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UNRAVELLING THE ETHNOMEDICINAL SIGNIFICANCE, PHYTOCHEMISTRY AND PHARMACOLOGICAL POTENTIAL OF *COPTIS TEETA* WALL

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ABSTRACT

The plant kingdom, one of the main life-supporting systems, was a gift from nature to the planet. The distribution of medicinal plants varies depending on the geographical zones around the world. Certain medicinal plants have huge potential for distribution, while others such as *Coptis teeta*, are gradually losing their natural habitat and facing extinction. The non-timber forest plant *Coptis teeta* is primarily found in northwest Yunnan (China), Bhutan, and northeast India, particularly in Arunachal Pradesh's temperate zones. The rhizome of this plant is well-known in Chinese and North East Indian traditional medicine for preventing and treating a variety of human illnesses. According to numerous reports and studies, *Coptis teeta* includes a number of alkaloids, such as berberine, palmatine, jatrorrhizine, coptisine, columbamine, and epiberberine, as well as secondary metabolites, lignans, phenylpropanoids, flavonoids, phenolic acids, saccharides, and steroids. In order to improve drug quality assessment and management, numerous high-content components in *Coptis* extracts will be studied qualitatively and quantitatively. Due to its diverse nature and extensive range of pharmacological actions, *Coptis teeta* cultivation and multiplication should be done with care and patience. This review's goals are to summarise the present level of knowledge regarding the *Coptis teeta* plant, outline its pharmacological functions, and identify the causes of its extinction.

Key Words: *Coptis teeta,* secondary metabolites, traditional medicine, Berberine

INTRODUCTION

Medicinal plants represent one of the oldest and most important sources of therapeutic agents used for the prevention and treatment of human diseases. Since ancient times, humans have relied on plants to meet

their basic healthcare needs, owing to their wide availability and diverse bioactive compounds. Traditional medical systems across different civilizations, including Ayurveda, Traditional Chinese Medicine, and Unani, have extensively utilized medicinal plants for the management of various ailments. Even today, plant-derived medicines continue to play a significant role in modern healthcare, serving as sources of numerous pharmaceutical drugs and lead compounds for new drug discovery (Cheema and Singh, 2021). Fruits, leaves, and tubers were first used by humans as food and medicine. As a result of these experiences, a knowledge system was created and assimilation into man culture, which was then passed down from generation to generation, culminating in the traditional knowledge system (De Pasquale, 1984). Similarly, there are a number of historical facts that suggest the ancient use of natural remedies to treat primary health problems in various parts of the world. With a growing global interest in adopting and researching traditional systems, as well as investigating their potential based on various health-care systems, an assessment of traditional medicine's rich legacy is critical. Furthermore, in the recent past, the use of plants as medicines has included the isolation of active chemicals, starting with the isolation of morphine from opium in the early nineteenth century (Cheema et al., 2014), *Rosa damascene* (Khare et al., 2018)*), Lawsonia inermis* (Singh et al., 2017), *Alnus nepalensis* (Saxena et al., 2016), *Pluchea lanceolata* (Mohanty et al., 2013), *Christia vespertilionis* (Upadhyay et al., 2013) and *Conyza sumatrensis (*Boniface et al., 2015*)*, as well as Phyto molecule derivates including ursolic acid derivatives (Kalani et al., 2014), all have medicinal properties.

The indigenous communities of Arunachal Pradesh possess extensive traditional knowledge of medicinal plants, which has been developed and preserved over generations. This ethnomedicinal knowledge includes the identification, preparation, and therapeutic use of a wide range of medicinal herbs for the treatment of various human ailments. While formal records are unavailable for this region, traditional knowledge remains an important repository of indigenous information. Its timely documentation is critical to safeguard this knowledge from permanent loss. R. Wilcox and Captain Bedford first described this herb in 1825, followed by Grifth in 1836 from the Mishmi Hills of Indian flora (Payum, 2017). *C. teeta* was utilised by the Mishmis and other tribes of Arunachal Pradesh to cure malaria, stomach discomfort, and diarrhoea etc (Shankar and Rawat, 2013). *Coptis teeta* is currently priced at around Rs.2000/kg (Bajpay *et al*., 2019). Nearly the last decade, the combined effects of unregulated collection and forest degradation have resulted in a population drop of over 60%. As a result, the species is listed in Red List Category as Endangered. India has around 90% of the *C. teeta* population, hence it is considered representative of the global population (Mukherjee, 2019).

