Ilam University of Medical Sciences

Plant Biotechnology Persa

Online ISSN: 2676-7414

Homepage: https://pbp.medilam.ac.ir

Medicinal Plants with Efficacy in Attention Deficit Hyperactivity Disorder (ADHD): Mechanistic Insights

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Article Info

Article type:
Review Article

Article History:
Received: 11 July 2025
Revised: 12 Sep 2025
Accepted: 14 Sep 2025
Published Online:

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A B S T R A C T

Objective: From the perspective of Traditional Iranian Medicine (TIM), Attention Deficit Hyperactivity Disorder (ADHD) is attributed to an imbalance in bodily temperament and a weakening of the cerebral and nervous faculties. This disequilibrium manifests as poor concentration, heightened irritability, and impulsive hyperactivity. Although conventional therapies offer symptomatic relief, their adverse effects in many patients highlight the need for complementary treatment strategies. Medicinal plants that restore temperament balance and modulate neurological function have emerged as promising alternatives. This review aims to identify key botanicals that alleviate ADHD symptoms and to explore their mechanisms of action.

Methods: This systematic review draws upon classical TIM texts in conjunction with contemporary scientific literature retrieved from databases such as Google Scholar, SID, Magiran, PubMed, and Scopus. Keywords related to ADHD and herbal medicine were used to guide a comprehensive search and analysis.

Results: The evidence highlights several plants with notable therapeutic potential, including *Melissa officinalis L., Valeriana officinalis L., Crocus sativus L., Passiflora incarnata L., Mentha spicata L., Matricaria chamomilla L., Lavandula angustifolia Mill., Vaccinium corymbosum L., Rosmarinus officinalis L., Ocimum basilicum L., Camellia sinensis (L.) Kuntze, Curcuma longa L., Boswellia serrata Roxb., Mentha piperita L., Pinus spp., Plantago major L., Linum usitatissimum L., Avena sativa L., Tulipa spp., and Hypericum perforatum* L. These botanicals exhibit beneficial effects by calming the nervous system, enhancing cognitive function, regulating internal temperament (particularly the balance of heat and moisture), and modulating central nervous system activity. According to TIM principles, such actions help restore humoral equilibrium and vital forces, thereby supporting cognitive and behavioral improvement.

Conclusion: Current evidence suggests that the judicious use of TIM-based medicinal plants may provide an effective complementary approach to ADHD management. However, determining optimal dosages, verifying clinical efficacy, and ensuring safety require rigorously designed, large-scale controlled clinical trials. Integrating traditional knowledge with contemporary neuroscience and pharmacology presents promising avenues for the development of safe, natural, and effective ADHD therapies.

Keywords: Attention Deficit Hyperactivity Disorder, Traditional Iranian Medicine, Medicinal Plants, Temperament Modulation, Complementary Therapy

➢ **How to cite this paper**
Ahmadi H, Khaksarian M. Medicinal Plants with Efficacy in Attention Deficit Hyperactivity Disorder (ADHD): Mechanistic Insights. Plant Biotechnology Persa. 2026; 8(2): Proof.

DOI:

Publisher: Ilam University of Medical Sciences

Introduction

Neurological and psychiatric disorders constitute some of the most pressing challenges to global public health, exerting a growing burden on healthcare and social systems worldwide. Among these, Attention Deficit Hyperactivity Disorder (ADHD) stands out as one of the most prevalent neurodevelopmental conditions in children, affecting approximately 5–10% of the global pediatric population [7–9]. ADHD profoundly impairs academic achievement, social functioning, and overall mental well-being, often resulting in long-term repercussions for individuals, families, and society. The disorder imposes a considerable economic and social burden, encompassing increased healthcare expenditures, specialized educational support, and reduced productivity underscoring its significance as a major public health concern [8,9].

ADHD is a multifactorial disorder influenced by genetic, environmental, and neurobiological determinants [10]. Structural and functional abnormalities in brain regions responsible for attention regulation, impulse control, and emotional processing such as the prefrontal cortex, basal ganglia, and cerebellum alongside dysregulation of dopaminergic and noradrenergic neurotransmission, play pivotal roles in its pathophysiology [11,12]. Environmental exposures (e.g., lead, prenatal stress, nutritional deficiencies) and psychosocial factors (e.g., family conflict, socioeconomic adversity) further exacerbate symptom severity. These neurochemical and structural disruptions collectively result in executive dysfunction, attentional deficits, and impaired behavioral regulation [13].

