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Research Article

SACRED BOTANICAL HERITAGE OF HINDUISM: ANTI CANCER PERSPECTIVE FROM SIDDHA PHARMACOLOGY

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Abstract

The Siddha system medicine recognizes several sacred plants; including Vilvam, Vembu, Thulasi, Maavilai, Arugampul, Athi(Peepal) and Vetrilai, which have long been employed in traditional therapeutics owing to their significant medicinal and bioactive potential. Scientific research increasingly demonstrates their protective properties against cancer through mechanisms such as antiproliferation, apoptosis, and inhibition of metastasis (Subapriya & Nagini, 2005; Alzohairy, 2016; Sarkar *et al.,* 2023). Evidence from experimental and review studies suggest that these plants contain bioactive phytochemicals capable of regulating oxidative stress and tumor-related signaling pathways. During this review, molecular mechanisms, important phytochemicals, and available preclinical and limited clinical studies are examined in relation to Siddha concepts of disease, humoral balance, and Rasayana therapy. Overall, the available evidence indicates that further translational research is needed to evaluate these sacred plants as complementary therapies for cancer prevention and treatment.

Keywords: Siddha Medicine, Hindu Sacred Plants, Anticancer Activity, Ethnopharmacology, Phytochemicals, Traditional Medicine, Rasayana Therapy, Oxidative Stress, Apoptosis and Medicinal Plants.

INTRODUCTION

Siddha medicine, one of the oldest traditional medical systems of South India, is based on the theory of three humours: Vatham, Pitham and Kabam. Health is considered a balance of these humours, while disease occurs when they become disturbed (Thiyagarajan, 2005; Zysk, 2010). Many sacred plants used in Hindu rituals are also incorporated into Siddha formulations for the management of chronic diseases. In recent years, experimental oncology research has focused on these plants because of their bioactive phytochemicals that demonstrate anticancer activities including apoptosis induction, cell-cycle arrest, antioxidant effects and immune modulation (Aggarwal *et al.,* 2012; Choudhari *et al.,* 2020). The present review focuses on selected sacred plants frequently used in Siddha medicine and summarizes available scientific evidence supporting their potential anticancer activity.

METHODOLOGY

A structured literature search strategy was conducted using PubMed and related databases. Medical Subject Headings (MeSH) and free-text keywords were combined using Boolean operators to identify relevant literature on sacred plants and anticancer activity (Lefebvre *et al.,* 2011). The search strategy was designed to balance sensitivity and specificity by integrating controlled vocabulary with synonyms and related terms (Bramer *et al.,* 2018). The review process followed systematic search stages including preparation, database searching, supplementary searching and reference management (Cooper *et al.,* 2018). Citation tracking and reference screening were also applied to ensure comprehensive identification of relevant publications (Hirt *et al.,* 2021).

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Overview

Sacred plants in the Siddha medical system hold both cultural and therapeutic significance. Species such as Aegle marmelos, Azadirachta indica, and Ocimum sanctum are revered in Hindu tradition and widely used in Siddha formulations. Modern pharmacological research indicates that these plants can regulate important cancer-related pathways including oxidative stress, inflammation and apoptosis (Alzohairy, 2016; Bhatia *et al.,* 2015).

For example, Aegle marmelos contains marmelosin, a furanocoumarin compound reported to exhibit antioxidant and antiproliferative effects in experimental models (Baliga *et al.,* 2013). Studies have shown that marmelosin may inhibit inflammatory mediators such as TNF-α and induce apoptotic changes in immune cells (Dutta *et al.,* 2023).

Similarly, Azadirachta indica (Neem) contains bioactive limonoids such as nimbolide and gedunin that target multiple cancer hallmarks including proliferation, angiogenesis and metastasis (Subapriya & Nagini, 2005; Alzohairy, 2016). These compounds regulate signaling pathways such as NF-κB, MAPK and PI3K/Akt which are involved in tumor development. Ocimum sanctum (Tulsi) is another sacred medicinal plant widely studied for its anticancer potential. Phytochemicals such as eugenol, rosmarinic acid and flavonoids present in Tulsi exhibit antioxidant and cytotoxic activities in several cancer cell lines (Prakash & Gupta, 2005; Sarkar *et al.,* 2023). Long-term experimental animal studies have demonstrated that topical application of ethanolic leaf extract of Ocimum sanctum significantly reduces the development of skin papillomas induced by 7,12-dimethylbenz[a]anthracene (DMBA) in mice. This protective effect has been associated with the enhancement of antioxidant defense mechanisms, particularly through the increased

