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Phytotherapy in Breast Cancer: An Overview

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A B S T R A C T

Introduction: Breast cancer is among the most prevalent malignancies affecting women, typically presenting as a palpable lump or tissue alterations in the breast. Its etiology is multifactorial, involving genetic predispositions, hormonal imbalances, and environmental factors. Early diagnosis and effective treatment are critical for improving survival rates and quality of life. This review aims to identify and analyze the most influential medicinal plants used in Iranian traditional medicine for breast cancer and to examine their potential mechanisms of action in disease prevention and therapy.

Methods: A systematic search was conducted using keywords such as "medicinal plants," "traditional medicine," "breast cancer," and "Iran" across PubMed, Scopus, Web of Science, and Google Scholar, in addition to reference books and specialized encyclopedias.

Results: The literature review identified several medicinal plants reported to be effective against breast cancer, including *Thymus vulgaris* L., *Rosmarinus officinalis* L., *Origanum vulgare* L., *Zingiber officinale* Roscoe, *Foeniculum vulgare* Mill., *Allium sativum* L., *Vitis vinifera* L., *Portulaca oleracea* L., *Matricaria chamomilla* L., *Phaseolus vulgaris* L., *Solanum lycopersicum* L., *Cicer arietinum* L., *Allium cepa* L., *Triticum aestivum* L., *Punica granatum* L., *Malus domestica* Borkh., *Prunus avium* L., *Curcuma longa* L., *Linum usitatissimum* L., *Borago officinalis* L., *Olea europaea* L., *Achillea millefolium* L., *Viola odorata* L., *Apium graveolens* L., *Vitex agnus-castus* L., *Glycyrrhiza glabra* L., *Brassica rapa* L., *Avena sativa* L., *Aloe vera* (L.) Burm.f., *Calendula officinalis* L., *Camellia sinensis* (L.) Kuntze, *Daucus carota* L., and *Capsicum annuum* L. These plants exert anti-cancer effects through tumor growth inhibition, apoptosis induction, anti-angiogenesis, and anti-inflammatory activities. Detailed botanical information and traditional applications are summarized in Table 1.

Conclusion: Current evidence indicates that medicinal plants used in Iranian traditional medicine, due to their bioactive compounds, may serve as effective complementary therapies for breast cancer prevention and management. Further experimental and clinical studies are required to develop safer and more effective therapeutic interventions.

Keywords: Women, Breast cancer, Medicinal plants, Traditional medicine, Iran

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Introduction

Cancers represent a major global health challenge, as uncontrolled cellular proliferation poses a significant threat and constitutes a leading cause of mortality worldwide [1-3]. Among these, breast cancer is particularly significant, ranking among the most common cancers in women globally, including in Iran, and contributing substantially to cancer-related mortality [4,5]. Breast cancer is characterized by abnormal proliferation of breast tissue cells, forming malignant tumors capable of metastasizing to adjacent tissues and distant organs [6]. Its development is influenced by genetic factors, hormonal changes, lifestyle, diet, and environmental exposures. Age, family history, and reproductive factors further elevate the risk [7,8].

Early detection of breast cancer manifested as painless lumps, nipple or skin changes, or axillary lymph node enlargement is critical for timely diagnosis and improved therapeutic outcomes [9]. Screening strategies, including self-examination, clinical breast examination, mammography, ultrasound, MRI, and biopsy, significantly reduce mortality by enabling early intervention [10].

Timely diagnosis and appropriate treatment are pivotal for reducing mortality and improving quality of life [11]. Conventional treatments, including surgery, chemotherapy, radiotherapy, and hormonal therapy, have distinct benefits and limitations [12]. Concerns regarding their side effects have increased interest in complementary and alternative approaches [13].

Phytotherapy, or treatment with medicinal plants, is a major branch of traditional medicine and has gained substantial scientific attention [14]. Medicinal plants contain bioactive compounds such as flavonoids, alkaloids, terpenes, and polyphenols—that may exert anti-cancer effects via tumor cell proliferation inhibition, apoptosis induction, anti-angiogenesis, anti-inflammatory activity, and immune modulation [15,16]. Historical evidence and traditional Iranian medical texts emphasize the longstanding use of medicinal plants for women's health and chronic disease prevention [17].

