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Traditional use, Pharmacognosy, Phytochemistry and Pharmacology of *Cryptocoryne spiralis* (Retz.) Fisch. ex Wydler: A review

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Abstract

Cryptocoryne spiralis (Retz.) Fisch. ex Wydler (Araceae) is an aquatic medicinal plant found in India and Bangladesh. It is widely used in folk medicine against several ailments. Though the plant is primarily considered as a substitute or adulterant, it is known to contain several therapeutically important phytoconstituents whose efficacy is well established by several biochemical and pharmacological studies. This review critically evaluates the conventional remedies and recent research on this plant, providing clarity on its traditional use, pharmacognosy, phytochemistry and pharmacology.

Keywords: *Cryptocoryne spiralis*, araceae, ethnobotany, pharmacognosy, phytochemistry, pharmacology

Introduction

Using plants as medicine has been a goal for mankind since ancient times. About one fourth of the prescribed drugs are plant origin and more than three quarter people depend on medicines that are derived from medicinal plants ^[1]. An increasing demand for medicinal plants in pharmaceutical industries in recent years has raised its importance to cover a substantial proportion of the global drug market ^[2]. Hence, botany, pharmacognosy, phytochemistry and pharmacology have undergone a huge turnaround and have become significant areas, resulting in initiation of active research programs either to isolate new lead compounds or to produce standardized extracts ^[3].

Cryptocoryne spiralis (Retz.) Fisch. ex Wydler (family - Araceae) is an aquatic herb found in the rice fields of India and Bangladesh. It is commonly known as “Country Ativisha” (English) or “Nattu Athividayam” (Tamil) in Siddha medicine, used traditionally in the treatment of fever, jaundice, abdominal complaints, diarrhoea, cough and vomiting in infants ^[4]. This review aims to provide various studies on its medicinal potential, biology, pharmacognosy, phytochemistry and pharmacological actions.



Fig 1: Dried Rhizome of *Cryptocoryne spiralis*

Taxonomy

The genus *Cryptocoryne* Fisch. ex Wydler belonging to the family – Araceae (subfamily – Aroideae, tribe – Cryptocoryneae) consisting around 70 species, native to Indomalaysian region ^[5]. The species has four infraspecific taxa, namely, *Cryptocoryne spiralis* var. *spiralis*,

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Cryptocoryne spiralis var. *cognatoides* (Blatt. & McCann) S.R. Yadav, K.S. Patil & Bogner, *Cryptocoryne spiralis* var. *huegelii* (Schott) Bogner, and *Cryptocoryne spiralis* var. *caudigera* Bogner [6,7].

Habit and Habitat

Marsh, rhizomatous creeping perennial herb; deeply rooted in clayey soil. Rhizome up to 1.5 cm across. Leaves tufted apically on rhizome; petiole up to 25 cm long, blade 18 × 3 cm, linear-lanceolate. Flowers dark purple, 1-4, with coiled spathe. Peduncle up to 8 cm; spathe up to 13 cm long, basal tubular part 2 cm; limb expanded, lanceolate, acuminate, spirally twisted, up to 11.5 cm long, purplish to green outside, dark purplish and with sub-horizontal lamellations within; spadix about 1.5 cm, with ♀ portion up to 4 mm, interstice up to 11 mm, ♂ up to 4 mm; ♀ flowers with subsessile style and broadly elliptic stigma; neuter flowers few, dark purplish coloured. Fruit septicidal sub-ovoid syncarp, α - seeded; seeds striate, endospermous. Grown at plains from the coast, up to 1000 m, by river banks, water courses, paddy fields etc.; partially submerged.

Distribution

South India, extending to Bangladesh. In India, it is found in Karnataka, Kerala, Maharashtra and Tamil Nadu [8].