Current pharmacological treatments for ADHD primarily comprise central nervous system stimulants (e.g., methylphenidate, amphetamines) and non-stimulant medications (e.g., atomoxetine, guanfacine) [14]. Although these agents are effective in improving attention and reducing impulsivity, long-term use is often constrained by adverse effects, including insomnia, appetite suppression, anxiety, and cardiovascular complications [15]. Non-pharmacological interventions—such as behavioral therapy, parent training, and cognitive-behavioral therapy are also recommended to enhance functional outcomes and complement pharmacotherapy.

Within the framework of Traditional Iranian Medicine (TIM), ADHD is interpreted as a manifestation of temperament imbalance particularly an excess of heat and moisture and a weakening of the cerebral faculties encompassing cognitive and nervous functions [16,17]. Therapeutic strategies in TIM emphasize restoring temperament balance and reinforcing brain and nerve functions. Medicinal plants rich in bioactive compounds with anti-inflammatory, antioxidant, and neurochemical regulatory properties are believed to modulate central nervous system activity, alleviate anxiety, enhance attention, and stabilize mood [18–20].

To bridge traditional and modern paradigms, this review systematically examines medicinal plants with potential efficacy in alleviating ADHD symptoms and elucidates their mechanisms of action by integrating the concept of temperament from TIM with contemporary neurochemical and neurophysiological evidence. Given the current lack of comprehensive reviews addressing ADHD from this integrative perspective, the present work seeks to advance safe, natural, and evidence-based therapeutic options for managing this disorder.

Methodology

This systematic review was undertaken to identify and characterize medicinal plants with demonstrated efficacy in the management of Attention Deficit Hyperactivity Disorder (ADHD) and to elucidate their underlying mechanisms of action. In the first stage, authoritative texts and classical sources of Traditional Iranian Medicine (TIM) were comprehensively reviewed. Subsequently, an extensive electronic search was conducted across major international and national scientific databases, including PubMed, Scopus, Google Scholar, SID, and Magiran, to collect the most recent and relevant empirical evidence.

Inclusion Criteria

Studies evaluating the effects of medicinal plants on ADHD symptoms or related neuropsychiatric conditions were included in this review. In addition, classical sources of Traditional Iranian Medicine (TIM) that documented plants used for the management of ADHD-like neurological or psychiatric manifestations were also considered.

Exclusion Criteria

Studies that lacked full-text availability, demonstrated poor scientific quality or absence of peer review, or

focused on psychiatric disorders unrelated to ADHD or on irrelevant plant species were excluded from this review. Data extracted from the eligible sources were systematically organized into comprehensive tables and charts. Subsequently, the pharmacological mechanisms of the identified plants were analyzed and compared in the context of the theoretical principles of Traditional Iranian Medicine (TIM) to elucidate their potential roles in the management of ADHD.

Results

The findings of this review highlight several medicinal plants frequently cited in Traditional Iranian Medicine (TIM) as effective in alleviating the symptoms of Attention Deficit Hyperactivity Disorder (ADHD). Among the most prominent are *Melissa officinalis* L., *Valeriana officinalis* L., *Crocus sativus* L., *Passiflora incarnata* L., *Mentha spicata* L., *Matricaria chamomilla* L., *Lavandula angustifolia* Mill., *Vaccinium corymbosum* L., *Rosmarinus officinalis* L., *Ocimum basilicum* L., *Camellia sinensis* (L.) Kuntze, *Curcuma longa* L., *Boswellia serrata* Roxb., *Mentha piperita* L., *Pinus* spp., *Plantago major* L., *Linum usitatissimum* L., *Avena sativa* L., *Tulipa* spp., and *Hypericum perforatum* L.

These botanicals possess a broad spectrum of pharmacological properties, including anxiolytic and sedative effects, enhancement of cognitive performance, regulation of bodily heat and moisture key elements in traditional temperament theory and modulation of central nervous system activity. Through these mechanisms, they contribute to improved concentration, reduced anxiety, and better control of hyperactive behaviors. From the TIM perspective, these therapeutic effects are attributed to the restoration of temperament balance and the harmonization of vital bodily forces, which collectively facilitate cognitive and behavioral recovery.

