols, shogaols	Reduces histamine release, anti-inflammatory effects	[233]
Ficus carica (Fig)	Flavonoids, phenolic acids	Reduces histamine release, anti-inflammatory properties	[234]
Magnolia officinalis (Magnolia Bark)	Magnolol, honokiol	Inhibits histamine release, reduces inflammation	[235]
Solanum lycopersicum ((Tomato)	Lycopene	Antioxidant, anti-inflammatory, reduces histamine release	[236]
Rosmarinus officinalis (Rosemary)	Rosmarinic acid, carnosic acid	Inhibits mast cell degranulation, anti-inflammatory properties	[237]
Boswellia serrata (Frankincense)	Boswellic acids	Anti-inflammatory, inhibits histamine release	[238]
Piper nigrum (Black Pepper)	Piperine	Reduces histamine release, anti-inflammatory effects	[239]
Centaurea cyanus (Cornflower)	Flavonoids, anthocyanins	Anti-inflammatory, inhibits histamine release	[240]
Curcuma longa (Turmeric)	Curcumin	Anti-inflammatory, inhibits histamine release	[241]
Echinacea purpurea (Echinacea)	Immunomodulatory compounds	Reduces inflammation, alleviates allergy symptoms	[242]
Allium cepa (Onion)	Quercetin	Anti-inflammatory, inhibits histamine release	[243]
Achillea millefolium (Yarrow)	Flavonoids, sesquiterpene lactones	Inhibits histamine release, anti-inflammatory properties	[244]
Passiflora incarnata (Passion flower)	Flavonoids, alkaloids	Modulates immune responses, reduces histamine levels	[245]

spp.) oil, containing cineole, exhibits antiseptic properties, commonly used in respiratory infections and skin ailments.[260-262] Lavender (*Lavandula angustifolia*) essential oil has antiseptic and antimicrobial properties, useful for treating cuts, burns, and skin infections.[263] Chamomile (*Matricaria chamomilla*) extracts possess mild antiseptic properties, soothing skin irritations and minor wounds.[264,265] Calendula (*Calendula officinalis*) extracts have antiseptic and anti-inflammatory properties, valuable for wound healing and treating skin infections.[266-268] Clove (*Syzygium aromaticum*) oil, rich in eugenol, possesses strong antiseptic and analgesic properties, used in dental care products.[269,270] Cinnamon (*Cinnamomum verum*) bark and oil contain cinnamaldehyde, effective against various pathogens.[271] Sage (*Salvia officinalis*) contains essential oils with antibacterial and antifungal activities, traditionally used as a mouth rinse and in topical formulations.[272,273] Lemon (*Citrus limon*) essential oil, containing limonene and citral, is used in cleaning products and topical applications for its antiseptic effects.[274] Grapefruit (*Citrus paradisi*) seed extract contains polyphenols and flavonoids, exhibiting antimicrobial activity against bacteria, fungi, and viruses.[275] Lemongrass (*Cymbopogon citratus*) essential oil, rich in citral, has antimicrobial properties against bacteria and fungi.[276,277] Rosemary (*Rosmarinus officinalis*) essential oil, with rosmarinic acid and camphor, demonstrates antimicrobial activity.[278] Billygoat weed (*Ageratum conyzoides*) contains compounds with antimicrobial and anti-inflammatory properties, effective for treating infections.[279] St. John's Wort (*Hypericum perforatum*) oil, with hypericin and flavonoids,

is useful in treating wounds and minor burns.[280] Peppermint (*Mentha piperita*) oil, rich in menthol and menthone, has antimicrobial activity against various pathogens.[281] Oregano (*Origanum vulgare*) essential oil, containing carvacrol and thymol, is effective against bacteria and fungi.[282] Geranium (*Pelargonium graveolens*) essential oil, with citronellol and geraniol, is used in skincare and wound care for its antibacterial and antifungal properties (Table 10).[283]

These plants provide natural alternatives to synthetic antiseptics, offering broad-spectrum antimicrobial activity and potential therapeutic benefits. Further research is necessary to explore their mechanisms of action and clinical applications.

