



Pharmacological Facet of *Curcuma longa*: A Review

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ABSTRACT

The plant *Curcuma longa*, a perennial herbaceous member of the Zingiberaceae (ginger family), produces turmeric. Protein, fat, minerals, carbs, and moisture are all included in turmeric. Curcumin (diferuloylmethane), a phenolic diketone that makes up 34 percent of curcumin and is made up of curcumin I, curcumin II, and curcumin III, is what gives turmeric its characteristic yellow colour. Curcumin have versatile pharmacotherapeutic potential and their biological functions have been thoroughly investigated in recent years. As the main bioactive component, curcumin has numerous pharmacological properties including antioxidant, anti-inflammatory, anti-hypertensive, anti-diabetic, hepatoprotective, anti-rheumatoid arthritis and anti-cancer properties. In persons who are active, it improves recuperation and performance. It helps with viral infections and dental issues such as dental pain, gingivitis. Covid also benefits from curcumin. ar-turmerone also possesses antiinflammatory properties. Ar-turmerone is a potentially effective treatment for a number of neurologic conditions like schizophrenia. Multiple health advantages are provided by curcumin when mixed with boosting agents.

Keywords: Turmeric, curcumin, antioxidant, anti-inflammatory.

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INTRODUCTION

Throughout human history, natural plant products have been employed for a variety of reasons. Many of these natural compounds contain pharmacological or biological properties that can be used in the development of pharmaceutical drugs. Plant-based medicines have been essential to the health care of many societies, both ancient and contemporary. ¹ The Indian holistic medical system "Ayurveda" primarily employs plant-based medicines or concoctions to treat a variety of illnesses, including cancer. The majority (61%) of the 877 or more small-molecule medications that were made available globally between 1981 and 2002 can be attributed to natural products. ² Despite the fact that many synthetic medications are created using combinatorial chemistry, plant-based drugs are better suitable for human usage, at least in terms of biochemistry.

The usage of the turmeric plant for medical purposes dates back over 4000 years. Turmeric is utilised in Southeast Asia both as a primary spice and as a part of religious rituals.

Turmeric, which is a vivid yellow colour, is also referred to as "Indian saffron" because of this. Susruta's Ayurvedic Compendium, which dates back to 250 BC, suggests using a turmeric-containing salve to treat food poisoning. Turmeric is usually referred to as "haldi" in North India, a name derived from the Sanskrit term haridra, and as "manjal" in the south, a name that appears frequently in ancient Tamil literature. The word turmeric, which means "turmeric," comes from the Latin terra merita, which alludes to the hue of pulverised turmeric, which resembles a mineral pigment. In various languages, it is referred to as "yellow root" or simply "terre merite."

The herbaceous perennial plant *Curcuma longa*, a member of the ginger family Zingiberaceae, and a native of tropical South Asia, produces turmeric. For optimum growth, the turmeric plant requires temperatures between 20°C and 30°C as well as a sizable amount of annual rainfall. Individual plants have long, oblong leaves and can reach a height of 1 m. Plants are harvested yearly for their rhizomes, and some of those rhizomes are used to reseed the plant the next season. The rhizome, which is tuberous and has a rough, segmented skin, is where turmeric is obtained. In the ground, the rhizomes develop beneath the leaf. They have a dull orange interior and a yellowish brown outside. The main rhizome is 2.5-7.0 cm (1-3 inches) in length and 2.5 cm (1 inch) in diameter, with smaller tubers branching out. It is pointed or tapered at the distal end. After being dried, the turmeric rhizome can be processed into a yellow powder with a bitter, barely acid, yet sweet flavour. ³ 80 percent of the world's turmeric crop



is used by India, which also produces nearly all of it. Indian turmeric is regarded as the greatest in the world due to its natural properties and high level of the significant bioactive component curcumin. The greatest production and most significant trading hub for turmeric in the world

is Erode, a city in the South Indian state of Tamil Nadu. "Yellow City," "Turmeric City," or "Textile City" are some of its other names. Sangli, a city in Maharashtra, is the second-largest and most significant location for the production and trade of turmeric after Erode.