Given the growing interest in integrating traditional knowledge with modern science, this review aims to identify and evaluate the most effective medicinal plants for breast cancer as documented in Iranian traditional medicine and to examine their potential roles in prevention and therapy [18]. The findings may provide a foundation for future laboratory and clinical studies and support the development of safe and effective complementary therapies.

Methodology

This study was conducted as an analytical review of traditional medical sources and contemporary scientific literature. Its primary objective was to identify medicinal plants effective in preventing and treating breast cancer and to analyze their potential mechanisms of action.

Literature Search

Keywords such as "medicinal plants," "breast cancer," and "Iran" were used in reputable sources, including Iranian traditional medicine reference books and specialized encyclopedias [19–26]. National literature and authoritative reference texts were also examined to gather historical and traditional data.

Inclusion and Exclusion Criteria

Inclusion criteria: Studies assessing the effects of medicinal plants on breast cancer, including in vitro and in vivo experiments, clinical trials, and traditional Iranian medical sources, published in English or Persian between 2000 and 2024.

Exclusion criteria: Studies with insufficient data, unrelated to breast cancer, duplicate publications, or sources lacking credible scientific documentation.

Data Extraction

Data extracted included plant names, utilized parts, bioactive compounds, mechanisms of action (e.g., tumor growth inhibition, apoptosis induction, anti-

angiogenesis, anti-inflammatory activity), and study type. Data were organized into tables for comparative analysis.

Data Analysis

Collected data were analyzed descriptively and analytically. Mechanisms of action were discussed based on laboratory and clinical evidence, emphasizing relevance to breast cancer prevention and treatment.

Transparency and Reproducibility

All procedures for source searching, selection, and data extraction were thoroughly documented to ensure reproducibility by other researchers.

Results

The review revealed that medicinal plants such as *Thymus vulgaris* L., *Rosmarinus officinalis* L., *Origanum vulgare* L., *Zingiber officinale* Roscoe, *Foeniculum vulgare* Mill., *Allium sativum* L., *Vitis vinifera* L., *Portulaca oleracea* L., *Matricaria chamomilla* L., *Phaseolus vulgaris* L., *Solanum lycopersicum* L., *Cicer arietinum* L., *Allium cepa* L., *Triticum aestivum* L., *Punica granatum* L., *Malus domestica* Borkh., *Prunus avium* L., *Curcuma longa* L., *Linum usitatissimum* L., *Borago officinalis* L., *Olea europaea* L., *Achillea millefolium* L., *Viola odorata* L., *Apium graveolens* L., *Vitex agnus-castus* L., *Glycyrrhiza glabra* L., *Brassica rapa* L., *Avena sativa* L., *Aloe vera* (L.) Burm.f., *Calendula officinalis* L., *Camellia sinensis* (L.) Kuntze, *Daucus carota* L., and *Capsicum annuum* L. demonstrate notable anti-cancer activity. Their mechanisms include tumor growth inhibition, apoptosis induction, suppression of angiogenesis, and anti-inflammatory activity. Detailed botanical information and traditional uses are summarized in Table 1.

Table 1: Botanical Information of Medicinal Plants Used in Iranian Traditional Medicine for Breast Cancer Treatment

English Name	Scientific Name	Family	Plant Part Used
Thyme	*Thymus vulgaris* L.	Lamiaceae	Leaf, Flower
Rosemary	*Rosmarinus officinalis* L.	Lamiaceae	Leaf
Oregano	*Origanum vulgare* L.	Lamiaceae	Leaf, Flower
Ginger	*Zingiber officinale* Roscoe	Zingiberaceae	Rhizome
Fennel	*Foeniculum vulgare* Mill.	Apiaceae	Seed, Leaf
Garlic	*Allium sativum* L.	Amaryllidaceae	Bulb
Grape	*Vitis vinifera* L.	Vitaceae	Fruit, Leaf