Coptis teeta Wall. is a perennial herbaceous plant endemic to Arunachal Pradesh (Mishmi Hills) in India and widely dispersed in temperate regions such as Arunachal Pradesh, Sikkim, and Bhutan. Plants are small (30-50 cm), stemless, perennial, blooming, evergreen. Leaves are 5–20 cm in length, pinnatifid, with a 3-lobed lamina and glabrous petioles. Flowers are small, few flowered, white or yellowish in colour, and inflorescence is panicle. Rhizomes are horizontal to oblique (5–15 cm in length) with fibrous roots that have a bitter taste, external skin that is yellowish brown, and pith that is yellow–orange, with multiple nodes and rootlets. It has a brownish yellow rhizome and is widely used as a medication in the Ayurvedic, Siddha, and Unani medicinal systems. Inflammation, eye ailments, skin diseases, stomach issues, constipation, jaundice, and urine disorders, cancer and inflammation, clearing heat, eliminating dampness, purging fire, and detoxification are all treated with it. It is often used to treat bacillary dysentery, typhoid, tuberculosis, epidemic

cerebrospinal meningitis, empyrosis, pertussis, and other disorders. Rhizomes have a bitter taste due to many alkaloids (Berberine, Coptisine, and Palmatine, among others) that are helpful in inhibiting certain microorganisms and can be used to cure a variety of diseases (Bhattee and Beniwal, 1988, Payum, 2017, Latif *et al*., 2008). The main active element in this plant is berberine (6–8.5%) that possess antimicrobial and antibacterial activity, anti-diarrheal activity, anti-hypertensive activity, anti-arrhythmic activity, anti-hyperlipidemic activity, anti-inflammatory activity, anti-depressant activity, antioxidant activity, anti-trachoma, cholesterol reduction activity, and anti-diabetic activities (Payum, 2017, Sun *et al*., 2009).

PHYTOCONSTITUENTS

Coptis teeta rhizomes are a pungent and sour cooling herb that includes multiple active ingredients that are helpful in controlling various microorganisms and are also used to treat a variety of diseases while being safe and efficient. Berberine (13,13a-didehydro-9,10-dimethoxy-2,3-(methylenedioxy), the plant's major active element, is found in 6–8.5 percent of the rhizomes (Bajpay *et al*., 2019). Other compounds like 1,2,3, Propanetriol, Benzenepropanoic acid, methyl ester., 2-methoxy-4-venylphenol, Phenol,2,6-dimethoxy, Cysteamine Sulfonic Acid, Pentadecanoic Acid, n-Nonadecanol-1, 9,12-Octadecadienoic acid (Z,Z)-, Methyl Ester., 9,12,15-Octadecatrienoic acid, Methyl Ester(Z,Z,Z)-, Methyl Streate, Indeno[1,2-b] quinoxalin-11-one, 2-methyl, Stigmast-5-EN-3 -OL,(3.BETA.)-, Phenol,2,6-dimethoxy, Dichloroacetic Acid, undec-2-enyl ester, Benzoic acid, 4 Hydroxy-3-methoxy-, methyl ester, etc are also present (Payum, 2017, Mukherjee, 2019). Organic acids e.g. Quinic acid (27.85 mg/g), Acetic acid (0.18 mg/g), Malic acid (15.25 mg/g), Tartaric acid (0.46 mg/g), Oxalic acid (0.34 mg/g) and Citric acid (1.53 mg/g) are also present in *Coptis teeta* plant (Bhattee and Beniwal, 1988).

BIOLOGICAL ACTIVITIES OF *COPTIS TEETA*

Fresh and dried *Coptis teeta* rhizomes are commonly used as a remedy. The bitter flavour of the leaf and rhizome is caused by berberine and coptine. Due to a lack of resources, research on this endangered medicinal plant's various biological activities are limited, but it has potential and should be further examined for its therapeutic properties.