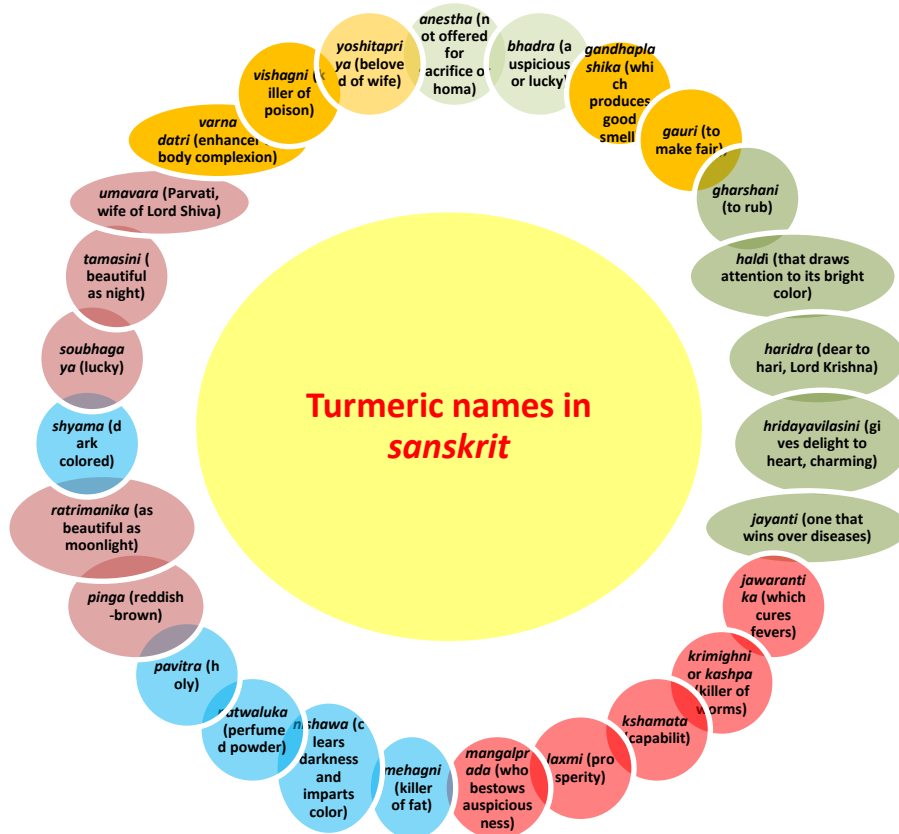


Figure 1: Various names of turmeric in sanskrit

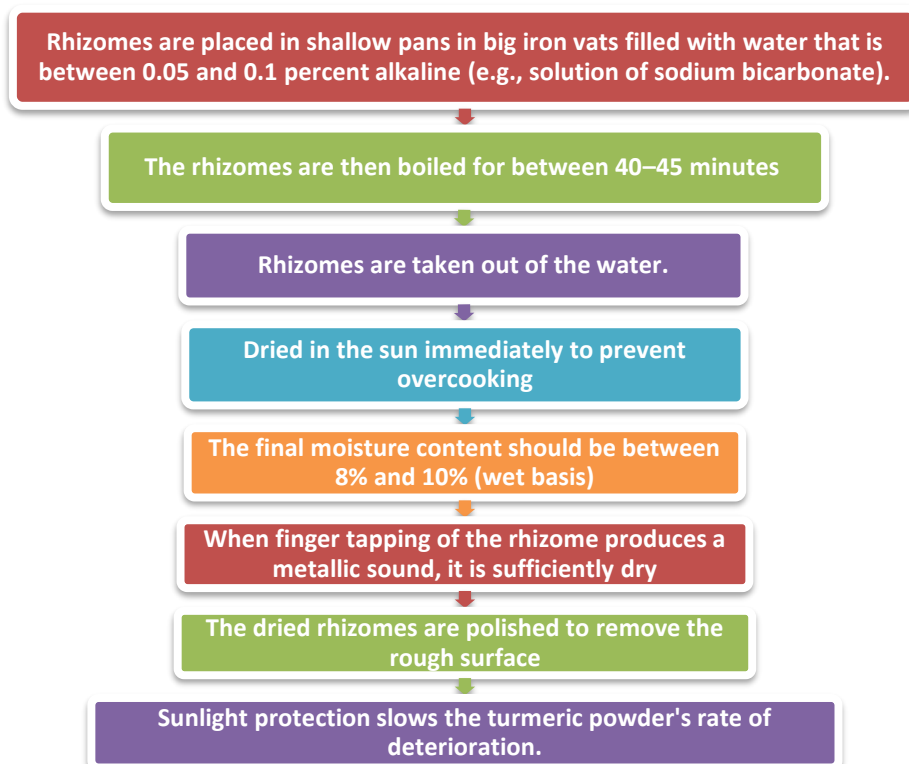


Figure 2: Processing of turmeric

Table 1: Taxonomical Characters

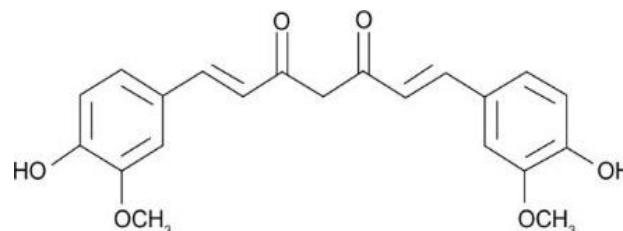
Domain	Eukaryota
Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Liliopsida
Subclass	Zingiberidae
Phylum	Spermatophyta
Subphylum	Angiospermae
Order	Zingiberales
Family	Zingiberaceae
Genus	<i>Curcuma</i>
Species	<i>Longa</i>

Phytoconstituents

Protein makes up 6.3% of turmeric's composition, along with fat (5.1%), minerals (3.5%), carbs (69.4%), and moisture (13.1 percent). The yellow colour is caused by the phenolic diketone curcumin (diferuloylmethane), which is made up of curcumin I (94%), curcumin II (6%), and curcumin III (3%). (0.3 percent). Additionally, it contains 1,8-cineole, 2-bornanol, 2-hydroxy-methyl-anthraquinone, 4-hydroxybisabol-2, 10-diene-9-one, 4-methoxy-5-hydroxybisabol, 4-hydroxy-cinnamoyl-(Feruloyl)-methane, alpha-atlantone, alpha-pinene, alpha-terpineol, ar-turmerone, arabinose Cuminy alcohol, Curcumene, Curcumenol, Curcumin, Curdione, Cobalt, Copper, Eugenol, Epiprocurcumenol, Eucalyptol, Feruloyl-p-coumaroyl-methane, Gamma-atlantone, Germacrone, Germacrone-13-al; Guaicol, Isoborneol, L-alpha-curcumene (4.2 percent). turmerone, arturmerone, curcumene,

germacrone, and ar-curcumene make up the majority of its ingredients, Other chemicals compound are copper/zinc, campesterol, stigmaterol, beta-sitosterol, cholesterol, fatty acids and metallic elements potassium, sodium, magnesium, calcium, manganese, iron.⁴

The major bioactive compound curcumin, sometimes called diferuloyl methane, is a symmetric chemical moiety with the molecular weight of 368.38 and the chemical formula C₂₁H₂₀O₆. It has the IUPAC name (1E,6E) -1,7-bis(4-hydroxy-3-methoxyphenyl) 1,6-heptadiene and 3,5-dione. A seven-carbon linker composed of an, -unsaturated-diketone moiety connects two aromatic ring systems with o-methoxy phenolic groups. The diketo group exhibits keto-enol tautomerism, which, depending on the setting, can occur in a variety of conformers.

**Figure 3:** structure of curcumin

Management

The anti-inflammatory and antioxidant properties of curcumin appear to be the key causes of its possible positive benefits. Curcumin's interactions with (and modification of) a number of molecular targets, including as transcription factors, enzymes, cell cycle proteins, receptors, cell surface adhesion molecules, growth factors, and protein kinases, are what cause these effects..

