Pharmacological importance of *Curcuma aromatica* Salisb and scope for its cultivation in Northeastern region of India

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Abstract

Curcuma aromatica Salisb., also known as wild turmeric, is a perennial herb native to South and Southeast Asia, particularly India. It is renowned for its rhizomatous growth, distinct camphoraceous odor, and light yellow-orange rhizomes. The plant has a long-standing history in traditional medicine, especially in Ayurveda, where it has been used for over 6,000 years to treat various ailments, including skin diseases, digestive issues and infections. Rich in bioactive compounds such as curcumin, essential oils, terpenoids and flavonoids, *C. aromatica* exhibits significant pharmacological properties, including anti-inflammatory, antibacterial and anticancer effects. Beyond medicinal uses, it is valued in the cosmetic and food industries for its aromatic and antioxidant properties. In Northeast India, the plant holds cultural significance among local tribes, who utilize it for various health conditions. The rising demand for natural products has increased its economic importance, providing opportunities for sustainable farming. *C. aromatica* thrives in tropical and subtropical climates, particularly in Northeast India, where favorable conditions support its cultivation. Sustainable propagation through micropropagation techniques can help preserve genetic diversity while meeting market demands. Future research is needed to further explore its therapeutic potential and integrate it into modern healthcare practices.

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1. Introduction

C. aromatica Salisb also ~~commonly~~ known as wild turmeric, is a perennial herb of the ginger family (Zingiberaceae), recognized for its rhizomatous growth, camphoraceous odor and light yellow-orange rhizomes. Native to South and Southeast Asia, particularly India, it is widely distributed in regions such as the Western Ghats and Northeastern Himalayas, where it thrives in the wild (Dhiman *et al*., 2023). This plant has a long history of use in traditional medicine, especially in Ayurveda, where it has been employed for over 6,000 years to treat a variety of ailments including skin diseases, digestive issues, and infections (Ravindran *et al*., 2007; Mohanty *et al.*, 2015). The rhizomes are rich in bioactive compounds like terpenoids, flavonoids and essential oils, which exhibit significant pharmacological properties, including anti-inflammatory, antibacterial and anticancer effects (Kojima *et al.*, 1998; Sharma *et al*., 2020).

In addition to its medicinal uses, *C. aromatica* is also valued in the cosmetic and food industries for its aromatic and antioxidant properties. Its use in skincare products is attributed to its ability to enhance skin tone and texture, reduce inflammation and promote overall skin health (Sikha *et al*., 2015). The rising demand for natural and organic products has further boosted its economic significance, making it a valuable resource for sustainable farming and modern healthcare applications (Panich *et al*., 2010; Hu *et al.*, 2011). Further research is needed to fully understand and utilize the plant's bioactive compounds, ensuring its continued importance in traditional medicine and potential integration into contemporary therapeutic practices (Hasmeda *et al*., 1996). The rising demand for natural and organic products has increased the economic significance of *C. aromatica*, providing opportunities for sustainable farming in regions like Northeast India, where it is cultivated

extensively (Tushar *et al.*, 2010). ~~Further research is necessary to fully explore its therapeutic potential and integrate it into modern health care practices (Hasmeda *et al.*, 1996).~~

2. Influence of cultural heritage

C. aromatica Salisb is well regarded in India for its various traditional uses, particularly in Northeast India. It is recognized as a tonic, carminative, astringent. The plant is used to treat bruises, corns, sprains and to enhance complexion. A paste made from the rhizome with milk is commonly applied to treat dysentery and gastric ailments. Additionally, the aqueous extracts of the rhizomes are used to alleviate indigestion, rheumatism and dysentery (R. R. Rao, 1981; S. K. Jain, 1995).

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In Northeast India, particularly among the Khasi and Garo tribes of Meghalaya, *C. aromatica* holds significant cultural and medicinal value. The tribes use a paste of the rhizomes, consumed with water, to prevent helminth infections. The rhizomes are also traditionally used to assist in expelling a stillborn baby from the womb and to treat various ailments like digestive disorders, skin diseases, menstrual irregularities and mental health conditions. The leaves of the plant are also used to heal wounds and fractured bones (Kirtikar *et al.*, 1978; Dhiman *et al.*, 2023). *C. aromatica* is deeply integrated into the traditional healthcare practices of Northeast India, where it is utilized for both preventive and curative purposes. The plant's versatile applications in local medicine highlight its importance in folk medicine and cultural practices in the region. ~~The plant's versatile applications in local medicine highlight its importance in the region folk medicine and cultural practices.~~

3. Medicinal and therapeutic values

C. aromatica Salisb ~~or wild turmeric~~, is highly valued in Ayurveda and traditional medicine for its wide range of therapeutic properties. It is commonly used to treat skin conditions, as well as diseases related to the cardiovascular and respiratory systems. In cosmetic formulations and traditional medicinal practices, it is recognized for its anti-inflammatory properties, its ability to enhance blood circulation, improve complexion, remove blood stasis and its potential in cancer treatment. ~~The rhizomes of *Curcuma aromatica*~~ Plant rhizomes are often combined with astringents and aromatic substances to treat various conditions, such as bruises, sprains, hiccups, bronchitis, cough, leucoderma and skin eruptions. The paste of rhizomes is a popular home remedy for headaches and is also applied in cases of snake bites due to its purported antidote properties. These diverse medicinal applications underscore the plant versatility and its integral role in traditional health practices (Ravindran *et al.*, 2007).