A. Antimicrobial activity:

Coptis teeta wall. is a medication preferred by the Unani system of medicine for treating eye conditions (Ates and Turgay, 2003). A number of the plant's compounds have been demonstrated to be both safe and effective in the treatment of bacterial diseases, including diarrhoea. (Preethi *et al*., 2010). Whooping cough, diphtheria, typhoid fever, tropical diarrhoea, eye irritation, and colds can all be treated with *Coptis teeta's* pharmacological properties (Hsieh *et al*., 2001). The growth inhibitory activity of extracts produced by organic solvents from the root of *Coptis teeta* in Myanmar (Burma) was investigated in axenic culture against *Giardia lamblia*, *Trichomonas vaginalis*, and *Entamoeba histolytica* (Lone *et al*., 2014, Kaneda *et al*., 1990). The rhizome of *Coptis teeta* is used by a tribe in north-east India to treat diarrhoea. Berberine inhibits *Shigella dysenteriae*, *Salmonella paratyphi*, and several *Klebsiella* species, which cause a variety of intestinal illnesses (Wagner, 2005). Berberine shows the anti-diarrheal properties by inhibiting the transit of the small intestine (Eaker and Sninsky, 1989). Berberine was found to have antibacterial action against all MRSA strains tested. Berberine's minimal inhibitory concentrations (MICs) against MRSA ranged from 32 to 128 mg/mL. With 64 mg/mL or less of berberine, MRSA was inhibited 95% of the time (Yu *et al*., 2005).

B. Antioxidant activity:

Plant parts such as fruits, vegetables, and medicinal herbs contain numerous antioxidant substances in the form of phenolic compounds

(phenolic acids, flavonoids, quinones, coumarins, lignans, tannins), nitrogen compounds (alkaloids, amines), vitamins, terpenoids (carotenoids), and other endogenous metabolites, which act as free radical scavengers. The dried ethanol root extract of *Coptis teeta* contained alkaloids, flavonoids, and glycosides, according to preliminary phytochemical investigation. The ethanolic root extract from *Coptis teeta* has strong potential anti-oxidant activity (Lone *et al*., 2014, Tan *et al*., 2007). The extract had a significant IC_{50} against the *in vitro* results, indicating that it had significant free radical scavenging action (Pourmorad *et al*., 2006). Berberine, which is abundant in *Coptis teeta* rhizome, has been studied for its antioxidant properties. Both in cells cultivated with high glucose-containing medium (Liu *et al*., 2008) and in a range of diabetic animal models, berberine has been shown to suppress oxidative stress (Lao-ong *et al*., 2012).

C. Anti-inflammatory and Analgesic activity-

The anti-inflammatory effects of *Coptis* rhizome ethanol extract demonstrated the greatest reduction in inflammation. The pre-treatment with Methanolic extract of *C. teeta* revealed that the extract is helpful in the early phase of inflammation, which is predominantly caused by the release of histamine and serotonin. Up until the third hour of the experiment, the extract's anti-inflammatory impact continues to remain noticeable. The results of the study strongly suggest that Methanolic extract of *C. teeta* has peripheral analgesic efficacy, and that their mechanisms of action may be mediated by inhibition of local peritoneal receptors, possibly including COX inhibition. The study's findings indicate the analgesic and anti-inflammatory action of standardised methanolic extracts of *C. teeta* rhizome, as well as validating the pharmacological backdrop of *C. teeta* rhizome's traditional use (Chelleng *et al*., 2024). The initial immune response to red blood cells and antibody production were altered differently depending on the route of application of berberine *in vitro* treatment of splenocytes (Ivanovska and Philipov, 1996, Li *et al*., 2015).

D. Antidiabetic activity

Coptis teeta Wall. was the sole traditional use for diabetes treatment that had no mention of antidiabetic action, accounting for 10% of the research status. Several studies have been conducted to assess the efficacy of berberine in the treatment of diabetes. *C. teeta* rhizomes stimulated the increase in glucose uptake (Zhang *et al*., 2021). Berberine has the ability to lower and sustain blood sugar levels through two mechanisms: blocking sugar absorption from the intestine and increasing and boosting insulin production (Wang *et al*., 2011, Yin *et al*., 2008). Berberine has been demonstrated to increase cyclic AMP levels by inhibiting the phosphodiesterase enzyme. A rise in cyclic AMP levels has also been linked to an increase in insulin secretion. The hypoglycemic/antidiabetic efficacy of berberine could be due to these actions (Chander Semwal *et al*., 2009). To understand the specific mechanism of the hypoglycaemic action, further detailed chemical and pharmacological research is required.