activity of enzymes such as glutathione-S-transferase (Prakash & Gupta, 1994). Mechanistically, polyphenolic compounds present in Ocimum sanctum, including eugenol, quercetin, and apigenin, contribute to anticancer activity through several pathways. These phytochemicals have been reported to induce cell-cycle arrest, modulate epigenetic regulation, and enhance apoptosis in cancer cells (Sarkar *et al.,* 2022). Evidence from other sacred plants traditionally used in Siddha medicine also indicates notable anticancer potential. Extracts derived from Mangifera indica (mango), particularly from the peel, kernel, and leaves, contain polyphenolic compounds such as mangiferin, gallic acid, and quercetin. These compounds have been shown to inhibit inflammatory and tumor-related processes both in vitro and in vivo by regulating oxidative stress and interfering with signaling pathways such as PI3K/Akt while also influencing cell-cycle regulatory mechanisms (Yadav *et al.,* 2022; Khan *et al.,* 2010). Additionally, mango peel extract has been reported to induce apoptosis in colon cancer cells by generating reactive oxygen species (ROS), activating stress-related kinases, and causing DNA damage through activation of the γH2AX pathway (Imran *et al.,* 2019). Another sacred medicinal plant, Cynodon dactylon (Arugampul), has also demonstrated promising anticancer properties in experimental models. Studies involving chemically induced colon carcinogenesis have shown that methanolic extracts of this plant enhance antioxidant enzyme activity and significantly reduce dysplastic changes in colon tissue of treated animals (Mahapatra *et al.,* 2011).

Further research indicates that root extracts of Cynodon dactylon exhibit hepatoprotective and anticarcinogenic effects in experimental models of liver cancer induced by diethyl nitrosamine. These protective effects are believed to be associated with the upregulation of antioxidant enzymes such as glutathione peroxidase (GPx), glutathione-S-transferase (GST), and catalase (CAT) (Prasad *et al.,* 2015). Collectively, these findings suggest that sacred plants used in Siddha spiritual and ritual practices possess pharmacologically active constituents that may contribute to cancer prevention and therapy. Integrating traditional Siddha knowledge with modern mechanistic pharmacology may therefore support the development of these botanicals as potential adjunctive agents in cancer management. However, despite promising preclinical evidence, well-designed clinical studies remain limited. Further research is needed to address issues such as extract standardization, bioavailability, safety assessment, and appropriate dosage determination.

Siddha Conceptualization of Hindu Sacred Plants

Siddha worldview: elements, humours and the role of plants

Siddha medicine interprets health and disease within a cosmological framework based on the Panchabhuta (five elements) and the three biological humours Vatham, Pitham, and Kabam which regulate physiological functions in the human body. According to this concept, disease arises when imbalance occurs among these humours (Thiyagarajan, 2005; Zysk, 2010). Within this framework, medicinal plants are not merely sources of chemical compounds but are considered therapeutic agents that express specific qualities such as heating, cooling, drying, or moistening properties, which help restore humoral balance.

Gunapadam (Siddha pharmacology): properties, taste and elemental classification

In Siddha pharmacology, medicinal substances are classified according to characteristics including Suvai (taste), Gunam (quality), Veeryam (potency or thermal nature), Vipakam (post-digestive effect), and Prabhavam (specific pharmacological action). These parameters guide practitioners in selecting suitable plant drugs for correcting particular humoral disturbances and determining appropriate formulations and dosages.

Sacredness and therapeutic selection

Certain plants such as Aegle marmelos, Azadirachta indica, and Ocimum sanctum hold sacred status in Hindu religious traditions and are frequently used in temple rituals and household worship. Their widespread availability and cultural significance have contributed to their continued therapeutic use in Siddha medicine. Ethnobotanical studies suggest that these culturally embedded plants are often perceived as possessing purifying and detoxifying properties, which reinforces their role in treating various disorders (Patwardhan *et al.,* 2015; Baliga *et al.,* 2013).

Mapping Classical Qualities to Modern Pharmacology (A Translational Lens)

Traditional Siddha descriptors such as Veerya (potency), Suvai (taste), and Prabhava (specific therapeutic action) can be interpreted alongside modern pharmacological observations. For instance, herbs described as having “hot” or “pungent” properties in Siddha literature may exert stimulatory effects on circulation or metabolic processes and may act as pro-oxidant agents at certain concentrations. In contrast, plants classified as having “cooling” properties often demonstrate antioxidant or anti-inflammatory effects in experimental pharmacological studies. Recent translational reviews indicate that many Siddha medicinal plants classified according to these traditional parameters display biochemical activities such as antioxidant, anti-inflammatory, and immunomodulatory actions that are relevant to cancer biology. This conceptual overlap provides a useful framework for integrating classical Siddha theory with modern mechanistic research in oncology (Patwardhan *et al.,* 2015; Baliga *et al.,* 2013).

