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Medicinal Plants as Analgesics: A Comprehensive Review of Their Benefits, Adverse Effects, and Mechanisms of Action

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A B S T R A C T

Objective: Pain is among the most common symptoms across various diseases and can profoundly impact individuals' daily lives. The use of medicinal plants for pain relief has a long-standing history in traditional medical systems worldwide and has recently attracted renewed attention as a natural and innovative approach to pain management. The bioactive compounds found in these plants render them valuable alternatives or adjuncts to conventional pharmaceutical therapies. This study aims to review and introduce the most important native Iranian medicinal plants with analgesic effects, based on both traditional sources and contemporary research.

Methods: This review was conducted using keywords such as "medicinal plants," "pain," "analgesics," and "Iranian traditional medicine." Data were gathered through searches in reputable databases including Google Scholar, SID, Magiran, PubMed, and Scopus, as well as from written sources on traditional medicine.

Results: Numerous medicinal plants with analgesic properties were identified, including *Mentha piperita* L., *Rosmarinus officinalis* L., *Lavandula angustifolia* Mill., *Tanacetum parthenium* (L.) Sch. Bip., *Valeriana officinalis* L., *Salvia officinalis* L., *Ocimum basilicum* L., *Syzygium aromaticum* (L.) Merr. & L.M. Perry, *Curcuma longa* L., *Capsicum annuum* L., *Zingiber officinale* Roscoe, *Boswellia serrata* Roxb. ex Colebr., *Rosa damascena* Mill., *Eucalyptus globulus* Labill., *Cinnamomum verum* J. Presl, *Carum carvi* L., *Nigella sativa* L., *Salix alba* L., *Harpagophytum procumbens* DC., *Hypericum perforatum* L., *Aloe vera* (L.) Burm.f., *Camellia sinensis* (L.) Kuntze. These plants have been widely used for alleviating various types of pain.

Conclusion: Medicinal plants hold a prominent place in Iranian traditional medicine for pain treatment, acting through mechanisms such as inflammation reduction and nervous system relaxation. Given the side effects associated with synthetic drugs, these plants offer a safe and effective option for complementary and alternative therapies. Future research should focus on identifying active compounds, assessing safety, and standardizing herbal products to harness the full potential of these plants in modern medicine.

Keywords: Pain, Herbal analgesics, Phytotherapy, Medicinal plants, Traditional medicine, Iran

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Introduction

Pain is one of the most complex yet fundamental physiological responses of the body to injury or dysfunction of organs and tissues [1]. It serves as a vital defensive mechanism, functioning as an alert system against internal and external threats [1]. However, when pain becomes chronic or prolonged, it not only loses its protective role but can also lead to profound psychological and physical consequences such as impaired quality of life, depression, anxiety, sleep disturbances, and diminished individual and social functioning [2]. The pathophysiology of pain encompasses a series of intricate neural and chemical processes initiated by the activation of specialized sensory receptors called nociceptors [3]. These receptors, located in the skin, muscles, joints, and viscera, respond to harmful thermal, mechanical, or chemical stimuli and transmit electrochemical signals via peripheral nerves to the spinal cord and ultimately to pain processing centers in the brain, such as the thalamus and cerebral cortex [4]. Subsequently, the body responds to these stimuli by activating protective mechanisms including inflammation, muscle spasms, and the release of chemical mediators such as prostaglandins, bradykinin, and cytokines, which can exacerbate the pain sensation. In chronic or neuropathic pain conditions, structural and functional changes occur in neural pathways, resulting in heightened sensitivity to painful stimuli (hyperalgesia) or the perception of pain in the absence of a stimulus (allodynia) [4].

Pain can originate from diverse causes, ranging from inflammatory and neuropathic pain to chronic conditions such as migraine, arthritis, and cancer. Although conventional pharmacological treatments including acetaminophen, ibuprofen, naproxen, and, in more severe cases, opioids—are effective [5], they are often accompanied by side effects such as gastrointestinal ulcers, renal impairment, and dependency [6,7]. These concerns have driven increased interest toward complementary and alternative approaches, particularly the use of herbal medicines, which are regarded as safer and more compatible with human physiology [8]. Iranian traditional medicine, with its rich heritage spanning centuries, offers a valuable compendium of knowledge regarding the analgesic applications of medicinal plants, which today align with contemporary scientific findings [9]. Medicinal plants exert their analgesic effects through bioactive compounds such as flavonoids, alkaloids, terpenoids, and phenolics, acting via mechanisms including anti-inflammatory activity, modulation of the nervous system, and interference with pain pathways [10]. Given these attributes, the incorporation of these plants in modern phytotherapy has gained considerable acceptance [11].