Purslane	*Portulaca oleracea* L.	Portulacaceae	Leaf, Stem
Purslane	*Portulaca oleracea* L.	Portulacaceae	Leaf, Stem
Chamomile	*Matricaria chamomilla* L.	Asteraceae	Flower
Kidney Bean	*Phaseolus vulgaris* L.	Fabaceae	Seed
Tomato	*Solanum lycopersicum* L.	Solanaceae	Fruit
Chickpea	*Cicer arietinum* L.	Fabaceae	Seed
Onion	*Allium cepa* L.	Amaryllidaceae	Bulb
Wheat	*Triticum aestivum* L.	Poaceae	Seed
Pomegranate	*Punica granatum* L.	Lythraceae	Fruit
Apple	*Malus domestica* Borkh.	Rosaceae	Fruit
Cherry	*Prunus avium* L.	Rosaceae	Fruit
Turmeric	*Curcuma longa* L.	Zingiberaceae	Rhizome
Flaxseed	*Linum usitatissimum* L.	Linaceae	Seed
Borage	*Borago officinalis* L.	Boraginaceae	Leaf, Flower
Olive	*Olea europaea* L.	Oleaceae	Fruit, Leaf
Yarrow	*Achillea millefolium* L.	Asteraceae	Leaf, Flower
Sweet Violet	*Viola odorata* L.	Violaceae	Leaf, Flower
Celery	*Apium graveolens* L.	Apiaceae	Leaf, Stem
Vitex	*Vitex agnus-castus* L.	Lamiaceae	Fruit, Leaf
Licorice	*Glycyrrhiza glabra* L.	Fabaceae	Root
Turnip	*Brassica rapa* L.	Brassicaceae	Root, Leaf
Oat	*Avena sativa* L.	Poaceae	Seed

Aloe vera	*Aloe vera* (L.) Burm.f.	Asphodelaceae	Leaf (Gel)
Calendula	*Calendula officinalis* L.	Asteraceae	Flower
Green Tea	*Camellia sinensis* (L.) Kuntze	Theaceae	Leaf
Carrot	*Daucus carota* L.	Apiaceae	Root
Red Pepper	*Capsicum annuum* L.	Solanaceae	Fruit

Analysis of Table 1 indicates that the most frequently represented families are Lamiaceae (4 species), Asteraceae (4), Apiaceae (3), Fabaceae (3), and Portulacaceae (2). Families such as Zingiberaceae, Amaryllidaceae, Rosaceae, and Solanaceae are represented by two species each, while Vitaceae, Poaceae, Lythraceae, Linaceae, Boraginaceae, Oleaceae, Violaceae, Brassicaceae, Asphodelaceae, and Theaceae are represented by a single species.

Regarding plant parts, leaves were the most commonly used, followed by fruits and flowers, highlighting their prominence in the medicinal applications of these plants.

Discussion

Breast cancer remains one of the most prevalent and life-threatening malignancies among women. Integrating phytotherapy as a complementary approach alongside conventional treatments is significant due to the natural anti-cancer properties of medicinal plants and their generally lower side-effect profiles [27]. In Iranian traditional medicine, a diverse range of plants including *Thymus vulgaris*, *Rosmarinus officinalis*, *Origanum vulgare*, *Zingiber officinale*, *Foeniculum vulgare*, *Allium sativum*, *Vitis vinifera*, *Portulaca oleracea*, *Matricaria chamomilla*, *Phaseolus vulgaris*, *Solanum lycopersicum*, *Cicer arietinum*, *Allium cepa*, *Triticum aestivum*, *Punica granatum*, *Malus domestica*, *Prunus avium*, *Curcuma longa*, *Linum usitatissimum*, *Borago officinalis*, *Olea europaea*, *Achillea millefolium*, *Viola odorata*, *Apium graveolens*, *Vitex agnus-castus*, *Glycyrrhiza glabra*, *Brassica rapa*, *Avena sativa*, *Aloe vera*, *Calendula officinalis*, *Camellia sinensis*, *Daucus carota*, and *Capsicum annuum* have traditionally been employed for breast cancer management. Their efficacy has been evaluated in both human cell lines and animal models, supporting the scientific validation of traditional knowledge.