Preparation, Purification (Suddhi) and Formulation Principles

In Siddha pharmaceutics, drug preparation and purification processes (Suddhi or Marunthu preparation) play a critical role in determining therapeutic efficacy and safety. Traditional methods include procedures such as washing, decoction, calcination, grinding, and the use of Anupana (specific vehicles or co-administration substances). These processes are believed to modify the pharmacological qualities of medicinal substances while reducing toxicity. Modern pharmacological studies support this concept by demonstrating that processing methods can significantly alter phytochemical composition, improve bioavailability, and reduce harmful constituents in herbal preparations. Consequently, the traditional pharmaceutical practices described in Siddha texts may have an important influence on the biological activity of plant-derived medicines (Baliga *et al.,* 2013).

Individualization: Udaliyal (Constitution), Dosage and Therapeutic Context

A distinctive feature of Siddha medical practice is the emphasis on individualized therapy based on Udaliyal, or constitutional type. Each individual is believed to have a dominant humoural pattern Vatham, Pitham, or Kabam which influences susceptibility to disease and response to treatment. Accordingly, the same medicinal plant may be prescribed in different forms, doses, or formulations depending on the patient's constitution and the nature of the humoral imbalance. This personalized therapeutic approach is well documented in classical Siddha texts and continues to be emphasized in modern Siddha medical education and clinical practice (Thiyagarajan, 2005; Zysk, 2010).

Ritual, Purity and Psychosocial Dimensions of Therapy

The therapeutic use of sacred plants in Siddha medicine is also influenced by cultural and ritual practices. Activities such as offering plants in temples, inhaling their aroma, or wearing certain plant parts may contribute to therapeutic outcomes by influencing behavioral and psychosocial factors. These practices may indirectly promote health by encouraging hygienic habits, dietary discipline, and increased patient engagement in treatment. Contemporary ethnomedical studies suggest that the cultural and ritual significance of medicinal plants may enhance treatment adherence, perceived therapeutic value, and community acceptance. Such factors are increasingly recognized as important considerations in the design of culturally appropriate clinical research involving traditional medical systems (Patwardhan *et al.,* 2015).

Implications for Anticancer Research and Clinical Translation

In Siddha medicine, sacred plants are regarded as multifunctional therapeutic agents capable of cleansing humoral toxins, restoring Rasayana (rejuvenation) effects, and correcting elemental imbalances believed to underlie chronic diseases. Interestingly, these traditional concepts align with several modern objectives of cancer prevention, including the reduction of chronic inflammation, improvement of metabolic regulation, and enhancement of host immune responses (Thiyagarajan, 2005; Narayanan *et al.,* 2022). To translate these traditional insights into modern medical applications, rigorous scientific approaches are required. These include phytochemical standardization of plant extracts, toxicological evaluation (including the impact of traditional processing techniques), investigation of potential herb–drug interactions, and carefully designed clinical trials that incorporate Siddha-based therapeutic outcomes. Evidence from recent controlled trials involving Siddha formulations for other conditions suggests that combining classical therapeutic knowledge with modern clinical research methodologies may provide a productive pathway for translational medicine (Narayanan *et al.,* 2022). From the Siddha perspective, sacred plants possess specific elemental and humoral properties that guide their therapeutic selection, preparation, and individualization. Contemporary pharmacological and ethnobotanical research increasingly validates the biological activities attributed to these plants. Consequently, an integrated research framework combining pharmacognosy, molecular pharmacology, and traditional diagnostic principles may significantly advance anticancer drug discovery based on Siddha medicinal plants (Baliga *et al.,* 2013; Patwardhan *et al.,* 2015).

Review of Individual Hindu Sacred Plants — Siddha Uses and Phytochemical Constituents

Aegle marmelos (Vilvam / Bael)

Siddha Uses

In Siddha medicine, Aegle marmelos (Vilvam) is widely used for treating gastrointestinal disorders such as diarrhea and dysentery, as well as fever and respiratory ailments. It is also considered a rejuvenating herb and frequently incorporated into decoctions and polyherbal formulations aimed at correcting Pitham-related disorders and strengthening digestive function. These traditional uses have been documented in ethnopharmacological surveys and traditional medicinal literature of South India (Rahman *et al.,* 2014; Karthikeyan *et al.,* 2023).

