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Exploring the therapeutic potential: A comprehensive review on the Phytochemistry of *Curcuma aromatic*

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Abstract

Curcuma aromatic Salisb. (*C. aromatica*) is commonly known as wild turmeric mentioned as 'Vanaharidra' in Ayurveda, belongs to the 'ginger family' Zingiberaceae. It is a perennial herb with characteristic aromatic rhizomes used in many traditional systems of medicines in India, China and other Southeast Asian countries. The rhizome of the plant is rich in alkaloids, flavonoids, curcuminoids, tannins and terpenoids which are reported to be the reasons for its various pharmacological properties. The extraction of compounds in different solvents shows that the plant contains curdione, neocurdione, germacrone as its major components. Extensive literature survey showed that the plant has anti-angiogenic, cholerectic and cholagougic, anthelmintic, antimicrobial, wound healing, anticancer, antioxidant, antidiabetic, anti-inflammmatory, analgesic, antitussive, larvicidal, antimelonogenic, anti-nephrotic, antiplatelet, anti-hyperlipidemic, antivenom, and neuroprotective properties. The plant thus proves to be a promising candidate for the development and designing of modern drugs for several diseases. The present study was aimed to review the phytochemical and pharmacological properties of C. aromatic Salisb.

Keywords: Curcuma Aromatic Salisb; Zingiberaceae; Neuroprotective

1. Introduction

Herbs have provided all living organisms with medicine from the earliest beginnings of civilization. The word herb is used as herbal medicine and is also known as botanical medicine, means a plant or a part of plant that is used to make medicine to assist the curing process during illness and ailment [1]. Throughout history, various cultures have handed down their accumulated awareness of the medicinal use of herbs to successive generations. Herbal medicines are also in great demand in the developed world for primary health care because of their efficacy, safety and lesser side effects. This vast body of information serves as the basis for much allopathic medicine today[2].Curcuma aromatica also known as wild turmeric, Vanaharidra, Kasturi Arisina or Kasturi Manjal. Curcuma aromatica, the traditional aromatic and medicinal cosmetic is the second most commonly cultivated and utilized species next to Curcuma longa. Its rhizomes are light yellow in colour with a pleasant, camphoraceous aroma [3]. It is considered as an endangered wild turmeric, although popular regionally, due to non-availability of planting material for large scale cultivation. It is a promising drug for therapeutic purpose due to its wound healing, anti-inflammatory, anti-oxidant anti-tumour and immunomodulatory properties.

The rhizome is as an antidote and a blood purifier. It is a useful component for treating bruises, worm infestations, fever, skin infections and as tonic for women after child birth [4-6].Also, the rhizomes of *C. aromatica* are used internally as a tonic and carminative, while being topically applied for various skin ailments, sprains, bruises, as an antidote for snake venom, and also to enhance complexion [2,7,8,9]. Villagers in the northeastern part of India are using aqueous extracts and

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paste (with milk) of *C. aromatica* rhizomes and leaves for the treatment of indigestion, rheumatism, wound healing, and dysentery and also in the prevention of helminth infections [10]. In Thailand, the rhizome and roots of *C. aromatica* are often used in cosmetics and spas for skincare [11].

Figure 1 Rhizome and flowering plant of *C.aromatica*

1.1. Taxonomical Classification

- Domain :Eukaryota
- Kingdom :Plantae
- Subkingdom :Viridiplantae
- Phylum :Tracheophyta
- Subphylum :Euphyllophytina
- Infraphylum :Radiatopses
- Class :Liliopsida
- Subclass :Commelinidae
- Superorder :Zingiberanae
- Order :Zingiberales
- Family :Zingiberaceae
- Subfamily :Zingiberoideae
- Genus :*Curcuma*
- Species :*aromatica*

1.2. Vernacular name

Table 1 Vernacular name

Language	Vernacular name	Language	Vernacular name
Spanish	Curcuma	English	Turmeric
French	Saffron des Indes	Hindi	Haldi
German	Kurkumagelbwurz	Bengali	Holud
Swedish	Gurkmeja	Gujarathi	Haldi
Burmese	Fanwin	Kannada	Arishina
Arabic	Kurkum	Malayalam	Halad

Dutch	Geelwortel	Sindhi	Halda
Thai	Kamin	Punjabi	Haldhor,Haldhar
Indonesian	Kunjit, Kunyit	Tamil	Manjal
Italian	Curcuma	Telugu	Pasupu
Chinese	Yu.chin	Sanskrit	Haridra, Harita

2. Morphological studies

Figure 2 Flowering cone, with two yellow flowers visible.

