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MEDICINAL BENEFITS OF PLANT *Curcuma zedoaria* - SHORT REVIEW

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ABSTRACT

The perennial herb *Curcuma zedoaria*, often called white turmeric, belongs to the Zingiberaceae family and is valued for its medicinal qualities in traditional Asian medicine, especially in Ayurveda and Traditional Chinese Medicine. Its rhizomes are used extensively for their therapeutic properties since they contain a range of bioactive chemicals. White turmeric is particularly well-known for its capacity to increase circulation, ease pain, and aid with digestion. Strong compounds like curcumenol and sesquiterpenes, which are abundant in the plant, give it anti-inflammatory, antioxidant, and anticancer properties. These substances are essential for lowering inflammation, preventing oxidative stress, and possibly even destroying cancer cells. Furthermore, *Curcuma zedoaria's* essential oils enhance its therapeutic efficacy. The plant's uses in contemporary medicine are increased by these oils' noteworthy antibacterial, antifungal, and anticancer qualities. Research keeps showing how potential the plant is for modern therapies, particularly for infections and inflammatory diseases. White turmeric may provide substantial therapeutic benefits in the creation of novel medications, as evidenced by the synergistic effects of its bioactive components and essential oils, which show a harmonious fusion of traditional medical knowledge and cutting-edge scientific advancement.

KEYWORDS: *Curcuma zedoaria*, Curcumenol, Anti-inflammatory, Antioxidant, and Anticancer properties.

INTRODUCTION

Curcuma zedoaria, commonly known as white turmeric, is a significant member of the Zingiberaceae family and is widely used in traditional medicine across countries such as China, Korea, and Japan. It has been found to enhance blood circulation, regulate menstrual flow, relieve rheumatic pain, and alleviate abdominal cramping.[1] The rhizome of *Curcuma zedoaria* is utilized by rural communities for its stimulant, diuretic, expectorant, demulcent, carminative, and rubefacient properties. Additionally, the root is employed to treat conditions like fever, coughs, colds, indigestion, and flatulence.

Zedoaria is a perennial herbaceous plant with an upright pseudo stem, a corm, underground cylindrical branches or rhizomes, and fleshy roots. The rhizomes of *C. zedoaria* contain several sesquiterpenes known for their anti-cancer and antioxidant properties.[2,3] These rhizomes are also effective in treating conditions like flatulent colic, amenorrhea, hepatocirrhosis[4], and blood aggregation.[6] Research by Kim et al. found that certain partially purified polysaccharides from *C. zedoaria* show significant dose-dependent anti-tumor activity and stimulate macrophage activation.[7] Given the importance of *C. zedoaria*, this study aims to isolate polysaccharides and conduct structural analyses, particularly focusing on the water-soluble fraction, as previous research in this area has been limited.

Curcuma zedoaria has been a staple in traditional medical systems like Ayurveda and Traditional Chinese Medicine (TCM) for centuries. The rhizomes of this plant are commonly used in cooking and are a key ingredient in various traditional medicines. Due to its significant therapeutic potential, as revealed by phytochemical studies [table 1.1], *Curcuma zedoaria* is an attractive target for pharmaceutical research. This review examines the chemical composition, pharmacological effects, traditional applications, safety, and potential future research areas of *Curcuma zedoaria*, which has been explored for its healing properties over thousands of years.

Scientific classification of *Curcuma zedoaria*

Kingdom	:	Plantae
Clade	:	Angiosperms
Clade	:	Monocots
Order	:	Zingiberales
Family	:	Zingiberaceae
Genus	:	*Curcuma*
Species	:	*Curcuma zedoaria*

Table 1.1: Therapeutic uses according to Part Used.

1.	Tuber	Source of *Shoti* starch used as a substitute of arrowroot.
		Fresh juice is given to children for worm infestation.
2.	Root	Contain camphoraceous smell and have cooling, diuretic properties.
		Fresh root effectively regulates the discharge in case of leucorrhea and gonorrhea.
		Gives relief in flatulence, dyspepsia.
		Used as a tonic for the heart and brain
3.	Leaves	Juice is given for treating dropsy.
		Used in cosmetics to treat chronic skin diseases.
4.	Rhizome	Have aromatic, stomachic, carminative, stimulant, cooling and diuretic properties.
		Powder is used for culinary purposes because of its unique smell
		Rhizomes are chewed to soothe cough
5	Whole plant	It tones the uterus and acts as an aphrodisiac.
		Used to improve digestion and liver function.
		Have stimulant, carminative, expectorant, demulcent, diuretic and rubefacient properties.
		Helps to regulate menstruation
		Used as anti-venom for the Indian cobra.
		Used in juice form to treat urinary tract infections.