Phytochemicals and Anticancer Relevance

Phytochemical analyses of Aegle marmelos have identified several bioactive compounds including coumarins (marmelosin and imperatorin), alkaloids such as aegeline, flavonoids, tannins, and other phenolic constituents. Experimental studies suggest that these compounds exhibit antioxidant, anti-inflammatory, and antiproliferative effects in cancer models. In animal experiments, extracts of A. marmelos have demonstrated tumor-suppressive activity through mechanisms such as modulation of oxidative stress markers and inflammatory mediators including TNF-α (Dutta *et al.,* 2023; Sahu *et al.,* 2020).

Azadirachta indica (Vembu / Neem)

Siddha Uses

Azadirachta indica (Neem) is traditionally valued in Siddha medicine as a blood purifier, antimicrobial agent, and antipyretic. It is commonly used in the treatment of skin disorders, infections, and inflammatory conditions. Its bitter taste and detoxifying properties are believed to reduce excess Pitham and Kabam and eliminate metabolic toxins (Alzohairy, 2016; Kausik *et al.,* 2020).

Phytochemicals and Anticancer Relevance

Neem contains a wide range of bioactive compounds, particularly limonoids such as nimbolide, gedunin, and azadirachtin, along with flavonoids and phenolic molecules. Nimbolide has been extensively investigated for its anticancer potential. Studies indicate that it can promote apoptosis, inhibit metastasis and angiogenesis, and regulate oncogenic signaling pathways including NF-κB, PI3K/Akt, and MAPK in multiple cancer models (Gupta *et al.,* 2018; Kharwar *et al.,* 2023).

Ocimum sanctum / Ocimum tenuiflorum (Perumal-Thulasi / Holy Basil)

Siddha Uses

Ocimum sanctum (Tulsi) holds a highly revered status in Hindu households and temple traditions. In Siddha medicine it is considered an adaptogenic and Rasayana herb and is used for treating respiratory disorders, fever, and inflammatory conditions. Tulsi's hot and pungent properties (Veerya and

Suvai) are believed to correct Vatham–Pitham imbalances and promote detoxification processes (Prakash & Gupta, 2005; Cohen, 2014).

Phytochemicals and Anticancer Relevance

Tulsi leaves contain numerous phenolic compounds including eugenol, rosmarinic acid, flavonoids, and terpenoids. These phytochemicals demonstrate antioxidant, anti-inflammatory, and cytotoxic activities in several experimental cancer models. Eugenol and related polyphenols are known to induce apoptosis, regulate cellular redox balance, and enhance the sensitivity of tumor cells to chemotherapeutic agents (Sarkar *et al.,* 2023).

Mangifera indica (Maavilai / Mango)

Siddha Uses

In Siddha and other traditional practices, mango leaves and other plant parts are utilized for wound healing, anti-inflammatory remedies, and general tonic preparations. Leaves and kernels are often included in herbal preparations used for metabolic disorders and digestive disturbances (Imran *et al.,* 2017).

Phytochemicals and Anticancer Relevance

Mangifera indica is rich in bioactive compounds such as mangiferin, gallotannins, gallic acid, and quercetin. Mangiferin, a C-glucosyl xanthone, has demonstrated significant anticancer effects including inhibition of tumor cell proliferation, induction of apoptosis, and suppression of metastasis. Mechanistic studies suggest that these effects occur through regulation of oxidative stress and signaling pathways such as PI3K/Akt and β-catenin, along with inhibition of matrix metalloproteinases involved in tumor invasion (Yadav *et al.,* 2022; Li *et al.,* 2023).

Cynodon dactylon (Ganapati-Arugampul / Durva)

Siddha Uses

Cynodon dactylon (Arugampul) is commonly used in Siddha materia medica and is also associated with Hindu ritual practices. It is administered as a juice or decoction for treating urinary disorders, wound healing, and general health improvement. In some traditional formulations it is prescribed to correct Vatham and Kabam imbalances (Mahapatra *et al.,* 2011).

Phytochemicals and Anticancer Relevance

Phytochemical investigations of Cynodon dactylon reveal the presence of phenolic acids, flavonoids, and catechin derivatives. Experimental studies demonstrate that extracts of this plant exhibit antioxidant activity and cytotoxic effects against multiple cancer cell lines. Animal studies using chemically induced tumor models have shown reduced dysplasia and improved antioxidant enzyme levels following treatment with plant extracts (Prasad *et al.,* 2015; Kumar *et al.,* 2016).