It is a wild plant, cultivated throughout India chiefly in Bengal and Kerala (Travancore). It is an erect, perennial herb. Rhizomes are large, tuberous, yellow or orange- red inside and aromatic in taste. Leaves are large, green, oblong-lanceolate/ oblong elliptic, with acuminate apex, 38- 60 x 10- 20 cm size, often variegated above, pubescent beneath, base deltoid with long petioles. Rootstock large, of palmately branched, sessile annulated biennial tubers. Flowering stem appears with or before the leafing stem, as thick as the forefinger and sheathed.

Flowers are fragrant, shorter than the bracts, in spikes 15- 30 cm long; flowering bracts 3.8- 5 cm long, ovate, recurved, cymbiform, rounded at the tip, pale green, connate below forming pouches for the flower, bracts of the coma 5- 7.5 cm long, more or less tinged with red or pink. Calyx 8 mm long, irregular with 3- lobed, corolla tube 2.5 cm long with upper half like funnel- shaped, lobes pale rose- coloured, the lateral lobes oblong, the dorsal longer, ovate, concave, arching over the anthers. Lip yellow, obovate, deflexed, subentire or obscurely 3- lobed. Lateral staminodes oblong, obtuse and as long as corolla- lobes [12]. The plant develops clumps of erect, unbranched leaf stems that on full growth can reach a height of about 1 m from the stout, underground rhizome and with enlarged colored bracts tipped with pink. The inflorescences usually appear from the base of the rhizomes before the leaves are produced in early spring.

Figure 3 Leaf stems

Figure 4 Rhizomes of *C.aromatica*

The flowers are fragrant and pinkish-white with an orange lip. The plant grows fast, wild, and vigorously in the monsoon season. The foliage dries in late autumn and the rhizomes remain dormant in winter; the rhizome, when mature, possesses a characteristic fragrance [13].

3. Root

3.1. Macroscopical Characters

Roots are long, occurs along with rhizomes and measures 16.2 cms. to 9.8 cms. and 4.1 cms. to 2.2 cms. in diameter. Fresh root has a Camphoraceousodour, outer surface smooth, light yellow in colour inner surface white with yellowish wood. Dried roots are brown in colour and has fragrant odour. Roots are straight or slightly curved.

3.2. Microscopical Characters

To transverse section of the root shows epidermis, cork, cortex and stellar portion with small pith (Fig. 6-1). The outer layer epidermis is made up of single layer of parenchymatous tissue. Followed by epidermis 4 to 5 layers of thick walled brown coloured parenchymatous cork is present. Followed by cork is the cortex made up of thin walled more or less circular to Isodiameteric parenchymatous cells with little intercellular spaces? Cells contain ovoid to oblong simple starch grains and little yellow cell content (Fig. 6-2). The cells of the cortex are radially elongated and get disintegrated forming large air canals. (Fig. 6-3). the air canals are interrupted at intervals by parenchyma. Followed by this is the endodermis which is thick walled on the inner tangential and radial walls. Followed by endodermis is the pericycle composed of a single layer of thin walled parenchymatous tissue. Following the pericycle is the central stele which shows typical monocotyledonous structure with a number of phloem and xylem strans alternating radially. (Polyarch condition). Xylem is surrounded by sclerenchymatousfibres with yellow cell content. In the center small pith is present which is made up of thin walled, rounded parenchymatous cells. Some of the cells are filled with yellow cell content (Fig. 6-4).

4. Rhizome

4.1. Macroscopical Characters

Rhizomes are large, central rhizomes oblong or conical, 2 – 3" in diameter, external surface dark grey, marked with circular rings and gives off many thick root lets at the ends of some of them are orange yellow tubers of almond shape are present. Lateral rhizomes about as thick as the finger with few fleshy roots.