Table 2: pharmacological facet of curcumin

Curcumin			
S.No	Pharmacological Activity	Description	References
1.	Anti-hypertensive	<ul style="list-style-type: none"> In vascular smooth muscle cells, curcumin reduced AT1R expression in a concentration- and time-dependent manner. Curcumin reduces AT1R-mediated vasoconstriction in A10 cells via altering SP1/AT1R DNA binding, which subsequently delays the onset of hypertension in an Ang II-induced hypertensive model. 	5
2.	Anti-oxidant	<ul style="list-style-type: none"> It lowers oxidative stress levels, which are linked to, among other things, the body's capacity to chelate heavy metals or control the activity of various enzymes. 	6
3.	Anti-inflammatory	<ul style="list-style-type: none"> Curcumin controls inflammatory signalling pathways and prevents the generation of inflammatory mediators to produce anti-inflammatory effects. Curcumin regulates inflammatory mediators and combats inflammatory illnesses through binding to Toll-like receptors (TLRs), nuclear factor kappa-B (NF-B), mitogen-activated protein kinases (MAPK), activator protein 1 (AP-1), and other signalling pathways. 	7
4.	Anti-ulcer	<ul style="list-style-type: none"> Curcumin's antiulcer effectiveness was demonstrated by reducing a number of ulcerative factors, such as pepsin inhibition, pepsin hyperactivity, gastric acid hypersecretion, total peroxides, myeloperoxidase activity, and apoptotic incidence. 	8

5.	Anti-diabetic	<ul style="list-style-type: none"> Curcumin (300 mg/kg b.w./day) significantly decreased fasting plasma glucose, cholesterol, triglycerides, and low-density lipoprotein when given to STZ-induced diabetic Wistar rats for eight weeks (LDL) -levels of cholesterol 	9
6.	Hypolipidemic	<ul style="list-style-type: none"> Curcumin treatment reduced blood total cholesterol, triacylglycerols, LDL, VLDL, phospholipid, endothelin-1, and homocysteine concentrations while raising HDL and Apo A levels in rats with high cholesterol diet-induced hypercholesterolemia. These findings imply that curcumin may be useful in regulating cholesterol levels, enhancing dyslipidemia, and maybe lowering cardiovascular problems brought on by hypercholesterolemia. 	10
7.	Anti-cancer	<ul style="list-style-type: none"> Nuclear element B is a transcription factor that promotes inflammation and regulates the expression of numerous proteins, including the cytokines interleukin (IL)-1, IL-2, and interferon (IFN), which are engaged in a variety of cell signalling pathways linked to the development of cancer and inflammation. Curcumin reduces NF-B activity by preventing I kappa B kinase (I-B) phosphorylation and preventing nuclear translocation of the NF-B p65 subunit. 	11, 12
8.	Anti-atherosclerosis	<ul style="list-style-type: none"> Curcumin's anti-atherosclerotic effects manifest as a suppression of M1 to M2 macrophage polarisation or as an induction of M2 polarisation via macrophage release of IL-4 and/or IL-13. 	13,14
9.	Wound healing	<ul style="list-style-type: none"> Curcumin can improve the development of granulation tissue, collagen synthesis, tissue remodelling, and wound contraction. 	15
10.	Anti-coagulant	<ul style="list-style-type: none"> The activated partial thromboplastin time (aPTT), prothrombin time (PT), as well as cell-based thrombin and activated factor X (FXa) production activities, have all been used to determine the anticoagulant capabilities of curcumin and its derivative (bisdemethoxycurcumin, BDMC). The outcome shown that curcumin and BDMC considerably lengthened aPTT and PT and reduced thrombin and FXa activities. 	16, 17
11.	Analgesic	<ul style="list-style-type: none"> A total of eight RCTs with 606 randomly assigned subjects matched our inclusion criteria. Pain was observed to be significantly decreased by curcuminoids (SMD: 0.57, 95 percent CI: 1.11 to 0.03; P = 0.04). This pain-relieving effect was discovered to be independent of the dosage and length of curcuminoids administration and was unaffected by publication bias. In all reviewed RCTs, turmeric was well tolerated and safe. 	18
12.	Antinociceptive	<ul style="list-style-type: none"> Curcumin acted as an antinociceptive agent by promoting Pomc expression and DRG neurons' release of enkephalin and beta-endorphin. These findings showed that curcumin reduced bone pain caused by cancer by acting on endogenous opioid peptides, particularly -endorphin and enkephalin. 	19
13.	Anti-microbial	<ul style="list-style-type: none"> Its protective effects against Gram-negative uropathogens such Escherichia coli, Pseudomonas aeruginosa, Proteus mirabilis, and Serratia marcescens, as well as its ability to delay the development of struvite stones linked to uTIs. Curcumin has demonstrated a synergistic antimicrobial action with antibiotics and antifungals against a variety of infections, including Candida albicans, enterotoxigenic Escherichia coli (ETEC), Pseudomonas aeruginosa, and methicillin-resistant S. aureus. 	20
14.	In arthritis	<ul style="list-style-type: none"> These RCTs offer scientific proof for the effectiveness of turmeric extract (approximately 1000 mg of curcumin per day) in the treatment of arthritic pain. 	21
15.	Anti-epileptic	<ul style="list-style-type: none"> In a kainate model of temporal lobe epilepsy, curcumin also has anti-epileptogenic effect because it lessens the severity of spontaneous recurring seizures. 	22
16.	Multiple sclerosis	<ul style="list-style-type: none"> In CNS-related conditions, such as MS, curcumin may modify cell cycle regulating proteins, enzymes, cytokines, and transcription factors. 	23
17.	Anti-alzheimer	<ul style="list-style-type: none"> The two main indicators for the diagnosis of Alzheimer's disease are amyloid and highly phosphorylated tau protein. Due to curcumin's inherent fluorescence and strong affinity for amyloid-, it was created as a diagnostic probe in the early stages of medical research. Curcumin has been found to efficiently preserve the normal structure and function of brain arteries, mitochondria, and synapses, lower risk factors for a number of chronic diseases, and reduce the risk of Alzheimer's disease in both prevention and treatment of the condition. 	24
18.	Chronic anterior uveitis	<ul style="list-style-type: none"> 32 individuals with chronic anterior uveitis received 375 mg of curcumin three times each day for a period of 12 weeks. Curcumin was just as effective as corticosteroid therapy, the only available standard treatment, in 86 percent of patients. 	25,26
19.	Dental pain	<ul style="list-style-type: none"> Applying roasted, ground turmeric to sore teeth reduces pain and swelling. 	26,27