4. Chemical constitute

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C. aromatica Salisb, ~~commonly known as aromatic turmeric,~~ is rich in various bioactive compounds. The primary constituents include curcumin, which ranges from 3% to 7% in the dried rhizome and is known for its antioxidant and anti-inflammatory properties (Khan *et al.*, 2016). The essential oil of *C. aromatica* contains volatile compounds such as tumerone, with concentrations typically between 2% and 6%, and zingiberene, around 10% (Arutselvan *et al.*, 2009). Additionally, the plant contains demethoxycurcumin and bisdemethoxycurcumin, which are ~~derivatives of~~ curcumin derivates with potential therapeutic benefits (Huang *et al.*, 2017). These constituents contribute to the plant's therapeutic potential and distinctive aroma.

C. aromatica essential oil contains major constituents like camphor (26.32%) and borneol (16.45%), with notable antioxidant activities (Choudhary *et al*., 1996). Its methanol extract shows strong free radical scavenging, particularly against DPPH and superoxide radicals (Archana *et al*., 2005). Polar extracts' high total phenolic content contributes significantly to its antioxidant potential (Madsen et al., 1996; Decker, 1997). Variations in essential oil composition are influenced by factors like harvest season and geographical origin (Burt, 2004).

5. Pharmacological effects

C. aromatica Salisb, widely recognized for its diverse bioactive compounds, demonstrates a range of pharmacological effects. Traditionally, its rhizomes have been used for their anti-inflammatory, antibacterial,l and anticancer benefits (Kojima *et al.*, 1998). ~~In various traditional medicine systems, the plant is employed to address digestive issues, skin conditions and liver ailments.~~ The plant addresses digestive issues, skin conditions, and liver ailments in various traditional medicine systems. Additionally, it is used to treat dyspepsia, gout, wounds and infectionsand is applied externally for conditions such as scabies and smallpox (Dhiman *et al*., 2023; Kirtikar *et al*., 1978). The essential oils and curcumin from *C. aromatica* are noted for their antimicrobial, antifungal and anticancer properties, reinforcing its role in cancer therapy and its inclusion in therapeutic and cosmetic products (Sharma *et al*., 2020; Hasmeda *et al*., 1996). These pharmacological attributes highlight the plant potential in modern medicine and its significance in ~~both~~ traditional and contemporary health practices.

C. aromatica Salisb~~. (CA~~) demonstrates a wide range of pharmacological activities. Its anti-inflammatory properties are evidenced by both aqueous and alcoholic extracts, which show significant activity in mice models, affecting arachidonic acid metabolism and cyclo-oxygenase pathways (Sikha *et al*., 2015). The rhizome's wound-healing potential has been confirmed in rabbit studies, showing effectiveness in excision wound models with topical applications (Ravindran *et al*., 2007). Germacrone, a major bioactive component of ~~CA~~, exhibits anti-tumor effects by inducing apoptosis and cell cycle arrest in glioma cells (Hasmeda *et al.*, 1996). The oil from ~~CA~~ also shows promising results in inhibiting hepatoma growth in mice, with substantial tumor inhibitory rates (Rao, 1981). Anticancer activity has been demonstrated with aqueous extracts inhibiting colon carcinoma cell proliferation (Jain *et al*., 2016~~). CA's~~ mosquito-repellent activity is notable, with ethanol extracts showing effective repellency and larvicidal properties against Aedes aegypti (Sharma *et al*., 2020). Additionally~~, CA~~ has antiplatelet activity, with curcumin demonstrating strong inhibition of platelet aggregation (Kirtikar *et al.*, 1978). The ethanolic extract also exhibits significant antitussive effects in a sulfur dioxide-induced cough model (Jain *et al.*, 2016). Its antioxidant and free radical scavenging activities are highlighted by its potent effects in DPPH and superoxide radical-scavenging assays (Sikha *et al*., 2015). ~~CA~~ extracts also ~~provide~~ protect against UVA-induced melanogenesis and nephrotoxicity, showing their broad therapeutic potential (Sharma *et al*., 2020).

