REVIEW ARTICLE

Curcuma aromatica – perfect blend of traditional aroma with modern pharmacology

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Abstract

The botanical name for wild turmeric is *Curcuma aromatica* Salisb. Since ancient times, traditional medicine has made great use of the important medicinal plant *C. aromatica*. It has been used to treat wounds, skin infections, inflammatory diseases, insect bites, and gastrointestinal problems. The goal of this study is to examine the pharmacological and phytochemical properties of *C. aromatica* and to offer direction and insight for future research. The literature on the pharmacognostic, physicochemical, nutritional, bioactive compound, and biological activity of *C. aromatica* was systematically reviewed, and concepts for further research were also developed. Data analysis revealed that the pharmacological activity of *C. aromatica* was based on a variety of groups of chemicals, including alkaloids, flavonoids, curcuminoids, tannins, and terpenoids. According to the reviewed research, *C. aromatica* also exhibits antidiabetic, anticancer, anti-inflammatory, antioxidant, antitussive, antimicrobial, analgesic, wound healing, and antiepileptic properties. In this study, the research on the nutritional benefits, bioactive ingredients, and biological functions of *C. aromatica* has been methodically collated and reviewed. This is the most thorough review of *C. aromatica* that has been published, as far as we are aware.

Key words: Bioactive, *Curcuma aromatica*, nutritional, pharmacological, physiochemical, phytochemical

INTRODUCTION

"Vanaharidra" in Ayurveda, "wild turmeric" in English, "jangli haldi" in Hindi, and "Yu Jin" in Chinese are all names for *Curcuma aromatica* Salisb. In Southeast Asian nations, it is frequently used as a coloring and flavoring ingredient as well as in a variety of traditional treatments. It has been used therapeutically against a variety of microbial illnesses since ancient times and has a potent antibacterial action. Traditional medicine makes use of the rhizomes of *C. aromatica* to treat liver illnesses, prevent blood stasis, postpone aging, and relieve pain. In addition to being administered topically for a variety of skin conditions, sprains, bruises, as an antidote for snake venom, and to improve complexion, the rhizomes of *C. aromatica* are also used orally as a tonic and carminative. For the treatment of dyspepsia, rheumatism, wound healing, diarrhea, and the prevention of helminth infections, villagers in northeastern India use aqueous extracts and paste made from the rhizomes and leaves of *C. aromatic* [Figure 1].[1]

C. aromatica's roots and rhizome are frequently utilized in skincare products and spa treatments in Thailand. To possibly advance modern medicine, the traditional medical applications of *C. aromatica* rhizome extract are currently being investigated in contemporary scientific research. These applications include but are not limited to antioxidant, antimicrobial, anti-inflammatory, antidiabetic, anticancer, antitussive, antiangiogenic, antiacne, antiobesity, wound

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Figure 1: *Curcuma aromatica*

healing, and antiallergic. Alkaloids, curcuminoids, flavonoids, terpenoids, and tannins are just a few of the therapeutically significant phytochemicals that have been shown to be abundant in the rhizome of *C. aromatica*. Given the high therapeutic potential of this plant, chances for pharmaceutical uses may arise from the extraction and characterization of the important bioactive components with critical medicinal qualities. To better understand the published investigations on the phytochemical and pharmacological activities of the rhizomes, leaves, and essential oil of *C. aromatica*, we have collated and critically examined them in this review. It is anticipate that this may provide light on how *C. aromatica* may be used medically in the future to treat a variety of disorders.[2]