A detailed summary of the pharmacological actions, underlying mechanisms, and supporting scientific evidence for each plant is presented in Table 1.

Table 1: Medicinal Plants Effective in Treating ADHD According to Traditional Medicine

Persian Name	English Name	Scientific Name	Family	Plant Part Used	Traditional Use	Plant Type	Mechanism of Action	Ref.
Badranjbouyeh	Lemon Balm	*Melissa officinalis* L.	Lamiaceae	Leaves	Sedative, brain tonic	Perennial	Increases GABA, anxiolytic, anti-inflammatory	[21]
Sonboloteib	Valerian	*Valeriana officinalis* L.	Valerianaceae	Root	Sedative, improves sleep, reduces anxiety	Perennial	Increases GABA, inhibits CNS activity	[21,22]
Zafaran	Saffron	*Crocus sativus* L.	Iridaceae	Stigma	Memory enhancer, antidepressant, sedative	Perennial	Increases serotonin, antioxidant, anti-inflammatory	[22,23]
Gole Saati	Passionflower	*Passiflora incarnata* L.	Passifloraceae	Leaves and flowers	Sedative, anxiolytic, anti-insomnia	Perennial	Increases GABA, inhibits sympathetic activity	[24]
Naena	Mint	*Mentha spicata* L.	Lamiaceae	Leaves	Sedative, antispasmodic, aids digestion	Perennial	Anti-inflammatory, sedative, antispasmodic	[24,25]
Babouneh	Chamomile	*Matricaria chamomilla* L.	Asteraceae	Flowers	Sedative, anti-inflammatory, memory enhancer	Annual	Anti-inflammatory, sedative on nervous system	[26]
Ostokhodous	Lavender	*Lavandula angustifolia* Mill.	Lamiaceae	Flowers	Sedative, anti-stress, improves sleep	Perennial	Inhibits sympathetic system, anti-inflammatory	[27]
Bloberi	Blueberry	*Vaccinium corymbosum* L.	Ericaceae	Fruit	Memory enhancer, anti-inflammatory, antioxidant	Perennial	Neuroprotective, reduces oxidative stress	[28]
Rozmari	Rosemary	*Rosmarinus officinalis* L.	Lamiaceae	Leaves	Memory enhancer, improves circulation, anti-inflammatory	Perennial	Enhances cerebral blood flow, antioxidant	[29]
Reyhan	Basil	*Ocimum basilicum* L.	Lamiaceae	Leaves	Sedative, anti-inflammatory, memory enhancer	Annual	Anti-inflammatory, nervous system calming	[30]

Chay-e Sabz	Green Tea	*Camellia sinensis* (L.) Kuntze	Theaceae	Leaves	Increases focus, antioxidant, anxiolytic	Perennial	Contains caffeine, antioxidant, neuronal modulation	[31]
Zardchobeh	Turmeric	*Curcuma longa* L.	Zingiberaceae	Rhizome	Anti-inflammatory, memory enhancer, sedative	Perennial	Curcumin-mediated anti-inflammatory and antioxidant effects	[32]
Kondoor	Frankincense	*Boswellia serrata* Roxb.	Burseraceae	Resin	Anti-inflammatory, sedative, nervous tonic	Perennial	Inhibits inflammation, improves circulation	[33]
Naena-ye Felfeli	Peppermint	*Mentha piperita* L.	Lamiaceae	Leaves	Sedative, antispasmodic, memory enhancer	Perennial	Inhibits sympathetic system, sedative	[34]
Kaj	Pine	*Pinus* spp.	Pinaceae	Leaves and resin	Anti-inflammatory, respiratory tonic, sedative	Perennial	Antioxidant, anti-inflammatory, improves circulation	[35]
Abghashoghi	Plantain	*Plantago major* L.	Plantaginaceae	Leaves	Anti-inflammatory, sedative, wound healing	Annual	Anti-inflammatory, nervous system soothing	[36]
Katan	Flaxseed	*Linum usitatissimum* L.	Linaceae	Seeds	Brain tonic, anti-inflammatory, sedative	Annual	Omega-3 fatty acids, anti-inflammatory	[37]
Jo-e Dosar	Oats	*Avena sativa* L.	Poaceae	Seeds	Sedative, memory enhancer, anxiolytic	Annual	Sedative effect on CNS	[38]
Laleh Baghi	Tulip	*Tulipa* spp.	Liliaceae	Flowers	Sedative, anti-inflammatory	Perennial	Anti-inflammatory, nervous system calming	[39]
Gol-e Rraei	St. John's Wort	*Hypericum perforatum* L.	Hypericaceae	Flowers and leaves	Antidepressant, memory enhancer, sedative	Perennial	Increases serotonin and dopamine, anti-inflammatory	[40]