PHYTOCHEMICAL COMPOSITION

The therapeutic properties of *Curcuma zedoaria* are primarily attributed to the numerous bioactive compounds present in its rhizomes. One of the key components, curcuminoids, is well-known for its anti-inflammatory and anti-cancer effects. Unlike Curcuma longa, which has a higher concentration of curcumin, *Curcuma zedoaria* contains significant amounts of sesquiterpenoids such as curzerenone, germacrone, and furanodiene [table 1.2]. The rhizome also contains essential oils, which make up 3–5% of its composition, including compounds like terpinene, known for its antibacterial properties, and β-elemene, recognized for its anticancer effects. Additionally, polysaccharides and alkaloids in the plant may contribute to its immunomodulatory and liver-protective effects, while flavonoids such as quercetin and kaempferol enhance its antioxidant and anti-inflammatory properties.[1]

Curcuminoids

Strong antioxidant qualities are exhibited by curcuminoids, particularly curcumin, which are polyphenolic chemicals. Reactive oxygen species (ROS) are thereby neutralized, shielding cells from oxidative damage. Additionally, curcuminoids increase the activity of endogenous antioxidant enzymes that are essential for reducing oxidative stress, such as catalase and superoxide dismutase (SOD). Additionally, they increase their overall protective capacity by lowering the production of free radicals, which can harm cell membranes.[1]

Essential oils

Oils from Curcuma zedoaria are abundant in sesquiterpenes, including furanodiene, curzerenone, and curcumenone. These substances have shown strong antioxidant activity by directly scavenging free radicals and modifying the body's natural antioxidant defense mechanisms. As a result of their dual action, they effectively neutralize oxidative stress.[1]

Polyphenols and flavonoids

The antioxidant qualities of *C. zedoaria* are largely due to its polyphenols and flavonoids, which provide hydrogen atoms to counteract harmful free radicals. This procedure aids in preventing free radical-induced oxidative cell damage. These substances protect against diseases including cancer and cardiovascular disorders that are connected to an excess of reactive oxygen species (ROS) by reducing oxidative stress.[1]

Table 1.2: Chemical Constituents and their Action of *Curcuma zedoaria* rhizome.

Sr.No.	Action	Chemical constituents
1.	Analgesic Antinociceptive	Curcumenol
		Dihyrocurdione
2.	Anti-allergic effect	Curcumin
		Dihydrocurcumin
		Tetrahyrodemothxycurcumin
		Tetrahydrobismethoxycurcumin
3.	Anticancer effect	Curcumin
		Demothxycurcumin
		Bisdemothxycurcumin
4.	Anti-inflammatory effect	Curzenone
		Dehydrocurdione

5.	Cytotoxic effect	A-Curcumene
		b-tumerone
		Zerumbone
6.	Hepatoprotective	Furanodiene
		Germacrone
		Curdione
		Neocurdione
		Curcumenol
		Isocurcumenol
		Aerugidiol
		Zedoarondiol
		Curcumenone
		Curcumin

PHARMACOLOGICAL ACTIVITY

Antimicrobial and Antifungal activity

Extracts from the rhizome and tuber of Curcuma zedoaria display both antibacterial and antifungal properties[9], effectively inhibiting gram-positive bacteria such as *Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, and *Sarcina lutea*, as well as gram-negative bacteria like *Salmonella typhi*, *Vibrio parahaemolyticus*, *E. coli*, and *Shigella dysenteriae*. Fungal strains such as *Candida albicans* and *Aspergillus niger* are also inhibited, although certain bacteria, including *Vibrio cholerae*, *Klebsiella* sp., and *Pseudomonas aeruginosa*, show resistance.[5,8] Triterpenoids present in the extracts exhibit mild inhibition of *Staphylococcus aureus* and *E. coli* at concentrations between 500-1000 ppm, while the methanol extract demonstrates antimicrobial activity similar to that of kanamycin. Several extracts, including petroleum ether, hexane, chloroform, acetone, and ethanol, were tested using agar diffusion and broth dilution methods, with acetone and hexane extracts showing particularly strong antimicrobial effects.[10] These results support the traditional use of *C. zedoaria* in treating bacterial and fungal infections, with minimum inhibitory concentration (MIC) values ranging from 0.01 to 0.15 mg/ml across various strains.