BOTANICAL DESCRIPTION

Wild turmeric, or *C. aromatica*, is a member of the Zingiberaceae family and the genus Curcuma. There are between 70 and 100 species of rhizomatous plants of the genus *Curcuma*, which are widely recognized for their medicinal properties. The species of turmeric most often found worldwide include *Curcuma longa* Linn., *C. aromatica* Salisb., *Curcuma amada* Roxb., *Curcuma angustifolia* Roxb., *Curcuma caesia* Roxb., and *Curcuma zedoaria* Rosc. As the most important species in the family, *C. aromatica* comes in second place only to *C. longa* (turmeric). Widely found in tropical and subtropical areas, *C. aromatica* is mostly grown for its rhizomes in India, China, and Japan. A tall, annual herb known as *C. aromatica*, it has a distinct camphoraceous scent and a light yellow aromatic rhizome. The plant grows clusters of upright, unbranched leaf stems from a sturdy, subterranean rhizome that, when fully grown, can reach a height of about 1 m and have expanded colored bracts with pink tips. Before the leaves emerge in the early spring, inflorescences often start to form at the base of the rhizomes. The blooms have an orange lip and are fragrant and pinkish-white overall. During the monsoon season, the plant develops quickly, erratically, and actively. The rhizomes grow and have a distinctive scent before the leaves die in late fall and the rhizomes remain dormant in winter.[3]

NUTRITIONAL AND PHYSIOCHEMICAL CONTENTS

The primary edible parts of *C. aromatica* are the rhizomes. They are well recognized for having a high nutritional value and are particularly abundant in proteins, carbs, alkaloids, flavonoids, vitamin C, β-carotene, polyphenols, fatty acids, and essential oils. Due to its wonderful perfume, *C. aromatica*'s rhizomes are mostly employed in food preparation as a spice, food flavoring, and coloring ingredient. Crude protein, fat, and carbohydrates make up the rhizomes' nutritional make-up in that order: 19.44%, 2.5%, and 97.5%. The rhizomes also contain 3.21% ash and 19% moisture. Ash content (16.6% total ash, 2.8% acid insoluble ash, and 3.93% water-soluble ash), extractive values (0.4% alcohol soluble extractive value and 0.8% water-soluble extractive value), and moisture content (3.14%) are additional physicochemical characteristics that have been mentioned previously.[4]

PHYTOCHEMICAL CONSTITUENTS

Different extraction techniques were used to obtain qualitative and quantitative phytochemical analyses on various *C. aromatica* parts. Solvents are said to frequently contain a number of important classes of phytochemical compounds, including terpenoids, alkaloids, steroids, flavonoids, tannins, saponins, phytosterols, phenols, protein amino acids, volatile oils, and glycosides. The total flavonoid concentration varies from 106.8 g/mg eq to quercetin to 175 mg/g of rutin, while the total phenolic content of the rhizome extracts of *C. aromatica* is estimated to be between 151.33 g/mg eq to gallic acid and 265 mg/g of ascorbic acid. As a result, the existence of the aforementioned phytochemicals demonstrates the plant's capacity for both protection and disease prevention. It is also significant to point out that, in contrast to other *Curcuma* species, *C. aromatica*'s leaves have not been the subject of numerous phytochemical research (*i.e.*, *C. caesia*, *C. longa*, *C. amada*, and *Curcuma xanthorrhiza*).[5]

BIOACTIVE COMPOUNDS

The leaves, rhizomes, and essential oils of *C. aromatica* have yielded a total of 79 main chemicals over the past three decades. Alkaloids, flavonoids, curcuminoids, tannins, and terpenoids make up the majority of the main chemicals. It is interesting to note that the constituents of *C. aromatica* cultivated in the same or different places are the same in both the extracts of the leaves and rhizomes and their essential oils. Solvent extracts of *C. aromatica*'s leaves and rhizomes contained a total of 37 isolated and recognized chemicals.