Table 2 presents a statistical analysis of the medicinal plants, summarizing their frequency of use, targeted plant organs, lifespan, and reported mechanisms of action.

Figure 1 schematically illustrates the proposed mechanisms through which these medicinal plants, as described in Traditional Iranian Medicine (TIM), may exert therapeutic effects in ADHD. These plants are believed to modulate key neurotransmitter systems, including GABA and serotonin, reduce oxidative stress, regulate neuroinflammation, and influence sympathetic nervous system activity. Collectively, these multifaceted actions contribute to enhanced attention, improved cognitive function, and better behavioral regulation.

Figure 1: Mechanistic Overview of Medicinal Plants in ADHD Management

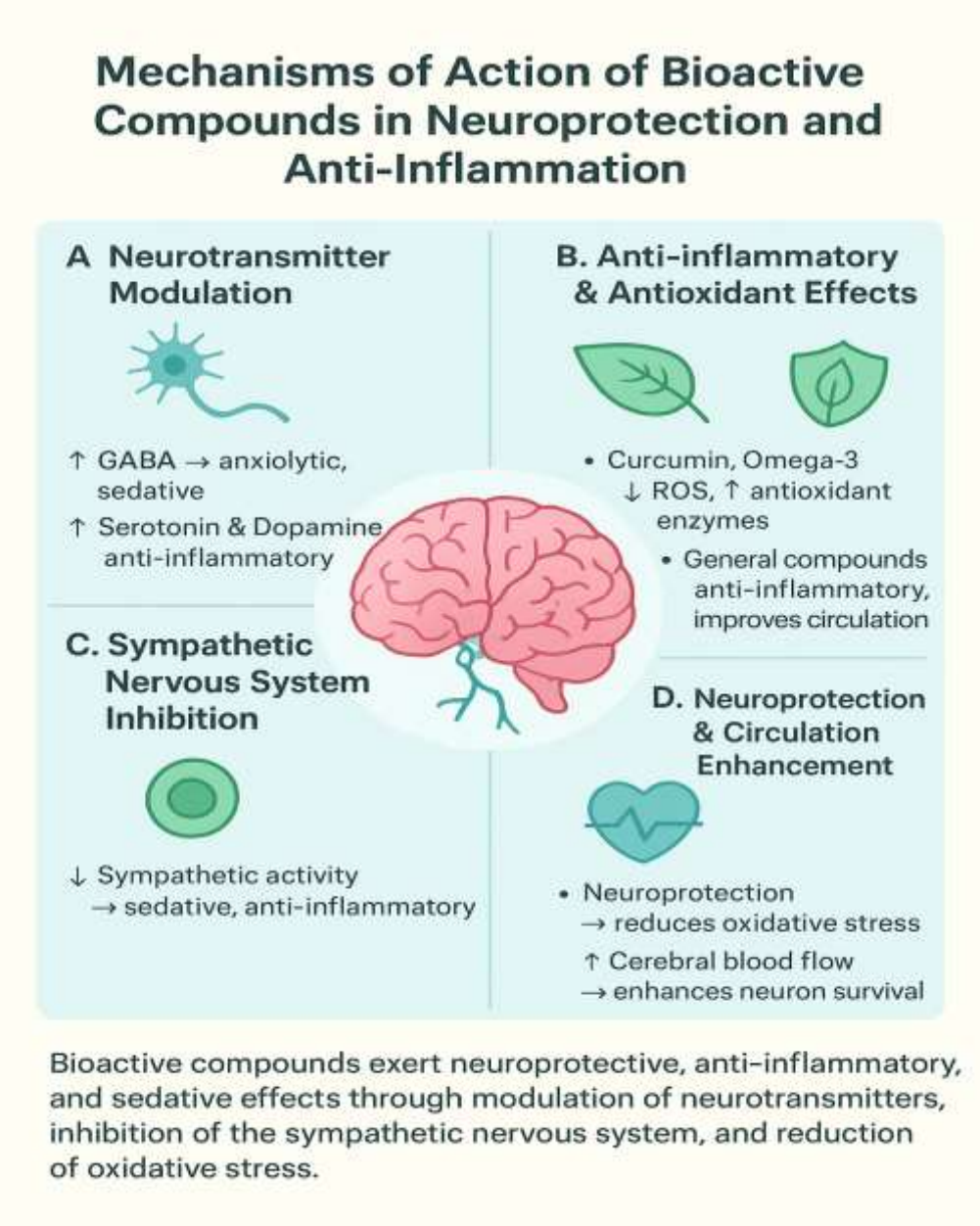

Table 2: Frequency Analysis, Plant Organ Structure, Lifespan, and Mechanisms of Action of Medicinal Plants in Treating ADHD According to Traditional Medicine

Analysis	Notes
Number of Plant Families	Analysis of the data from Table 1 indicates that the family **Lamiaceae** is the most frequently represented, with six occurrences, reflecting the highest frequency among the identified plant families. This concentration suggests a heterogeneous distribution pattern and underscores the relative prominence of Lamiaceae within the overall sample. In contrast, other families including Valerianaceae, Iridaceae, Passifloraceae, Asteraceae, Ericaceae, Theaceae, Zingiberaceae, Burseraceae, Pinaceae, Plantaginaceae, Linaceae, Poaceae, Liliaceae, and Hypericaceae appear only once each, classifying them in the low-frequency category. This disparity highlights the ecological and ethnobotanical significance of Lamiaceae and indicates a potential basis for further research into its role in medicinal applications and floristic composition.
Analysis of Plant Organs Used	Analysis of the plant organs utilized reveals that leaves are the most frequently used, with seven recorded instances. Flowers follow with four occurrences, and seeds appear twice. Other organs including root, stigma, combined leaf and flower, fruit, rhizome, resin, combined leaf and resin, and combined flower and leaf each appear once. This distribution indicates that leaves are the primary medicinal organ among the studied plants, with flowers and seeds representing the next most commonly employed parts.