Antioxidant activity

Sudipta et al. have investigated the antioxidant activity of *Curcuma zedoaria* using various methods, including metal chelation, direct radical scavenging, and enhancement of endogenous antioxidant systems. The plant demonstrates antioxidant effects by chelating transition metals such as iron and copper, which reduces reactive oxygen species (ROS) production through the Fenton reaction, while also neutralizing harmful free radicals like hydroxyl and superoxide anions. Additionally, *C. zedoaria* boosts the activity of antioxidant enzymes that help maintain cellular redox balance, including glutathione peroxidase, catalase, and superoxide dismutase (SOD). In vitro tests such as DPPH and FRAP further confirm the strong antioxidant properties of *C. zedoaria* extracts, comparable to ascorbic acid.[11] These findings are supported by in vivo studies, which show that *C. zedoaria* administration in animal models reduces oxidative damage and enhances endogenous antioxidant levels.

Anti-inflammatory activity

Curcuma zedoaria has been traditionally utilized for its anti-inflammatory properties.[12] Research indicates that the petroleum ether and chloroform extracts of C. zedoaria rhizomes demonstrate significant anti-inflammatory effects ($p < 0.001$) when compared to control groups and standard drugs such as Indomethacin (10 mg/kg, intraperitoneally) and Rumalaya forte (200 mg/kg). The highest levels of anti-inflammatory activity were observed with the petroleum ether extract at 200 mg/kg and the chloroform extract at 400 mg/kg, with peak effects occurring between 2 to 6 hours.

Anticancer

Compounds that inhibit cell growth are commonly used as cancer treatments, and extracts from the rhizomes of *Curcuma zedoaria* have demonstrated anti-cancer effects against four cancer cell lines: Ca Ski, MCF-7, PC-3, and HT-29. This activity is primarily attributed to protein-bound polysaccharides that can inhibit the growth of sarcoma-180 cells.[13] Known for its medicinal properties, the rhizome of *C. zedoaria*, also called Temu Putih, has shown promising results. A study revealed that a 200 mg/kg body weight dose of *C. zedoaria* rhizome extract was able to inhibit mitotic activity. Additionally, ethanol extracts of the rhizome effectively suppressed lung tumor growth in female mice, with inhibition rates of 49.63% at 250 mg/kg, 73.33% at 500 mg/kg, and 77.78% at 750 mg/kg.[14] The damage to sub-diploid cells was shown to increase with higher concentrations.

Leukemia, or blood cancer, is marked by the uncontrolled proliferation of white blood cells. Among the various sesquiterpenes tested, the curcuminoid compound from *Curcuma zedoaria* exhibited the strongest cytotoxic effects on the WEHI-3 and HL-60 leukemia cell lines, with IC50 values of 25.6 μM and 106.8 μM, respectively.[15] Furthermore, curcumenone compounds showed cytotoxicity against normal human umbilical vein endothelial (HUVEC) cells, with an IC50 value of 69.6 μM.

Analgesic activity

Different fractions of the hydroalcoholic extract from the rhizome of *Curcuma zedoaria* (dichloromethane, ethyl acetate, and methanol) were evaluated for analgesic

activity, along with curcumenol, using aspirin and dipyrone as reference drugs. The analgesic effects were tested in mice using various pain models, including writhing, formalin, and capsaicin tests.[16] Curcumenol exhibited significant analgesic properties, proving to be much more potent than the reference drugs, with 50% inhibitory dose (ID50) values of 22 mmol/kg for writhing, 12 mmol/kg for capsaicin, and 29 mmol/kg for the second phase of the formalin test. The dichloromethane extract showed a dose-dependent analgesic effect when administered intraperitoneally, with an ID50 of 3.6 mg/kg and a maximum inhibition of 69.5%, outperforming aspirin and dipyrone, which had ID50 values of 25 and 57 mg/kg, respectively. Additionally, this extract showed strong analgesic activity in the formalin test, further supporting the traditional use of *C. zedoaria* in the treatment of pain.[16]

Anti-cholesterol activity

Cholesterol is a condition characterized by excessive fat levels in the blood. Lim et al. reported that the hydroethanolic extract of *Curcuma zedoaria*, when administered at doses of 200-400 mg/kg, effectively reduced total cholesterol levels by 17.1% to 19.65% after 12 days of treatment, demonstrating significant antihyperlipidemic effects.[17] The cholesterol-lowering effects of *Curcuma zedoaria* are attributed to its ability to inhibit intestinal cholesterol absorption, promote the conversion of cholesterol into bile acids, and increase bile acid excretion through its choleretic properties.[18] Key sesquiterpenes, including furanodiene, germacrone, curcumenol, and curcumin, have also shown protective effects against liver damage induced by d-galactosamine or lipopolysaccharide in mice.