The essential oils from the leaves and rhizomes included 42 additional chemicals that were extracted and identified. The essential oils were also reported to have more potent antimicrobial, antioxidant, anticancer, and anti-inflammatory activities than the solvent extract counterparts.[6]

PHARMACOLOGICAL ACTIVITIES OF *C. AROMATICA*

Analgesic Activity

As a result of the medications' alleged negative side effects, which include addiction and gastrointestinal issues, the usage of analgesic treatments for pain management, such as opiates and non-steroidal anti-inflammatory drugs (NSAIDs), has decreased. Numerous plants, including *C. aromatica*, have been researched in an effort to develop natural substitutes for these medications and have proven to have strong analgesic properties. Using Eddy's hot plate (55°C) technique to inflict pain due to heat on rats, studies investigated the analgesic impact of an aqueous extract of *C. aromatica* rhizomes. In comparison to diclofenac sodium (10 mg/kg), the extract's oral administration at concentrations of 300 µg/kg and 500 µg/kg resulted in longer pain latency. Another research found that giving mice an aqueous extract of the rhizomes of *C. aromatica* decreased the amount of writhes they experienced during an acetic acid-induced writhing test. 1,8-cineole, linalool, borneol, camphene, and camphor were found to be present in *C. aromatica*, which was responsible for the plant's analgesic properties.[7]

Anticancer Activity

Cancer is a condition that causes tumors of cancerous cells to develop out of control in the human body. The second most common cause of mortality worldwide, both in industrialized and developing nations, is cancer, a serious issue for public health. The present course of treatment, which includes radiation, chemotherapy, and surgery, is frequently pricy and has serious side effects. Therefore, the emphasis now is on finding novel, risk-free, and affordable cancer alternative treatments, particularly derived from natural sources. Bioactive components from the essential oil of *C. aromatica*, such as ar-curcumene, 1,8-cineole, β-elemene, ar-turmerone, curcumol, camphor, germacrone, curdione, xanthorrhizol, zingiberene, and linalool have been shown to have anticancer effects.

Using a colorimetric MTT [3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyltetrazolium bromide] assay, studies investigated the cytotoxic activities of essential oils extracted from the rhizomes of *C. aromatica* against prostate cancer cells line and human hepatoma cells line. The essential oils considerably outperformed HepG2 in terms of anticancer activity, with an IC_{50} of 1.14 µg/mL compared to HepG2's 168.94 µg/mL. In another research, individuals with primary liver cancer and a transplanted rat model of hepatoma both saw immediate therapeutic responses following the infusion of essential oils through the hepatic artery. In a rat model, the esophagoduodenal anastomosis and intestinal metaplasia were both reported to be protected by essential oils. While employing 1,25-(OH)(2)-D(3)-treated Caco-2 clone cells, studies examined the inhibitory impact of curdione extracted from the rhizome of *C. aromatica* on CYP3A4. After 72 h of treatment, the data showed that curdione had the best inhibitory action, with an IC_{50} of 3.9 µg/mL and no cytotoxic effects. Thus, it was determined that curdione's inhibitory effect hastens the breakdown of CYP3A4. On human hepatoma SMMC-7721 cells, the molecular pathways underlying curcumin's apoptotic action were investigated. Curcumin modulated the expression of apoptotic proteins (bax/bcl-2) in SMMC-7721 cells, which led to the induction of apoptosis. Curcumin drastically reduced the proliferation of SMMC-7721 cells in a concentration-dependent manner. In a related study, it was examined the antiproliferative mechanism of the apoptotic action of β-elemene extracted from *C. aromatica* on a HepG2, and they found that β-elemene significantly and time- and dose-dependently suppressed the proliferation of HepG2 cells. Upregulation of Fas/FasL expression caused hepatoma HepG2 cells to undergo apoptosis.[8]