Analysis of Plant Lifespan (Annual, Biennial, Perennial)	Analysis of plant lifespans indicates that, among the 20 samples, 14 species (70%) are perennials, while 6 species (30%) are annuals. The predominance of perennial species may reflect their greater environmental stability and sustainability, as well as their enduring availability for traditional medicinal use.
Analysis of Mechanisms of Action	Analysis of the reported mechanisms of action indicates that anti-inflammatory properties are the most frequently observed, appearing in 15 instances. Sedative effects are reported in 10 cases, highlighting the significance of these plants in calming the nervous system. Enhancement of the neurotransmitter GABA is noted four times, underscoring its role in anxiety reduction and neural inhibition. Inhibition of the central nervous system and suppression of the sympathetic nervous system are each mentioned three times, reflecting diverse neuromodulatory effects. Antioxidant activity occurs six times, contributing to cellular protection and the reduction of oxidative stress. Other mechanisms including improved blood circulation, increased serotonin and dopamine levels, neuroprotection, and bioactive effects of compounds such as caffeine, curcumin, and omega-3 fatty acids are reported less frequently but remain noteworthy.

Discussion

Attention Deficit Hyperactivity Disorder (ADHD) is among the most prevalent neurodevelopmental disorders in children and adolescents and often persists into adulthood, adversely affecting academic performance, social relationships, and overall quality of life [41]. Although conventional pharmacotherapies—including stimulants (methylphenidate, amphetamines) and non-stimulants (atomoxetine, guanfacine)—effectively manage symptoms, their side effects, such as insomnia, appetite suppression, irritability, and cardiovascular risks, highlight the need for safer complementary treatments [41]. Non-pharmacological interventions, including behavioral therapy, parent training, and cognitive-behavioral therapy, are also recommended to improve functional outcomes and complement medical management.