Anti-ulcer activity

Gastric disorders such as hyper-acidity and ulcers require prolonged treatment, but extended use of drugs may interfere with normal body functions and affect the metabolism of other medications by inhibiting certain enzymes. Traditional systems like Ayurveda and Unani offer safer and more affordable treatments. *Curcuma zedoaria*, commonly used in Unani formulations for gastrointestinal issues, is often combined with agents that protect the gastric lining, although it is thought to inhibit gastric secretion. In an experiment with Wistar rats, four groups were treated with a control, omeprazole, or *C. zedoaria* root powder (100 mg/kg and 200 mg/kg). Gastric contents were analyzed for secretion volume, pH, acid content, and ulcer index. Both *C. zedoaria* and omeprazole significantly reduced pH, acid levels, and ulcer index, although only omeprazole reduced gastric volume. This study suggests *C. zedoaria's* potential to reduce acid and ulcers, despite conflicting traditional claims.[19]

Antihyperglycemic activity

Diabetes is a prevalent disease with no complete cure in conventional medicine, and its incidence is rising due to changing lifestyles. As plants have historically provided many medicinal drugs, scientific research is increasingly focused on plant-based remedies for diabetes with fewer side effects. Traditional medicine suggests that certain plants, such as *Curcuma zedoaria* (shoti) and *Sonneratia caseolaris* (choilani), can help lower blood sugar levels. Both are used in folk medicine in Bangladesh. *C. zedoaria*, a perennial herb native to India and Indonesia, is used to treat various conditions, including diabetes, leprosy, mental disorders, and digestive issues. It also possesses antihyperglycemic and antinociceptive properties. *S. caseolaris*, a mangrove species, contains phytochemicals like flavonoids and triterpenoids and is traditionally used for diabetes, as well as for its astringent and antiseptic properties. To assess their anti-hyperglycemic effects, Lim et al. conducted a study using methanol extracts of *C. zedoaria* rhizomes and *S. caseolaris* fruits in glucose tolerance tests on Swiss albino mice. The mice were divided into groups and given various doses of the plant extracts, a control vehicle, or the standard drug glibenclamide, followed by glucose administration. Blood samples taken two hours later showed that the plant extracts effectively lowered blood glucose levels, indicating their potential as anti-diabetic agents.[20]

Anti-allergic activity

The 80% aqueous acetone extract of *Curcuma zedoaria* rhizome, grown in Thailand, was shown to inhibit the release of beta-hexosaminidase, a marker of antigen-IgE-mediated degranulation, in RBL-2H3 cells and reduce passive cutaneous anaphylaxis in mice. From the active fraction, four curcuminoids (curcumin, dihydrocurcumin, tetrahydrodemethoxycurcumin, and etrahydrobisdemethoxycurcumin) along with two bisabolane-type sesquiterpenes were isolated to examine their effects on degranulation.[21] Curcumin exhibited the strongest inhibitory effect on beta-hexosaminidase release, with an IC50 value of 5.3 mM, followed by bisdemethoxycurcumin.

Anti-nociceptive activity

To investigate the antinociceptive activity of *Curcuma zedoaria*, extracts were obtained from roots, mother rhizomes, and rugous rhizomes during different seasons and tested using an acetic acid-induced abdominal constriction model in mice. A 10 mg/kg dose of rhizome extract collected during the autumn and winter seasons demonstrated significant antinociceptive effects when administered intraperitoneally, inhibiting 91.1% and 93.4% of abdominal constriction, respectively. Additionally, curcumenol and dihydrocurdione compounds from *Curcuma zedoaria* inhibited abdominal constriction by 64.0% and 46.0%, respectively, further supporting their antinociceptive and analgesic properties.[22]

Hepatoprotective activity

The hepatoprotective properties of *Curcuma zedoaria* have garnered significant attention due to its ability to safeguard liver cells from toxin-induced damage.