Antidiabetic Activity

Diabetes mellitus is a systemic, chronic, and fatal illness that can cause blindness, renal failure, amputations, heart attacks, strokes, and other serious consequences. Oxidative stress, which is brought on by diabetes mellitus and results in the oxidative breakdown of cellular membranes and redox imbalance, increases the formation of free radicals and lowers the body's antioxidant defense system. As a result, it has been proposed that in diabetes mellitus, increased oxidative stress and reduced antioxidant synthesis lead to an increase in free radical generation. As a result, one of the major problems of diabetes mellitus might be said to be the increased creation of free radicals. Numerous substances found in *C. aromatica* have been shown to have anti-inflammatory and anti-diabetic activities, including 1,8-cineole, ar-turmerone, curcumin, curcumol, demethoxycurcumin, germacrone, and xanthorrhizol. Besides, it was reported that the toluene extract of rhizomes of *C. aromatica* significantly decreased the glucose level from 278.53 to 116.5 mg/dL, increased protein level from 3.09 to5.78 mg/dL, decreased cholesterol level from 292.33 to 134.50 mg/dL, and reduced the triglyceride level from 85.66 to 64.16 mg/dL upon oral administration at a maximum single dose of 400 mg/kg in streptozotocin-induced diabetic rats.[9]

Antiepileptic Activity

Although the plant does contain chemicals with antiepileptic effects, such as androstan-17-one and linalool, the

activity of these compounds has not yet been determined using *C. aromatica* extracts or essential oils.[10]

Anti-inflammatory Activity

According to one definition, inflammation is a brief biological tissue reaction to potentially harmful stimuli, such as wounds, exogenic antigens, and endogenic antigens. Its purpose is to clear or remove the stimulus and repair the damaged tissue, which in turn promotes tissue regeneration and normal homeostasis. Although inflammation is a positive body defense mechanism, it has been well established that dysregulated and chronic inflammatory reactions are the root causes of many systemic diseases, such as diabetes, asthma, atherosclerosis, obesity, cancer, and pain. As a result, the cost of health care has increased for society.

Unfavorable side effects, including ulceration, headache, perforation, gastric irritation, hyperglycemia, hemolytic anemia, and a host of others, are associated with the majority of conventional NSAIDs, steroids, and immunosuppressant medications used to treat all types of inflammatory conditions. Given the negative effects of these medications, researchers are always looking for potential anti-inflammatory activity in alternative sources, particularly from traditionally safe medicinal plants.[11]

The essential oils of *C. aromatica* rhizomes collected from 12 different places in China were examined for their anti-inflammatory properties. 12-O-tetradecanolphorbol-13-acetate was used in their investigation to cause mice to develop ear edema. Ibuprofen was utilized as a positive control, and different essential oil treatments were given to several mouse groups. Ibuprofen (17.84%–54.57%), which is recognized for its anti-inflammatory impact, was shockingly outperformed by all essential oils in terms of their anti-inflammatory activity, which generally ranged from 20.56% to 61.34% and was dose-dependent. Further evidence of tissue alleviation from inflammation following therapy with both essential oils came from histological and immunohistochemical studies. The expression of COX-2 and TNF-α was significantly lower in the groups treated with essential oils than in the control group, according to a cytokine study. In contrast to the group that received ibuprofen, the difference was not statistically significant. When tested on mice with carrageenan-induced paw inflammation, the extracts of *C. aromatica* rhizomes were also said to show a potential anti-inflammatory activity comparable to prednisolone. However, given that they contain and may have a synergistic effect with various potent anti-inflammatory compounds, such as ar-turmerone, borneol, curcumin, curdione, linalool, 1,8-cineole, and xanthorrhizol, it is not surprising that the extracts and essential oil of *C. aromatica* have a greater anti-inflammatory effect than conventional drugs.[12]

Antimicrobial Activity

The food, beverage, and pharmaceutical businesses face several difficulties, including microbial contamination and resistance. To stop the growth of food-borne germs and increase the shelf life of processed foods, antimicrobial compounds, such as food preservatives, have been utilized. It has been demonstrated that a variety of plant compounds, including those from *C. aromatica*, exhibit antibacterial qualities. *C. aromatica* crude hexane extract was efficient against Gram-positive bacteria but unsuccessful against the tested Gram-negative bacteria. According to the phytochemical investigation, germacrone is responsible for the antibacterial action. It is important to remember that germacrone has also reportedly been linked to other biological activities, such as anti-inflammatory, anti-tussive, anti-tumor, and antifungal effects. Both Gram-positive and Gram-negative bacteria have been demonstrated to be inhibited by the essential oil that may be extracted from *C. aromatica*'s fresh rhizomes. After being isolated, curcumin (diferuloylmethane) was discovered to have antibacterial activity against strains of *Staphylococcus aureus* and *Saccharomyces cerevisiae*.[13]