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6. Cultivation Practices

It is well-suited to cultivation in tropical and subtropical climates and ~~in~~ northeast India, it is commonly grown in agroforestry systems or as a companion crop with other agricultural plants. The

plant thrives during the summer monsoon season, displaying rapid and vigorous growth. Its fragrant and attractive appearance is recognized, with a strong subterranean rhizome. ~~It is recognized for its fragrant and attractive appearance, with a strong subterranean rhizome.~~ In late autumn, the foliage dies off, leaving the rhizome dormant through the winter. By early spring, the plant begins to flower, producing white blooms with orange leaves at the base of the rhizome. The blooming stalks, approximately 20-25 cm in length, are adorned with large, colorful bracts that are pink-tipped. Fully matured plants can reach a height of around 90 cm (Dhiman *et al*., 2023).

I. Site selection

C. aromatica thrives in well-draining, fertile soils with ample sunlight. Research indicates that the plant achieves optimal growth in terms of height, number of leaves per plant, number of fingers per rhizome, ~~as well as~~ and the length and weight of individual rhizomes, when grown in conditions with full sunlight. This contrasts plants grown in open spaces with less direct sunlight, with significantly lower growth parameters ~~This is in contrast to plants grown in open spaces with less direct sunlight, where these growth parameters were significantly lower~~ (Hazarika *et al*., 2009).

II. Sustainable Propagation

It is primarily propagated through rhizome cuttings, which are widely used due to their effectiveness in establishing new plants. However, in many South Asian countries, the high demand from pharmaceutical industries has placed significant pressure on wild populations, leading to concerns about overharvesting and conservation (Kumar & Sikarwar, 2002). To address the challenges associated with commercial cultivation and to preserve genetic diversity, the development of optimized micropropagation protocols has emerged as a promising solution. Micropropagation techniques offer a sustainable approach by enabling the large-scale production of plants in controlled environments while safeguarding the species genetic integrity (Sharmin *et al.*, 2013).*Curcuma aromatica* is propagated through rhizome cuttings, ~~which are~~ planted at a depth of about 5-10 cm during the rainy season (Hazarika *et al*., 2009). It can be intercropped with rice, maize, and sugarcane crops, which helps enhance soil fertility and control weed growth (Kumar & Sikarwar, 2002). Harvesting of the rhizomes typically occurs 8-10 months after planting once the foliage has begun to die back (Sharmin et al., 2013).

7. **Scope for Cultivation:** The northeastern region of India presents significant potential for cultivating *Curcuma aromatica* Salisb due to its favorable climatic and ecological conditions. The region's tropical and subtropical climate, with ample rainfall and rich, well-draining soils, provides an ideal environment for the growth of wild turmeric. Additionally, the region's diverse ago-ecological zones support ~~the cultivation~~ cultivating ~~of~~ a wide range of crops, making it suitable for integrating *Curcuma aromatica* into existing agricultural systems.

a) **Favorable Climate**: The humid and temperate climate of northeastern India, with its substantial rainfall and moderate temperatures, supports the optimal growth of *Curcuma aromatica.* The plant thrives in environments with well-distributed rainfall and temperatures ranging from 20°C to 35°C (Hazarika *et al*., 2009).

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b) **Agroforestry Systems**: The region's traditional agroforestry practices align well with the cultivation of *Curcuma aromatica*. It can be integrated into existing systems or grown as a companion crop with staple crops like rice, maize, and sugarcane, enhancing soil fertility and reducing weed growth (Kumar & Sikarwar, 2002).

c) **Economic Potential**: The increasing demand for *Curcuma aromatica* in the pharmaceutical, cosmetic, and culinary industries presents a significant economic opportunity for northeastern India. Leveraging the region's unique biodiversity and traditional knowledge can lead to the production of high-quality, value-added products, thereby enhancing the economic potential of cultivating this plant.

d) **Conservation and Sustainability**: The development of sustainable cultivation practices and micropropagation techniques can address issues related to overharvesting and conservation, ensuring the preservation of the plant's genetic diversity while meeting market demands (Sharmin *et al.*, 2013).

8. Conclusion:

Curcuma aromatica Salisb, commonly known as wild turmeric, is a perennial herb with significant cultural and economic importance in South and Southeast Asia, particularly ~~in~~ Northeast India. Its extensive use in traditional medicine and increasing demand in pharmaceutical, cosmetic, and culinary industries underscore its value. The plant thrives in the tropical and subtropical climates of Northeast India, benefiting from the region's favorable weather and agroforestry systems. Sustainable cultivation practices, including optimized micro-propagation, are crucial to address overharvesting concerns and preserve genetic diversity. With its diverse therapeutic properties, from anti-inflammatory to antioxidant effects, *Curcuma aromatica* presents both cultural significance and economic potential, making it a promising candidate for expanded cultivation and integration into modern health practices.

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