Ficus religiosa (Brahman-Athi Illai / Peepal)

Siddha Uses

Ficus religiosa, commonly known as the peepal tree, is widely respected in both spiritual and medicinal traditions. In Siddha practice it is used to treat respiratory disorders, digestive complaints, and chronic inflammatory conditions. Different plant parts are selected depending on the humoral imbalance diagnosed in the patient (Nair *et al.,* 2021).

Phytochemicals and Anticancer Relevance

Phytochemical studies have identified flavonols, phenolic compounds, alkaloids, and phytosterols such as β-sitosterol and stigmasterol in Ficus religiosa. Extracts of this plant have demonstrated cytotoxic effects in several cancer cell lines including HeLa, HT-29, and MCF-7, primarily through mechanisms involving cell-cycle arrest and induction of apoptosis (Khan *et al.,* 2013).

Piper betle (Vetrilai / Betel Leaf)

Siddha Uses

Piper betle (Betel leaf) is traditionally used in Siddha medicine for digestive disorders, oral infections, wound healing, and topical therapeutic applications. The aromatic and stimulant properties of betel leaf have made it a common component of traditional formulations and household remedies (Bhardwaj *et al.,* 2022).

Phytochemicals and Anticancer Relevance

Betel leaves contain several bioactive phenolic compounds, particularly hydroxychavicol, chavibetol, and eugenol derivatives. These compounds have demonstrated the ability to induce apoptosis, cause cell-cycle arrest, and generate ROS-mediated cytotoxicity in various cancer cell lines including colon, pancreatic, and prostate cancers. Importantly, carcinogenic risks associated with betel chewing are largely linked to areca nut additives, rather than the medicinal use of betel leaf extracts themselves (Das *et al.,* 2021).

Integrating Sacred Symbolism with Anticancer Pharmacology

In the Hindu-Siddha worldview, sacred plants are closely associated with specific deities and symbolic meanings. For example, Vilvam (Aegle marmelos) is considered sacred to Lord Shiva, and its phytochemical constituents such as marmelosin have demonstrated anti-inflammatory and anticancer properties through modulation of the TNF-α/NF-κB pathway (Rajan *et al.,* 2023).

Similarly, Neem (Azadirachta indica) is associated with Goddess Shakti, representing purification and protection. Modern pharmacological studies show that neem-derived limonoids such as nimbolide can suppress cancer cell proliferation and angiogenesis by regulating signaling pathways including NF-κB and PI3K/Akt (Gupta *et al.,* 2018).

Tulsi (Ocimum sanctum) is traditionally linked to Lord Vishnu and symbolizes preservation and protection. Its polyphenolic compounds promote antioxidant defenses and induce apoptosis in tumor cells, supporting its traditional role as a rejuvenating and immune-enhancing herb (Cohen, 2014). Overall, Siddha medicine has historically recognized the therapeutic value of these sacred plants based on their perceived Rasayana, detoxifying, and humoral-balancing properties. Modern phytochemical and pharmacological research increasingly confirms that these plants contain biologically active compounds such as marmelosin, nimbolide, eugenol, mangiferin, hydroxychavicol, and flavonols, which possess antioxidant, anti-inflammatory, and anticancer activities. However, despite promising preclinical evidence, clinical validation remains limited. Future research should focus on extract standardization, safety evaluation, herb–drug interaction studies, and well-designed clinical trials to establish their therapeutic potential in cancer management.

DISCUSSION

The sacred plants reviewed in this article contain diverse phytochemicals that regulate oxidative stress, inflammation, apoptosis and angiogenesis processes closely associated with cancer progression. The Siddha conceptual framework of restoring humoral balance and promoting rejuvenation can be related to biological mechanisms such as antioxidant defense and immune modulation (Choudhari *et al.,* 2020). However, most available evidence originates from in vitro and animal studies, and well-designed clinical trials remain limited.

Conclusion

Sacred plants used in Siddha medicine, including Vilvam (Aegle marmelos), Vembu (Azadirachta indica), Thulasi (Ocimum sanctum), Maavilai (Mangifera indica), Arugampul (Cynodon dactylon), Athi (Ficus religiosa), and Vetrilai (Piper betle), demonstrate promising anticancer activity in experimental studies. Future research should focus on phytochemical standardization, toxicological evaluation, and controlled clinical trials to establish their role as complementary agents in cancer management.

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