Chromosome number

The somatic chromosome number of *C. spiralis* was reported as $2n = 112$ and they are short, ranging in length between 1.0 - 2.0 μ [9]. Whereas Sarkar *et al.*, reported $2n = 90$ chromosomes in a normal somatic complement and found four chromosomes to bear secondary constrictions [10]. A deviating plate with $2n = 86$ chromosomes has also been observed. In metaphase I, forty-five bivalents have been counted. Meiotic study also showed a number of irregularities like lagging and univalent formation. Arends *et al.*, reported the chromosomes number $2n = 33, 66$, and ca.132 and they concluded that the material collected by C.D.K. Cook proved to consist of two different forms. They had a different leaf-form, and the plants with $2n = 33$ flowered very quickly. The plants with $2n = 33$ are haploids of plants with $2n = 66$, while the plants with $2n =$ ca. 132 are "tetraploids" of plants with $2n = 66$ [11].

Adulterants / Substitutes

The genuine drug source of "Ativisha" is the tuber of *Aconitum heterophyllum* Wall. ex Royle (Ranunculaceae), but the rhizomes of *C. spiralis* are very often sold in the markets as *Nattu Athividayam*, as a substitute for *Ativisha* [12, 13]. Because it is inexpensive, freely available in the market and possesses some properties similar to *Ativisha* like tonic and antiperiodic. However, it has none of the other properties enumerated for *Ativisha*. Hence, some Ayurvedic scholars do not accept it as a substitute for *Ativisha* [14-16]. However, John Adams *et al.*, reported that there is greater phytochemical similarity (84.6%) between *Aconitum heterophyllum* and *Cryptocoryne spiralis*, which justifies why the latter is used in Siddha system of medicine as *Nattu Athividayam* [17].

C. spiralis has also been reported to be used as adulterant to genuine drugs of *Trillium govanianum* Wall. ex D.Don and *Paris polyphylla* Sm. in the commercial market, and is also sold under the name *Granthika Tagara* (as a replacement for *Tagara* plant - *Valeriana jatamansi* Jones ex Roxb.) in Dakshina Kannada district of Karnataka [18, 19].

Pharmacognostic studies

The macro and microscopic evaluation of *C. spiralis* have been studied by Anandakumar *et al.*, Prasad *et al.*, and John Adams *et al.*, [17, 20, 21].

Macroscopical characters

The drug consists of the dried, swollen rhizome; erect with a large terminal bud, up to 7 cm long and 1.5 cm in diameter, blackish brown or yellowish brown in colour; differentiated into nodes and internodes.

Microscopical characters

The rhizomes are circular and consist of a thin superficial periderm, wide cortex, and central stellar cylinder containing discrete vascular bundles. Periderm is ~50 μm wide, 3-4 layered thin-walled, rectangular or tabular suberised cells. Cortex that follows the periderm is homocellular with a radius of 1.3 mm, which consist of small angular, compact, and thin-walled parenchyma cells. Some of the cortical cells are dilated assuming wide circular outline and possess raphide. The stele consists of large vascular bundles arranged in a ring and smaller ones in the centre of the ring. The ring vascular bundle has a central mass of phloem ensheathed around by three or four layers of wide, thin-walled angular xylem. The central bundles have central mass of phloem and one or two layers of fairly thick-walled wide angular xylem elements. The vascular bundles are amphivasal type; possess the central phloem, surrounded by outer xylem.

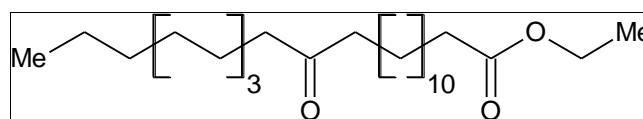
Chemical composition

The primary chemical study on the rhizome of *C. spiralis* was made by Anandakumar *et al.*, [20] and the analysis results are follows:

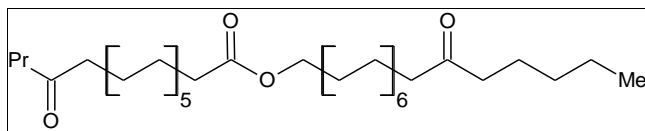
The primary chemical study on the rhizome of *C. spiralis*