This review aims to introduce and examine the most significant native Iranian medicinal plants with analgesic properties, analyzing authoritative traditional sources alongside recent scientific studies. It represents an effort toward developing safe, natural, and evidence-based therapeutic strategies for pain management.

Methodology

This study was conducted as a narrative review focused on the traditional analgesic effects of medicinal plants, particularly within the framework of Iranian traditional medicine. Data were collected from reputable traditional medical texts and supplemented by systematic searches in recognized electronic databases including PubMed, Scopus, Google Scholar, SID, and Magiran.

The literature search was performed using a combination of English and Persian keywords and their equivalents, covering the period from 2000 to 2024: “Herbal medicine” OR “medicinal plants” AND “Pain” OR “Analgesic” OR “Antinociceptive” AND “Traditional Iranian medicine” OR “Ethnobotany” OR “Persian medicine.” The corresponding Persian terms such as Iranian traditional medicine, Analgesic, Pain, ethnobotany, medicinal plants and anti-analgesic were also employed to search Persian-language databases.

Inclusion criteria encompassed studies and sources addressing native Iranian plants or those used in Iranian traditional medicine, published in either Persian or English. Exclusion criteria included non-scientific articles, letters to the editor, conference abstracts, brief notes, studies lacking sufficient detail on plant species, extraction methods, or analgesic mechanisms,

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research primarily focused on diseases unrelated to pain, duplicate publications, and articles with unreported conflicts of interest.

Based on these criteria, a systematic screening process was conducted to select the relevant literature.

Results

A comprehensive review of the literature revealed that numerous medicinal plants with analgesic properties have been identified, offering promising natural alternatives for alleviating various types of pain. Among these plants are *Mentha piperita* L., *Rosmarinus officinalis* L., *Lavandula angustifolia* Mill., *Tanacetum parthenium* (L.) Sch. Bip., *Valeriana officinalis* L., *Salvia officinalis* L., *Ocimum basilicum* L., *Syzygium aromaticum* (L.) Merr. & L.M. Perry, *Curcuma longa* L., *Capsicum annuum* L., *Zingiber officinale* Roscoe, *Boswellia serrata* Roxb. ex Colebr., *Rosa damascena* Mill., *Eucalyptus globulus* Labill., *Cinnamomum verum* J. Presl, *Carum carvi* L., *Nigella sativa* L., *Salix alba* L., *Harpagophytum procumbens* DC., *Hypericum perforatum* L., *Aloe vera* (L.) Burm.f., *Camellia sinensis* (L.) Kuntze. Detailed ethnobotanical and traditional knowledge pertaining to Iranian analgesic plants are presented in Table 1.

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Table 1. Overview of pharmacological properties, indications, and side effects of medicinal plants effective in pain relie