The lateral rhizomes measures 10.5 cms to 8.2 cms in length and 6 cms to 8 cms in breadth. The outer surface smooth, pale yellow colour, scaly leaves are present at the nodal region. Rhizomes have agreeable fragrant smell. Internally both central and lateral rhizomes have deep orange colour.

4.2. Microscopical Characters

T.S. of the lateral rhizome is circular in outline and shows epidermis, cork, cortex and ground tissue with scattered vascular bundles (Fig. 7-8). The outer layer is the epidermis made up of rectangular parenchymatous cells. Followed by epidermis is the cork which consists of 10 to 12 layers of thin walled suberised irregularly arranged parenchymatous cells (Fig. 7-9). Followed by cork is the cortex made up of 20 to 35 layers of thin walled, polygonal parenchymatous cell with abundant yellow cell content, simple starchgrain and few oilglobules. Most of the cells consists ovoid and oblong starchgrains. (Fig. 7-9). In the cortex region many cortical vascular bundles are scattered which are collateral and closed (Fig. 7-10) with out fibrous zone. Followed by the cortex is the endodermis which is single layered, thick walled and followed by endodermis is the single layer of pericycle which is made up of thin walled parenchymatous cells. Small vascular bundles are scattered with in the pericycle. (Fig. 7-11). The vascular bundles are smaller having 2 to 3 xylem elements which are present towards the pericycle, while those present towards the centre show 5 to 6 xylem elements (Fig. 7-12) with phloem. The vascular bundles are closed and collateral. The ground tissue of the stele is composed of thin walled, polygonal parenchymatous cells containing flattened, ovoid oblong starch grains and yellow cell content. The microscopical structures of the central rhizome is same as the lateral rhizome. Macerate of the rhizome shows thin walled, brown rectangular parenchymatous cork tissue (Fig. 7-13), polygonal parenchymatous tissue with yellow cell content (Fig. 7-14), helical to spiral vessel element (Fig. 7-15).

4.3. Pharmacognostic study

Pharmacognosticstudy was carried on the basis of Morphological characters such as color, odor, taste, size, fracture, texture etc. were considered. The results of the Pharmacognostic study were expressed in Table no.2

Table 2 Pharmacognostic study

Characters	**Observation**
Organoleptic characters	
Color	Deep Orange
Odor	Aromatic
Taste	Pungent
Characters	Observation
Macroscopic Features	
Shape	Finger shaped
Surface	Smooth or slightly
Texture	Hard and heavy
Fracture	short
Quantitative Macro Morphology	
Size	3-5 cm in diameter
Length	1-1.5 cm long

4.4. hysicochemical parameters

In this study ash values (total ash, acid insoluble ash and water soluble ash), extractive value (alcohol soluble extractive value and water soluble extractive value) and moisture content were determined. The total ash value was found to be 16.6% indicating the considerable presence of inorganic radicals.

The acid insoluble and watersoluble ash value was found to be 2.8% and 3.93% respectively where as the alcohol soluble extractive value and Water soluble extractive value was found to be 0.4% and 0.8% respectively and 3.14% of Moisture Content was present. The results of the Physicochemical Parameters are shown in Table no.2

Table 3 Physiochemical Parameters of *C. aromatica Salisb*

Total Ash	16.6%
Acid Insoluble ash	2.8%
Water soluble ash	3.93%
Alcohol soluble extractive value	0.4%
Water soluble extractive value	0.8%
LOD	3.14%

4.5. Phytochemical constituents

The Preliminary Phytochemical Investigations of Chloroform, Ethanolic and Aqueous extract of rhizome

Curcuma aromatic Salisb were preformed which reveals the presence of Alkaloid, Flavonoids, Glycoside, Tannins, Amino acid and Gum & Mucilage type of major secondary metabolites which revealed their potent therapeutic activity. The results of the screening were expressed in Table no.3.