Parameters	Results (% w/w)
Loss of weight on drying	16.09
Moisture content	15.00
Volatile matter	1.09
Ash content	7.30
Water soluble ash	7.02
Alkalinity of water soluble ash	0.17
Acid insoluble ash	0.62
Water soluble extractive	18.62
Alcohol soluble extractive	13.60
Chloroform soluble extractive	1.31
Reducing sugar	9.55
Total Sugar	11.89
Total nitrogen	7.56
Total glycosides	0.97
Total alkaloids	1.45

Gupta *et al.*, isolated two oxo fatty acid esters, ethyl 14-oxotetracosanoate and 15-oxoheptacosanyl 14-oxoheptadecanoate together with hentriacontane and sitosterol isolated from the rhizomes [22]. Further studies led to the isolation of two new fatty acids, 22-oxononacosanoic acid and 26-oxohentriacontanoic acid [23]. Gupta and Shukla have reported two steryl esters, 5 α -stigmast-11-en-3 β -yl palmitate and 24-ethyl-5- α -cholesta-8(14), 25-dien-3 β -yl stearate in *C. spiralis* based on the chemical and spectroscopic studies [24].



Ethyl 14-oxotetracosanoate



15-oxoeicosanyl 14-oxoheptadecanoate

Prasad *et al.*, carried out physicochemical evaluation and estimation of phytochemical constituents of the plant material [21, 25] and the analysis results are follows:

Physicochemical evaluation and estimation of phytochemical constituents of the plant material

Parameters	Results
Water extractive	19.670%
Methanol extractive	2.094%
Ethanol extractive	1.908%
Ethyl acetate extractive	0.254%
Chloroform extractive	0.249%
Acetone extractive	0.278%
Hexane extractive	0.105%
Petroleum ether extractive	0.121%
Total saponin content	2.79 mg/g ⁻¹
Total phenolics content	32.956 mg/g
Total tannins content	22.773 mg/g
Total flavonoids content	33.845 mg/g
Stigmasterol content	0.069% (w/w)
Total alkaloids content	0.881% (w/w)

John Adams *et al.*, reported the presence of alkaloids, saponins, phenols and tannins in rhizome [17]. Phytochemical screening of leaf and rhizome showed the presence of active compounds such as alkaloids, coumarins, flavonoids, saponins, tannins and glycosides [26].

GC-MS analysis of ethanol extracts of *C. spiralis* showed the important bioactive compounds, viz. cyclo hydrocarbon Bicyclo (2.2.1) heptanes, 2-methyl-3-methylene-2-(4-methyl-3-pentenyl)-(1S-exo), 3-Butoxy-1,1,1,7,7,7-hexamethyl-3,5,5-tris (trimethylsiloxy) tetrasiloxane, cyclohexasiloxane, dodecamethyl, 2-Ethoxy-3 chlorobutane, santalol, cis-alfa santalol, trans beta santalol, neomenthol, and menthol. These phytocompounds were reported responsible for various pharmacological actions [26].

Traditional uses

The rhizomes are used by the traditional healers for the treatment of diarrhoea, fever, jaundice, burns, boils [27, 28] and widely used as a substitute of *Aconitum heterophyllum* for the treatment of diarrhoea [21, 25]. It is used in the form of decoctions in combination with other drugs as a remedy for infantile vomiting and cough, and in case of adults for abdominal complaints and fever [29-31].

Pharmacological actions

Antioxidant activity

The ethanolic extract of *C. spiralis* showed very moderate antioxidant potential, which may be attributed to the low availability of phenols, tannins, and flavonoids. The total antioxidant capacity and reducing power of a plant play a dominant role in depicting its antioxidant activity [21].