Persian Name	English Name	Scientific Name	Family	Used Part	Possible Side Effects	Mechanisms of Action
Naena felfeli	Peppermint	*Mentha piperita* L.	Lamiaceae	Leaves and flowers	Skin allergies, stomach irritation [12]	Anti-inflammatory, muscle relaxant, analgesic [12]
Rozmari	Rosemary	*Rosmarinus officinalis* L.	Lamiaceae	Leaves	Skin sensitivity, stomach irritation [13]	Antioxidant, anti-inflammatory, neuroprotective [13]
Ostokhodous	Lavender	*Lavandula angustifolia* Mill.	Lamiaceae	Flowers	Skin irritation, headache [14]	Nervous system relaxant, anti-inflammatory, analgesic [15]
Babounegavi	Feverfew	*Tanacetum parthenium* (L.) Sch. Bip.	Asteraceae	Leaves and flowers	Allergies, indigestion [16]	Prostaglandin inhibition, anti-inflammatory [17]
Sonboloteib	Valerian	*Valeriana officinalis* L.	Valerianaceae	Root	Drowsiness, dizziness [18]	Central nervous system sedative [19]
Maryamgoli	Sage	*Salvia officinalis* L.	Lamiaceae	Leaves	Skin allergy, exacerbation of epilepsy [20]	Anti-inflammatory, antispasmodic, antioxidant [21]
Reyhan	Basil	*Ocimum basilicum* L.	Lamiaceae	Leaves	Skin allergies, stomach pain [22]	Anti-inflammatory, antioxidant, analgesic [23]
Mikhak	Clove	*Syzygium aromaticum* (L.) Merr. & L.M. Perry	Myrtaceae	Dried flower buds	Allergic reaction, skin irritation [24]	Local anesthetic, anti-inflammatory [25]
Zardchoubeh	Turmeric	*Curcuma longa* L.	Zingiberaceae	Root (rhizome)	Skin sensitivity, gastrointestinal discomfort [26]	Strong anti-inflammatory, antioxidant [27]
Felfeleghermez	Chili Pepper	*Capsicum annuum* L.	Solanaceae	Fruit	Skin burning, mucous membrane irritation [28]	Pain receptor stimulation, increased blood circulation [29]
Zangabil	Ginger	*Zingiber officinale* Roscoe	Zingiberaceae	Root (rhizome)	Stomach burning, allergy [30]	Anti-inflammatory, anti-nausea, analgesic [31]

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Kondor	Frankincense	*Boswellia serrata* Roxb. ex Colebr.	Burseraceae	Resin	Rare allergic reactions [32]	Inhibition of inflammatory enzymes, anti-inflammatory [33]
Golesorkh	Rose	*Rosa damascena* Mill.	Rosaceae	Flowers	Skin irritation [34]	Sedative, anti-inflammatory [35]
Okaliptous	Eucalyptus	*Eucalyptus globulus* Labill.	Myrtaceae	Leaves and leaf oil	Skin and mucous membrane irritation, toxic in high doses [36]	Anti-inflammatory, antiseptic, sedative [36]
Darchin	Cinnamon	*Cinnamomum verum* J. Presl	Lauraceae	Bark	Allergies, stomach irritation [37]	Antioxidant, anti-inflammatory [38]
Ziresian	Black Cumin	*Carum carvi* L.	Apiaceae	Seeds	Allergic reactions, mucous irritation [39]	Anti-inflammatory, analgesic, immune booster [39]
Siahdaneh	Black Seed	*Nigella sativa* L.	Ranunculaceae	Seeds	Rare allergic reactions [40]	Anti-inflammatory, analgesic, antioxidant [40]
Bidsefid	White Willow	*Salix alba* L.	Salicaceae	Bark	Stomach irritation, bleeding at high doses [41]	Prostaglandin synthesis inhibition, anti-inflammatory [41]
Panjesheitan	Devil's Claw	*Harpagophytum procumbens* DC.	Pedaliaceae	Root	Digestive issues, skin allergy [42]	Anti-inflammatory, analgesic [43]
Goleraei	St. John's Wort	*Hypericum perforatum* L.	Hypericaceae	Flowers and leaves	Photosensitivity, drug interactions [44]	Neurotransmitter modulation, sedative [45]
Aloevera	Aloe Vera	*Aloe vera* (L.) Burm.f.	Asphodelaceae	Leaf gel	Skin allergy, diarrhea [46]	Anti-inflammatory, skin and tissue repair [47]
Chayesabz	Green Tea	*Camellia sinensis* (L.) Kuntze	Theaceae	Dried leaves	Insomnia, stomach irritation [48]	Antioxidant, anti-inflammatory, sedative [49]

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Discussion

In traditional Iranian medicine, medicinal plants with analgesic properties hold a special and longstanding place. They have been used for centuries to alleviate various types of muscular, joint, and neurological pain. These plants, rooted in rich indigenous resources and the empirical knowledge of traditional physicians, contain potent natural compounds, making them suitable alternatives to synthetic drugs. Today, with the growing trend towards natural therapies, research into the analgesic properties of these plants is expanding rapidly.