Qualitative and quantitative phytochemical analyses on different parts of *C. aromatica* are obtained via various extraction methods, and solvents are reported to commonly contain several essential classes of phytochemical compounds, including alkaloids, terpenoids, flavonoids, steroids, saponins, tannins, phenols, phytosterols, glycosides, protein amino acids, and volatile oils. [15, 16, 17] The total phenolic content of the rhizome extracts of *C. aromatica* is reported in the range of 151.33 ± 13.9 µg/mg eq to gallic acid [18] to 265 ± 1.08 mg/g of ascorbic acid [17], and the total flavonoids content ranges from 106.8 ± 2.76 µg/mg eq to quercetin [18] to 175 ± 1.56 mg/g of rutin. [17]

4.6. Bioactive compounds

The bioactive compounds isolated and identified from the extracts and essential oils of *C. aromatica* obtained from different extraction methods respectively.

Major compounds isolated from solvent extracts of leaves and rhizomes of *C. aromatica*:

Soxhlet extraction method: (Compounds isolated (≥ 5%)

n-Heneitriacontan-14-one, Stigmasterol, n-Nonacosan-1-ol, n-Pentatriacontan-5-one, Curcumapentadecanol, Curdione,Neocurdione, Curcumol, (R)-(+)-1,2-hexadecanediol, Tetramethylpyrazine, Aromaticanoid (A to E), β-Sitosterol-3-O-β-D-glucopyranoside, Vatirenene, Androstan-17-one-3-ethyl-3-hydroxy(5à).

Cold maceration method: (Compounds isolated (≥ 5%)

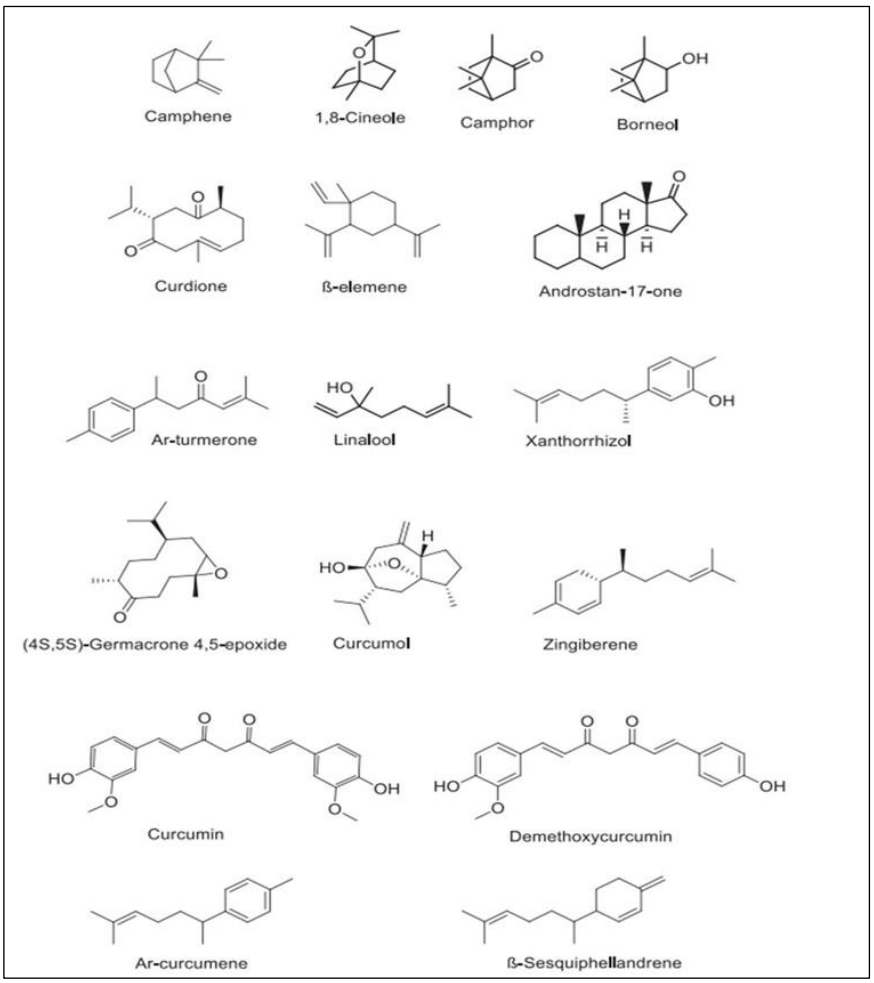

Figure 5 Chemical structures of some of the main bioactive compounds from extracts and essential oils from the leaves and rhizomes of ***C. aromatica***.