E. Anticancer Activity

Berberine, its salts, and derivatives have been found as the active chemical for suppressing lung cancer selectively and potentially without hazardous side effects (X. Xu *et al*., 2025, Maung Tin-Wa, 2010). Berberine has been shown to inhibit a variety of cancers, including esophageal cancer (Z. Xu *et al*., 2017). Berberine has been shown in numerous studies to alter tumour cell development by inhibiting tumour cell growth and inducing apoptosis and cell cycle arrest (Da Liu *et al*., 2019). Berberine appears to impede tumour cell migration and invasion, according to a significant body of experimental research. Berberine boosted E-cadherin protein expression in human lung cancer A549 cells in a concentration- and time-dependent manner, while drastically downregulating N-cadherin expression; these alterations hindered invasion and metastasis. Furthermore, discovered that the effect of berberine

on cancer cell metastatic potential is mediated by activation of the AMPK signalling pathway, which inhibits tumour cell adhesion, migration, and invasion by reducing the activity of ERK and the expression of COX-2 (Jin et al., 2017).

F. Antiviral Activity

Berberine is a good candidate for use in new antiviral medicines and therapies since it targets distinct stages of the viral life cycle. Berberine has been found to inhibit virus replication by focusing on specific interactions between the virus and its host. Berberine binds to DNA, preventing DNA synthesis and reverse transcriptase activity. Herpes simplex virus (HSV), human cytomegalovirus (HCMV), human papillomavirus (HPV), and human immunodeficiency virus (HIV) replication are all inhibited by berberine (Warowicka *et al*., 2020). Berberine inhibits six HIV-1 clade B isolates entirely and shows antiviral activity in a concentration-dependent manner, with IC_{50} values ranging from 5.5 to 10.25 g/ml (Shao *et al*., 2020).

G. Antihypertensive Activity

Berberine has been shown in several studies to have the ability to lower blood pressure (Hui *et al*., 1991). Berberine delayed the onset and attenuated the severity of hypertension in SHR rats. In spontaneously hypertensive rats, the antihypertensive effects of the berberine derivative 6-protoberberine (PTB-6) were investigated. PTB-6 reduced systolic blood pressure in conscious SHRs in a dose-dependent manner (6-PTB: 5 mg/kg, –31.1 1.6 mm Hg; 10 mg/kg, –42.4 3.1 mm Hg) (J.-C. Liu *et al*., 1999).

H. Hepatoprotective Activity

Several investigations have been conducted to determine the effectiveness of berberine as a hepatoprotective agent. Berberine pre-treatment significantly reduced doxorubicin induced structural damage in the liver, including vascular congestion, inflammatory cell infiltration, hepatocellular degeneration and necrosis, and liver fibrosis, according to histopathological examinations (Zhao *et al*., 2012). A separate study examined the protective effects of alkaloid isoquinoline berberine on CCl (4)-induced hepatotoxicity in mice. Berberine's hepatoprotective actions may be linked to free radical scavenging and oxidative/nitrosative stress reduction, as well as the regulation of the inflammatory response in the liver (Domitroviæ *et al*., 2011). Berberine may also be effective for preventing hepatotoxicity caused by methotrexate by improving biochemical and oxidative stress indices, according to a recent study (Mehrzadi *et al*., 2018).

I. Antimalarial activity

Coptis teeta, a plant of immense significance to the tribes of northeastern India, holds great application in treating a range of ailments, including parasitic diseases such as malaria (Latif *et al*., 2008). The *Coptis* rhizome exhibited exceptional anti-malarial potency, with an IC50 of 1.9 µg/ml against 3D7 and 4.85 µg/ml against Dd2, along with an impressive selectivity index (SI) surpassing 263 (3D7) and 103 (Dd2). Coptis rhizome exhibits anti-malarial properties through three significant chlorinated compounds: coptisine, berberine, and palmatine. These compounds displayed respective IC50 values of 1.1, 2.6, and 6.0 µM against 3D7 strain and 3.1, 6.3, and 11.8 µM against Dd2 strain. Coptisine chloride demonstrated the most potent anti-malarial effects among the tested compounds, showing an IC50 of 1.1 µM against 3D7 and 3.1 µM against Dd2, along with corresponding selectivity indices (SI) of 37.8 and 13.2, respectively. Significant anti-malarial activity was observed in mice infected with the Plasmodium yoelii 17X strain when administered the herbal extract of Coptis rhizome and its primary active compound, coptisine chloride. The anti-malarial effects remained consistent from day 3 to day 7 after infection, with a range of 50.38% to 72.13% ($P < 0.05$) for Coptis rhizome and 81% to 89% ($P < 0.01$) for coptisine chloride (Teklemichael *et al*., 2020). The antimalarial efficacy of methanol extracts from *Coptis teeta* was examined *in vitro* in a

separate investigation, while the identification of potential leads was conducted through an *in-silico* study. In the 3D7 strain of *P. falciparum*, the IC50 of the methanol extract from *Coptis teeta* was documented as 0.08 ìg/ml, while in the Dd2 strain, it was found to be 0.7 ìg/ml. In comparison to chloroquine, noroxyhydrastatine displayed superior binding affinity as observed in the docking study (Goswami *et al*., 2022).