Ethnobotanical studies conducted in Shahrekord, Iran, have identified a diverse array of medicinal plants used for pain relief, including species such as Salvia hydrangea, *Lavandula officinalis, Thymus vulgaris, Melissa officinalis, Mentha pulegium, Teucrium hyrcanicum, Salvia hypoleuca, Ziziphora tenuior, Teucrium polium, Origanum vulgare*, among many others [50]. In one such study, 23 species were documented specifically for their analgesic applications, with the highest usage reported for *Eugenia caryophylata* (44%), *Alhagi maurorum* (31%), and *Tribulus terrestris* (27%). The *Lamiaceae* family was notably prominent, represented by seven species, and the flower (25%), stem (22%), and leaf (19%) were the plant parts most commonly used to treat pain [51].

On a broader scale across Iran, numerous plants such as *Artemisia dracunculus, Berberis vulgaris, Carum copticum, Apium graveolens, Cinnamomum zeylanicum, Crocus sativus, Datura stramonium, Elaeagnus angustifolia, Foeniculum vulgare, Glycyrrhiza glabra, Hypericum perforatum, Mentha piperita, and Origanum vulgare* are traditionally recognized for their analgesic properties [52].

Furthermore, findings from another study highlight that plants like *Lavandula angustifolia*, *Ginkgo biloba*, *Melissa officinalis*, Salvia officinalis, and *Huperzia serrata* play significant roles in alleviating symptoms of dementia and Alzheimer's disease [53].

Research in the Arasbaran region also revealed the traditional use of medicinal plants such as *Juniperus communis, Equisetum arvense, Hypericum perforatum, Leonurus cardiaca, Origanum vulgare, Salvia sclarea, Ballota nigra, Papaver orientale, Lotus corniculatus, Rosa canina, Asperula odorata, and Hyoscyamus niger* in reducing anxiety and stress [54].

Finally, various studies have confirmed the effectiveness of plants like *Valeriana officinalis, Passiflora incarnata, Rosmarinus officinalis, Lavandula angustifolia, Hypericum perforatum, Mentha piperita, Matricaria chamomilla, Glycyrrhiza glabra, Melissa officinalis, Crataegus aronia, Humulus lupulus, Echium amoenum, Prunus dulcis*, and *Foeniculum vulgare* in managing and alleviating anxiety [55].

In summary, medicinal plants in traditional Iranian medicine have long been esteemed for their analgesic effects in treating muscular, joint, and neural pain. Thanks to their bioactive natural compounds, they represent a viable and safer alternative to chemical drugs. Ethnobotanical investigations across different regions have identified a wide variety of analgesic species, with the Lamiaceae family featuring species such as *Mentha piperita, Salvia officinalis, and Lavandula angustifolia* playing a particularly prominent role. The flower, stem, and leaf are the plant parts most commonly employed in pain relief. Beyond their analgesic properties, some of these plants, including *Lavandula angustifolia*, *Ginkgo biloba*, and *Melissa officinalis*, have also demonstrated efficacy in improving cognitive decline and Alzheimer's symptoms. Moreover, species like *Valeriana officinalis, Rosmarinus officinalis, and Hypericum perforatum* are frequently used in traditional settings to mitigate anxiety and stress. These findings underscore the significant role of traditional Iranian medicine in not only pain management but also in addressing neurological and psychological disorders, highlighting the potential for scientific research to foster novel therapeutic applications.

Conclusion

Medicinal plants in traditional Iranian medicine are recognized as effective agents in pain control, acting through mechanisms such as inflammation reduction and nervous system modulation. Given the undesirable side effects associated with synthetic drugs, these plants offer a safe and efficient alternative to conventional treatments. To better harness their potential, future research should focus on identifying the active compounds, conducting comprehensive safety evaluations, and developing standardized methods for herbal product formulation. Such efforts will pave the way for a successful integration of traditional herbal medicine with modern medical practice.

Statements and Declarations

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Competing interests

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

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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

SN: Conceptualization, the original draft writing, investigation, writing including reviewing and editing and investigation and formal analysis; PP: Conceptualization, supervision, and project administration; PP and SN Conceptualization, the original draft writing, investigation, writing including reviewing and editing.

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