Curcumin, Isozedoarondiol, Zedoarondiol, Aerugidiol, Demethoxycurcumin, Epiprocurcumenol, Isoprocurcumenol, 13-hydroxy-germacrone, (2S)-2-hydroxycurdione, (4S,5S)-(+)-germacrone4,5-epoxide, Procurcumenol, Curcumenone, Curcumene, Germacrone, Dehydrocurdione, Zederone, β-Sitosterol. [19] From the last three decades (1987–2019), a total of 79 major compounds have been identified from the leaves, rhizomes, and essential oils of *C. aromatica*. Most of the major compounds belong to alkaloids, flavonoids, curcuminoids, tannins, and terpenoids. Interestingly, there is no significant difference between the compounds found in the extracts of the leaves and rhizomes or their essential oils of *C. aromatica* grown either in the same or in different regions. A total of 37 compounds have been isolated and identified in the solvents extracts of leaves and rhizomes of *C. aromatica*. An additional 42 compounds were isolated and identified in the essential oils from the leaves and rhizomes. The essential oils were also reported to have more potent antimicrobial, antioxidant, anticancer, and anti-inflammatory activities than the solvent extract counterparts. (Xiang et al., 2018). [20]

5. Compound isolation methods

Major compounds isolated from the essential oils of leaves and rhizomes of *C. aromatica*:

Steam distillation method: Compounds isolated (≥ 5%)

Ar-curcumene, β-curcumene, Curzerene, Curzerenone, Zingiberene,ar-turmerone, Humulene oxide, β-selinene, Eucalyptol, Neocurdione, β-sesquiphellandrene, Ermanthin, 8,9-dehydro-9-formyl-cycloisolongifolene,Curcumene.

Hydrodistillation method: Compounds isolated (≥ 5%)

Camphor, 1,8-cineole, Germacrone, Isoborneol, Camphene, Limonene, P-cymene,α-terpineol, 2-oxabicyclo (3,2,1) octane-1-,4-dimethyl-8-methylene, Caryo-phyllene oxide, Patchouli alcohol, Elsholtzia ketone, Borneol, Vinyldimethylcarbinol, Cubenol, Cucumber alcohol (2,6-Nonadien-1-ol), Curdione, β- elemene, Eugenol, Isoledene, Bergamol, Agarospirol, α-caryophyllene, β-guaiene, Curcumene.

Simultaneous steam distillation and solvent extraction: Compounds isolated (≥ 5%) Linalool, Humulene oxide, Curcumol. [19]

6. Conclusion

C. aromatica is one of the most useful plants with highly potent pharmacological activities.The deep survey of literature revealed that the Curcuma aromatica is a source of many medicinally important chemical constituents, as curcumin, curcumene, xanthorrhizol, 1,8- cineole, carvone, camphor, borneol, limonene etc. belonging to class of mainly essential oils. The plant has also widely studied for various pharmacological activities like anti- angiogenic, cholerectic and cholagougic, anthelmintic, antimicrobial, wound healing, anticancer, antioxidant, antidiabetic, anti-inflammmatory, analgesic, antitussive, larvicidal, antimelonogenic, anti-nephrotic, antiplatelet, anti-hyperlipidemic, antivenom, etc. Beside these, neuroprotective property has also been studied.These properties are being used by the people in countries like India, China and other South East Asian countries. Hence it provides a wide area for research into the detail pharmacological actions of this drug which has not been explored much compared to its utility. This review spotlighted important findings of *C. aromatica* as one of the most medically crucial plant species of the genus Curcuma.However, scientific findings are still lacking on the in vivo toxicity, clinical trials, and nutritional content of this plant. These findings are crucial to providing immense opportunities for the development of new *C. aromatica*-based products in pharmaceutical industries and cosmetics.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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