Antidiarrhoeal activity

Prasad *et al.*, evaluated the antidiarrhoeal activity of *C. spiralis* rhizome extract in rats. The results illustrated a significant reduction in normal faecal output rate after 5th and 7th hour of treatment, while castor oil-induced diarrhoea

model depicted a protection of 55.44% at same dose level from diarrhoea. The other models except gastric emptying test demonstrated more pronounced effect at same dose level. A significant inhibition in nitric oxide, increase in carbohydrates, protein, DNA, Na⁺ and K⁺ level with minimum degeneration of colonic fibrous tissues and potent antibacterial activity were also observed. The antidiarrhoeal potential of *C. spiralis* was speculated to be as a result of antimotility and antisecretory type effect mediated through nitric oxide pathway [32].

Prasad *et al.*, scientifically validated the traditional substitution of roots of *Aconitum heterophyllum* with rhizomes of *C. spiralis* in the treatment of diarrhoea. The extracts showed a significant reduction in faecal output rate and demonstrated a protection of 63.068% at 50 mg/kg p.o. for chloroform fraction of *A. heterophyllum* extract and 59.090% at 100 mg/kg p.o. for ethyl acetate fraction of *C. spiralis* extract in castor oil-induced diarrhoea model [25].

Hepatoprotective activity

The rhizome of *C. spiralis* is traditionally used for the treatment of jaundice, but no valid scientific proof has been reported. Hence, Singhal *et al.* (2016) investigated the hepatoprotective effect of *C. spiralis* against thioacetamide induced acute liver failure in male Wistar rats. Thioacetamide induced acute liver failure model was developed by three day treatment protocol with 350 mg/kg dose i.p. alcohol extract of *C. spiralis* root and rhizome was administered p.o. at 300 mg/kg dose seven days prior to and three days post induction. Silymarin 50 mg/kg was used as standard. The extract and silymarin did not demonstrate any hepatoprotective effect rather aggravated the hepatotoxicity induced by thioacetamide as evidenced by the results of biochemical estimations and histopathology experiments. Thus, their study could not substantiate the claim regarding hepatoprotective effect of *C. spiralis* made in traditional systems of medicine [33].

Anti-microbial activity

Antibacterial activity of different solvent extracts of leaf and rhizome of *C. spiralis* were carried out by Wadkar *et al.*, using the methods of agar well diffusion and minimum inhibitory concentration (MIC) by serial dilution technique to determine the growth inhibitory effect of test organisms. The ethanolic and methanolic extracts of both rhizome and leaf of *C. spiralis* showed good antibacterial activity against Gram-positive bacteria. Ethanolic extract of rhizome was found with highest inhibition efficacy in terms of its MIC (200 µg/ml) against *Micrococcus aureus* and *Bacillus subtilis*. This is primarily due to the presence of neomenthol, menthol, santalol, cis-α santalol in the ethanolic extracts of the rhizome. These extracts revealed the presence of bio-active constituents which may act as effective sources of natural antimicrobials [26].

Prasad *et al.*, studied the antibacterial potential of the bioactive fraction of *C. spiralis* extract using disc diffusion method, where Muller Hinton agar plates were used as a nutrient medium. Four reference bacterial strains, i.e. *Escherichia coli*, *Shigella flexneri*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*, and seven clinical bacterial isolates – *Salmonella typhi*, *Shigella dysenteriae*, *Proteus vulgaris*, *Klebsiella pneumoniae*, *Shigella boydii*, *Bacillus cereus* and *Enterococcus faecalis* were used for the study. *C. spiralis* depicted a potent antibacterial activity against majority of bacterial strains; however, it was ineffective against *K. pneumoniae*. The extract fraction at 100 mg/ml

showed maximum inhibition as observed through the diameter of zone of inhibition. The fractions were more effective against Gram-positive bacteria compared with Gram-negative bacteria, showing MIC values ranging from 0.195 to 3.125 mg/ml [25].

Conclusion

This review provides detailed information about *C. spiralis* botanical features, adulteration/substitution potential, pharmacognosy, phytochemistry, traditional uses and pharmacological actions. It is evident that the plant is very sparsely studied based on the scarcity of pertinent literature. Hence, additional research is needed to fully understand and assess the many biological activities of either its extracts or the isolated chemicals with potential mechanisms of action.

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