Experimental studies indicate that *C. zedoaria* extracts, particularly those containing curcuminoids, exhibit antioxidant effects that help regulate liver enzyme activity. This suggests its potential in preventing liver diseases such as cirrhosis and hepatitis by reducing oxidative stress and inflammation, thus promoting healthy liver function and detoxification. Furthermore, sesquiterpenes and curcumin, extracted from an 80% aqueous acetone solution of *C. zedoaria* rhizomes, have shown protective effects against acute liver injury in mice.[23] The water extract also inhibited the proliferation of human hepatic myofibroblast (hMF) cells, which play a key role in liver fibrosis. This anti-proliferative and antifibrogenic activity underscores the potential therapeutic use of *C. zedoaria* in treating chronic liver conditions.

Anti-venom activity

The aqueous extract of *Curcuma zedoaria* exhibited inhibitory activity in a 96-well plate enzyme-linked immunosorbent assay (ELISA) by preventing the binding of anti-cobra venom antibodies to cobra venom antigens. The extract specifically targeted the neurotoxin and protein-degrading enzymes in the venom, indicating its potential as an anti-venom agent.[24]

Anti-amoebic activity

Lim *et al*. have reported *C. Zedoaria* Rosc rhizome extract against protozoan babesia gibsoni with IC_{50} value 41.7µg/ml. At a concentration of 1-10 mg/ml, the alcoholic extract of C. zedoaria rhizome suppressed the growth of *Entamoeba histolytica*.[17]

Anti-fertility activity

Nicolas Xavier Ongako et al. reported that the ethanol extract of *C. zedoaria* Rosc exhibited anti-fertility effects on seminiferous tubule cells in rat testes. After administering white turmeric rhizome, a significant decrease in the number of spermatogenic cell layers and mitosis count was observed, with a p-value of less than 0.05.[25]

Anti-mutagenic activity

A study evaluated the antimutagenic properties of 36 commonly used anticancer crude drugs derived from Chinese herbs using the Salmonella/microsomal assay. The test, conducted in the presence of picrolonic acid or benzo[a]pyrene, aimed to determine whether the drugs contained direct or indirect antimutagenic agents. Each herb was extracted by boiling in water for two hours, replicating the traditional Chinese method of preparing these remedies for oral consumption. *C. zedoaria* showed moderate activity against benzo[α]pyrene in the test.[26]

Toxicity and safety

A protein-rich flour derived from *Curcuma zedoaria* rhizomes was found to be toxic to animals. Rats fed a diet containing 320 g/kg of the flour experienced 100% mortality within six days, while weanling rats given 400 g/kg of dried rhizome meal lost weight rapidly, with two out of five dying within four days. Chicks fed diets containing 100-200 g/kg of the meal survived for 20 days but showed reduced body weight, food intake, and food conversion efficiency as the concentration of *C. zedoaria* increased.[27] While initial studies highlight the plant's therapeutic potential, more comprehensive clinical research is required to assess its safety for human use, particularly for sensitive populations such as pregnant women, nursing mothers, and children. This is crucial, as different groups may respond differently to the bioactive compounds in *C. zedoaria*. Without sufficient clinical validation, the widespread use of the plant in modern medicine could pose unintended health risks. Therefore, more rigorous and well-designed clinical trials are needed to thoroughly evaluate its potential side effects and ensure its safe use in medical practice.[27]

CONCLUSION

Curcuma zedoaria, a plant widely utilized in Indian traditional medicine, is believed to aid in treating various ailments such as cancer, ulcers, diarrhea, dysentery, and toothaches. Research has supported many of these traditional claims through biological evaluation methods. Cultivated primarily in India, Sri Lanka, and China, its tubers, known as zedoary root, are rich in starch and are commercially used as 'Shoti Starch,' a substitute for arrowroot and barley. Additionally, zedoary finds applications in producing liquors, stomach essences, bitters, perfumes, and cosmetics. With the growing global interest in herbal medicine, research into the pharmacological properties of bioactive compounds in plants like *Curcuma zedoaria* has increased. However, despite this interest, few traditional botanicals have been incorporated into evidence-based therapies, underscoring the need for further validation of Ayurvedic treatments' safety and efficacy.[28]

This review provides valuable insights into the chemical composition, pharmacology, and biological effects of *Curcuma zedoaria*, benefiting both researchers and readers. In Ayurveda, the plant, also known as Kachur, is recognized for its wide range of therapeutic properties, including anti-inflammatory, pain-relieving, digestive, liver-stimulating, and aphrodisiac effects. From a modern scientific perspective, *Curcuma zedoaria* has been shown to possess antimicrobial, antifungal, hepatoprotective, antioxidant, anticancer, and wound-healing properties, among others. These diverse biological activities are attributed to the plant's complex array of phytochemicals, contributing to its popularity and widespread use in ethnomedicine.[29]

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