Table 10: Plants with Antiseptic Properties in Traditional Medicine.

Plant / Essential Oil	Properties and uses	References
Tea Tree (*Melaleuca alternifolia*)	Powerful antiseptic and antimicrobial properties, effective against bacteria, fungi, and viruses	[246-248]
Neem (*Azadirachta indica*)	Strong antiseptic and antibacterial properties, used for skin infections and wound healing	[249]
Aloe vera (*Aloe barbadensis*)	Antiseptic properties, used for minor burns, cuts, and skin infections	[250-252]
Garlic (*Allium sativum*)	Broad-spectrum antimicrobial properties against bacteria, viruses, fungi, and parasites	[253-255]
Turmeric (*Curcuma longa*)	Contains curcumin with broad-spectrum antimicrobial activity, used internally and topically	[256]
Thyme (*Thymus vulgaris*)	Natural antiseptic and antibacterial agent, effective against various pathogens	[257-259]
Eucalyptus (Eucalyptus spp.)	Antiseptic properties, commonly used in respiratory infections and skin ailments	[260-262]
Lavender (*Lavandula angustifolia*)	Antiseptic and antimicrobial properties, useful for cuts, burns, and skin infections	[263]
Chamomile (*Matricaria chamomilla*)	Mild antiseptic properties, soothes skin irritations and minor wounds	[264,265]
Calendula (*Calendula officinalis*)	Antiseptic and anti-inflammatory properties, promotes wound healing and treats skin infections	[266-268]
Clove (*Syzygium aromaticum*)	Strong antiseptic and analgesic properties, used in dental care products	[269,270]
Cinnamon (*Cinnamomum verum*)	Contains cinnamaldehyde, effective against various pathogens	[271]
Sage (*Salvia officinalis*)	Essential oils with antibacterial and antifungal activities, used in mouth rinse and topical formulations	[272,273]
Lemon (*Citrus limon*)	Antiseptic effects, used in cleaning products and topical applications	[274]
Grapefruit (*Citrus paradisi*)	Seed extract with antimicrobial activity against bacteria, fungi, and viruses	[275]
Lemongrass (*Cymbopogon citratus*)	Antimicrobial properties against bacteria and fungi	[276,277]
Rosemary (*Rosmarinus officinalis*)	Demonstrates antimicrobial activity, contains rosmarinic acid and camphor	[278]
Billygoat weed (*Ageratum conyzoides*)	Antimicrobial and anti-inflammatory properties, effective for infections	[279]
St. John's Wort (*Hypericum perforatum*)	Useful in treating wounds and minor burns, contains hypericin and flavonoids	[280]
Peppermint (*Mentha piperita*)	Antimicrobial activity against various pathogens	[281]
Oregano (*Origanum vulgare*)	Effective against bacteria and fungi, contains carvacrol and thymol	[282]
Geranium (*Pelargonium graveolens*)	Used in skin care and wound care for antibacterial and antifungal properties	[283]

CONCLUSION

In conclusion, Indian medicinal plants exemplify a rich source of bioactive compounds deeply embedded in traditional healing systems. These plants have garnered increasing scientific recognition for their diverse pharmacological properties, ranging from antioxidant and anti-inflammatory effects to antimicrobial and neuroprotective capabilities. Their integration into modern healthcare presents promising avenues for addressing contemporary health challenges worldwide. Embracing India's botanical wealth not only supports sustainable drug development but also fosters cultural continuity and promotes biodiversity conservation efforts. Continued research and collaboration are essential to fully unlock the therapeutic potential of these invaluable natural resources.

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ABBREVIATIONS

MRSA: Methicillin-resistant *Staphylococcus aureus*; **HSV:** Herpes Simplex Virus; **HIV:** Human Immunodeficiency Virus; **HRSV:** Human Respiratory Syncytial Virus; **EGCG:** Epigallocatechin Gallate; **COX-2:** Cyclooxygenase-2; **IBD:** Inflammatory Bowel Disease; **TNF-α:** Tumor Necrosis Factor alpha.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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