Table 1. Major compounds found in Coptis teeta and their biological activities.

S. No.	Compound Name	Biological Activities	Ref.
1.	Hexadecanoic Acid, Methyl Ester	Antioxidant, Hypocholesterolemic, Nematicide, Pesticide, Antiandrogenic flavor, Hemolytic, 5-Alpha reductase inhibitor	Payum, 2017.
2	Pentadecanoic Acid	Antioxidant	Payum, 2017.
3	2-methoxy-4-venylphenol	Anti-tumour, Antimicrobial Anti-in?ammatory	Jeong *et al*., 2011, Jeong and Jeong, 2010.
4	9,12-Octadecadienoic acid (Z, Z)-, Methyl Ester.	Hepatoprotective, antihistaminic, hypocholesterolemic, antieczemic	Payum, 2017
6	Berberine	Antitumour, analgesic, Anesthetic, antibacterial, Antimalarial	Sun *et al*., 2009. Jeong *et al*., 2011.
7	Indeno [1,2-b] quinoxalin-11-one, 2-methyl	Anti-cell proliferation of tumour cell	Gazit *et al*., 1996.
8	Stigmast-5-EN-3-OL, (3. BETA.)-	Potent anti-diabetic agent in regulating glucose transport	Sujatha *et al*., 2010.
9	n-Nonadecanol-1	Anti-microbial	Dalli *et al*., 2007.
10	Coptisine, Palmatine	Antimalarial	Jeong and Jeong, 2010.
11	Noroxyhydrastatine	Antimalarial	Jeong *et al*., 2011

REASON FOR DEPLETION OF *COPTIS TEETA*

The *Coptis teeta* herb is enlisted in Red List Category as endangered (A2cd ver 3.1) (IUCN Red List of threatened species). The combined e?ects of unregulated collection and degradation of forest over the last decade years has resulted in decline of the population of over 60%. Therefore, the species has been assessed as Endangered. About 90% *C. teeta* population is in India, therefore considered representative of that of the global population (Payum, 2017). As previously stated, there are various reasons for the extinction of *Coptis teeta* in the wild. The rising need for herbal items, such as medicine and cosmetics, has resulted in a very high demand for raw plant parts, putting significant strain on their natural environment. Due to population pressure and other construction activities in the highlands, the natural habitat of this *unique* species is shrinking. Natural resources are being exploited indiscriminately and excessively. Due to a lack of agro-technology for the highly desirable *Coptis teeta* plants, farmers are hesitant to adopt them in the field. There have been no major attempts to cultivate on a commercial basis. The devastation of these flora is exacerbated by forest fires set by local hill tribes to clear land. Illegal trade in high-value medicinal plants that have been prohibited. Animals, both tame and wild, graze excessively. Cutting medicinal trees for fuel, wood, and other purposes, as well as lopping leaves for fodder and animal bedding. Climate and weather patterns are changing. There is a lack of understanding about this important legacy.

CONCLUSION

Extensive reports paint a sobering picture of *Coptis teeta*, a critically endangered jewel of the Eastern Himalayas. This valuable medicinal plant faces imminent peril, demanding urgent action for its protection. Evidence from multiple studies indicates that this plant harbors an arsenal of beneficial chemicals, effectively targeting a range of health issues such as cancer, malaria, diabetes, and even diarrhoea. Despite some success with various propagation techniques, protecting and conserving this herb in its natural habitat is essential for ensuring its long-term survival. Investigating its medicinal properties holds immense promise for tackling various health issues, making further research in this area a critical priority. By nurturing this precious plant, we not only secure the balance of nature but also unlock a treasure trove of possibilities for ourselves. Protecting it shields our environment, propagating it ensures abundance, and researching it unlocks a wealth of knowledge for generations to come.

CONFLICT OF INTEREST

None to declare

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