20.	Periodontal problems	<ul style="list-style-type: none"> • Topically applied Gingivitis and periodontitis can be treated by putting a paste comprised of 1 tsp of turmeric, 1/2 tsp of salt, and 1/2 tsp of mustard oil on the affected areas. It is advised to use this paste twice day to brush the teeth and gums. 	26,27
21.	Subgingival irrigant	<ul style="list-style-type: none"> • When used as a subgingival irrigant, 1% curcumin solution can improve the remission of inflammatory symptoms compared to saline and chlorhexidine irrigation. 	28
22.	Anti-parkinson	<ul style="list-style-type: none"> • By giving a H ion, curcumin shields mitochondria and neurons from the harmful effects of ROS. Lewy bodies (LB) are linked to the start of Parkinson's disease (PD). LB is formed when alpha-synuclein oligomers group together. There is evidence that curcumin inhibits the formation of alpha-synuclein oligomers. 	29,30
23.	In schizophrenia	<ul style="list-style-type: none"> • In a pilot research, patients with chronic stable schizophrenia received 180 mg/day of add-on curcumin at a lower dose. At 12 weeks, curcumin dramatically decreased pro-inflammatory cytokine (IL-6) levels and enhanced working memory function. • A double-blind, randomised controlled experiment was conducted to examine the effects of curcumin as an adjunct to continued antipsychotic therapy on positive, negative, and depressive symptoms. • An addition to the ongoing antipsychotic medication regimen for 16 weeks, nanocurcumin soft gel capsules (160 mg/day) was monitored in a double-blind, randomised, placebo-controlled research to see how it affected the negative symptoms of chronic stable schizophrenia patients. 	31
24.	In HIV	<ul style="list-style-type: none"> • Curcumin may lessen FGT inflammation, which is known to make it easier for people to contract HIV. Although the vaginal epithelial cells (GECs) lining the FGT play a crucial role in building a primary barrier against HIV entry, exposure to an intact virus or the HIV-1 glycoprotein 120 (gp120) causes an inflammatory response that causes the tight junction (TJ) proteins to be downregulated. 	32, 33
25.	Anti-depressant	<ul style="list-style-type: none"> • Curcumin improved serotonergic and dopaminergic transmission while inhibiting the MAO-A to counteract the depressive-like behaviour in mice brought on by prolonged stress. 	34,35
26.	In Covid	<ul style="list-style-type: none"> • Via the ACE2 receptor, the SARS-CoV-2 S glycoprotein promotes fusion and internalisation of the virus. It is responsible for this interaction. In order to cure COVID-19, it may be possible to target both the S glycoprotein and ACE2. Curcumin has a significant propensity for interacting with the S glycoprotein through the formation of six hydrogen bonds, according to in silico study. 	36
27.	Hepatoprotective	<ul style="list-style-type: none"> • Curcumin (200 mg/kg/day for 3 weeks) also had a protective effect on Non-Alcoholic Steatohepatitis (NASH) caused by CCl4. Male Wistar-Albino rats were shown to have decreased lipid accumulation and MDA deposition during the corresponding histological examination. In mice with methionine+choline-deficiency (MCD)-induced steatohepatitis, curcumin also successfully inhibited fibrosis (both formation and progression). 	37, 38