From the perspective of Traditional Iranian Medicine (TIM), ADHD is attributed to an imbalance in bodily temperament, particularly excessive heat and dryness, or, in some cases, abnormal coldness and moisture within the brain and nervous system [42]. This dysregulation results in impaired cognitive faculties, heightened irritability, restlessness, and diminished concentration. Therapeutic strategies in TIM focus on restoring temperamental balance, strengthening cerebral functions, and enhancing nervous system performance through medicinal plants and lifestyle modifications. Integrating these traditional concepts with modern neurochemical and neurophysiological evidence enables a more comprehensive understanding of ADHD pathophysiology. For instance, the traditional notion of "warm/cold" temperaments can be associated with neuroinflammation and dopaminergic activity, providing a mechanistic link between ancient wisdom and contemporary science.

Several botanicals including *Melissa officinalis*, *Valeriana officinalis*, *Passiflora incarnata*, *Ginkgo biloba*, *Crocus sativus*, *Bacopa monnieri*, *Centella asiatica*, *Rhodiola rosea*, and *Pinus pinaster* have demonstrated anxiolytic, sedative, antioxidant, anti-inflammatory, and neurotransmitter-modulating effects [43–47]. These properties may enhance attention, memory, and emotional regulation. However, many studies are limited by small sample sizes, heterogeneous study designs, short follow-up periods, and lack of standardization in dosing or formulations. Potential herb–drug interactions, particularly with

stimulants such as methylphenidate, must also be considered in clinical applications.

Mechanistically, medicinal plants may exert therapeutic effects through multiple pathways, including modulation of dopaminergic and serotonergic neurotransmission, reduction of oxidative stress and neuroinflammation, regulation of stress responses via the hypothalamic–pituitary–adrenal (HPA) axis, and restoration of cerebral temperament to strengthen cognitive functions [49]. Unlike single-target synthetic drugs, these complex phytochemicals act on multiple systems simultaneously, potentially enhancing efficacy while reducing adverse effects.

Given these findings, future research should prioritize well-designed, placebo-controlled randomized trials, standardized herbal preparations, dose optimization, and prospective meta-analyses. Such studies are essential to rigorously validate the safety, efficacy, and mechanistic basis of medicinal plants as adjunctive or alternative therapies for ADHD, thereby bridging the principles of Traditional Iranian Medicine with modern evidence-based approaches.

Conclusion

Comparative analysis of the findings from this review with contemporary scientific evidence indicates that several medicinal plants cited in Traditional Iranian Medicine particularly *Passiflora incarnata*, *Melissa officinalis*, *Crocus sativus*, and *Valeriana officinalis* exhibit pharmacologically validated effects in reducing anxiety, improving sleep, and enhancing attention in individuals with ADHD. These observations underscore the potential of integrating traditional medical principles with modern scientific evaluation to develop safe, effective, and multidimensional management strategies for ADHD.

From a practical perspective, these insights can inform clinicians, researchers, and policymakers in designing evidence-based interventions, standardizing herbal formulations, and incorporating complementary therapies into clinical guidelines. Notably, specific botanicals such as *Passiflora incarnata* and *Crocus sativus* merit further investigation through large, well-controlled clinical trials to establish optimal dosages, safety profiles, and both short- and long-term efficacy.

In conclusion, the convergence of Traditional Iranian medicinal wisdom with contemporary neuroscience offers a promising framework for ADHD management, emphasizing holistic, safe, and scientifically validated therapeutic options that complement conventional treatments.

Statements and Declarations

Funding support

The authors did not receive support from any organization for the submitted work.

Competing interests

The authors have no competing interests to declare that are relevant to the content of this article.

Ethics approval

This study was performed in line with the principles of the Declaration of Helsinki.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Author Contributions

HA contributed to the conceptualization of the study, literature review, data collection, and initial manuscript drafting. MKH supervised the study, provided critical insights on mechanistic interpretations, guided the manuscript structure, and performed revisions to ensure scientific accuracy. Both authors read and approved the final version of the manuscript.

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