Another study found that *C. aromatica* essential oil outperformed essential oils from other *Curcuma* species in terms of antifungal activity against *S. cerevisiae* (183.18 μg/mL) compared to *Curcuma nankunshanensis*, *Carex elata*, *Craigia kwangsiensis* var. nanlingensis, *Craigia yunnanensis*, and *Cryptophasa rubescens*. In addition to germacrone and curcumin, *C. aromatica* also contains bioactive substances like ar-turmerone, camphor, curdione, linalool, and xanthorrhizol that have been shown in other studies to have an antimicrobial effect against bacteria (*S. aureus*, *Bacillus cereus*, and *Escherichia coli*) and fungi alike (*Fusarium semitectum*, *Aspergillus flavus*, *Colletotrichum mus*, and *Colletotrichum gloeosporioides*). These results may not come as a surprise given that *C. aromatica* is frequently one of the best plant sources for the conventional and Ayurvedic treatment of a variety of infectious disorders.[14]

Antioxidant Activity

A molecule known as an antioxidant scavenges and neutralizes free radicals by giving an electron, lessening their potential for harm. *L*-ascorbic acid, a well-known antioxidant with an IC_{50} value of <60 μg/mL, has been shown to have comparable efficacy to *C. aromatica* rhizomes extracted in methanol and water. In a separate research, scientists used the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical-scavenging test to examine the antioxidative activity of the essential oils of *C. aromatica* rhizomes from 12 different regions in China. With an IC_{50} range of 1.57–21.36 μg/mL, the results once more demonstrated the antioxidative effectiveness of *C. aromatica*, which was indeed superior to the control, Trolox C (IC_{50} = 8.82 μg/mL). Researchers investigated the chemical makeup and antioxidant properties of both the

essential oil and organic extracts of *C. aromatica* leaves. DPPH and superoxide radical-scavenging tests were used to measure the antioxidant capabilities. When compared to the reference substance, butylated hydroxyanisole, which had an IC_{50} value of 18.27 µg/mL, both the essential oil extract and the methanol extract had stronger antioxidative activity (IC_{50} = 14.45 µg/mL and 16.58 µg/mL, respectively). The presence of antioxidant substances such 1,8-cineole, germacrone, xanthorrhizol, and β-sesquiphellandrene was linked to the activity.[15]

Antitussive Activity

The antitussive properties of *C. aromatica* have been studied. The plant's ethanol extract had a promising and similar dose-dependent antitussive efficacy to codeine phosphate. After 1.5 h of oral treatment, the extract reduced 79% of coughing at a dose of 400 mg/kg body weight, which is comparable to codeine phosphate's (87% at a concentration of 40 mg) effects in mice. Up to a level of 4 µg/kg, the ethanol extract's acute oral toxicity assessment revealed no harmful effects.[16]

Wound Healing Activity

Researchers investigated the wound-healing abilities of *C. aromatica* powdered rhizomes mixed with a soft white paraffin ointment. When the ointment was topically administered to rabbits with acute wounds, the wound significantly contracted and completely epithelized after 9–11 days. When given topically to Swiss albino mouse excision wounds, cream formulations of *C. aromatica* rhizome extracts also demonstrated considerable wound-healing activities.[17]

CONCLUSION

This study highlighted significant research on *C. aromatica*, one of the most important plant species in the genus Curcuma for medicinal purposes. The research also explains why this plant is used in India, China, and other Southeast Asian nations' traditional remedies. Scientific research on the *in vivo* toxicity, clinical trials, and nutritional value of this plant, however, is still missing. These results are essential in opening up a wide range of possibilities for the creation of new *C. aromatica*-based medicinal and cosmetic goods.

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