For example, *Thymus vulgaris* significantly reduced tumor volume by 84–85% in 4T1 breast cancer-induced syngeneic models, modulating molecular markers such as Bax, CD44, ALDH1A1, and VEGFR-2 [27]. *Rosmarinus officinalis*, with antioxidant, anti-inflammatory, and anti-angiogenic properties, can enhance tumor suppressor gene activity and potentiate chemotherapeutic effects, although controlled human studies remain limited [28]. *Origanum vulgare*, primarily via carvacrol, inhibited proliferation in triple-negative HCC-70 cell lines by over 90%, highlighting its therapeutic potential [29].

Ginger and its nano-encapsulated form (Zo-NPs) demonstrated superior protective effects compared to standard extracts, preserving breast tissue architecture, enhancing antioxidant enzymes (CAT, GSH, SOD), and reducing TNF-α levels [30]. Compounds from *Foeniculum vulgare*, such as α-pinene and D-limonene, exhibited potential anti-cancer activity through interactions with breast cancer target proteins [31]. Garlic extracts inhibited MCF-7 and MDA-MB-231 cell proliferation and migration via caspase-9 activation and apoptosis induction [32].

Vitis vinifera seed extracts showed strong antioxidant and anti-proliferative effects without harming normal

cells, inducing apoptosis through inhibition of Bcl-2, Bcl-xL, and survivin [33]. *Portulaca oleracea* activated the TLR4/MyD88/NF-κB pathway, promoting tumor apoptosis while suppressing growth and metastasis [34]. *Matricaria chamomilla* extracts reduced cell proliferation and migration and promoted apoptosis [35].

Other plants including *Phaseolus vulgaris*, *Solanum lycopersicum* (lycopene), *Cicer arietinum* (isoflavones), *Allium cepa*, *Punica granatum*, *Malus domestica*, *Linum usitatissimum*, *Olea europaea*, *Achillea millefolium*, *Viola odorata*, *Vitex agnus-castus*, *Glycyrrhiza glabra*, *Avena sativa*, *Aloe vera*, *Calendula officinalis*, *Camellia sinensis*, and *Capsicum annuum* demonstrated diverse mechanisms, including apoptosis induction, anti-proliferative effects, inhibition of angiogenesis, and modulation of key molecular pathways such as Bax/Bcl-2, NF-κB, mTOR, and TLR4/MyD88/NF-κB [36-53]. Most compounds exhibited low toxicity toward normal cells, supporting their potential as complementary preventive or therapeutic agents. However, the majority of studies remain preclinical, emphasizing the need for controlled clinical trials to establish optimal dosages, safety, and long-term efficacy.

Conclusion

This review demonstrates that medicinal plants used in Iranian traditional medicine, enriched with diverse bioactive compounds, possess significant anti-proliferative, pro-apoptotic, and anti-inflammatory activities against breast cancer cells. Key mechanisms include inhibition of cell growth, induction of apoptosis, suppression of angiogenesis, and modulation of molecular pathways such as Bax/Bcl-2, NF-κB, and mTOR. Plants such as thyme, rosemary, ginger, garlic, pomegranate, turmeric, and green tea not only inhibit cancer cell proliferation but also exhibit minimal toxicity toward normal cells. Leaves, fruits, and flowers were the most frequently utilized plant parts, contributing the majority of therapeutic effects. Although existing evidence is predominantly from in vitro and animal studies, controlled human trials remain limited. Rigorous clinical research with larger cohorts is therefore necessary to determine effective dosages, safety profiles, and long-term outcomes. Overall, phytotherapy represents a promising complementary strategy for breast cancer prevention and management and may guide the development of safe and effective adjunctive treatments.

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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

RA: Conceptualization; original draft preparation; investigation; writing, including review and editing; formal analysis; supervision; and project administration.

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