The majority of these advantages are a result of its antioxidant and anti-inflammatory properties. Due to curcumin's poor bioavailability, which appears to be primarily caused by poor absorption, fast metabolism, and rapid elimination, taking it by itself does not result in the related health benefits. A number of substances can improve bioavailability. For instance, piperine, the main active ingredient in black pepper, has been demonstrated to improve bioavailability by 2000% when coupled with curcumin in a complex.³⁹

Ar-turmerone also has anti-inflammatory capabilities as a result of blocking important microglial signalling pathways. Ar-turmerone is a viable therapeutic treatment for different neurologic disorders because microglia activation is a hallmark of neuroinflammation and is linked to a variety of neurologic disorders, including stroke and neurodegenerative diseases.⁴⁰ Anti-inflammatory properties of enhanced turmerones Curcuma oil in a model of endotoxemia and cytokine production caused by LPS. By

altering the TLR4-IRAK1-ROS-MAPK-NFB pathway in mouse macrophages and THP-1 monocytes, curcuma oil reduces inflammation and reverses the detrimental effects of LPS in mice.⁴¹

There is a lengthy history of safety with curcumin. For instance, the Allowable Daily Intake (ADI) value of curcumin is 0-3 mg/kg body weight, as reported by JECFA (The Joint United Nations and World Health Organization Expert Committee on Food Additives) and EFSA (European Food Safety Authority) reports.⁴² Despite this medication's well-known safety, several unfavourable side effects have been documented. In a dosage response trial, seven patients who received 500–12,000 mg and were monitored for 72 hours reported symptoms including diarrhoea, headache, rash, and yellow stools. In a different trial, some participants who received 0.45 to 3.6 g of curcumin per day for one to four months experienced diarrhoea, nausea, and a rise in the levels of the enzymes lactate dehydrogenase and alkaline phosphatase in their serum.³⁹



CONCLUSION

We focused on the biological activity of turmeric in this review. Due to its unique medicinal characteristics and diverse impacts on various bodily systems, turmeric is regarded as a safe, nontoxic, and potent substitute for many conventional medications. It holds great promise for the treatment of cancer. The usual method for obtaining turmeric's health benefits is through long-term, low-dose food ingestion. The appropriate use of turmeric in the treatment of human diseases requires a detailed understanding of effective dose, safety, and mechanism of action. Antibacterial, antiviral, anti-inflammatory, anti-tumor, antioxidant, antiseptic, cardioprotective, hepatoprotective, dental protective, neuroprotective, and digestive actions are just a few of turmeric's many benefits. Curcumin's potential to act as an adjuvant medication in the management of COVID-19 has been confirmed. If turmeric is to be used for addressing human needs and enhancing human welfare, additional clinical investigations are required.

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