**Review Article** 

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# TURMERIC: UNVEILING THE MEDICINAL PROPERTIES AND POTENTIAL USES OF CURCUMA LONGA

Kashinath A. Sakhare<sup>\*1</sup>, Shubhangi D. Dhoble<sup>1</sup>, Varsha M. Gaikwad<sup>1</sup>, Vaishnavi N. Mokashe<sup>1</sup>, Pandit S. Biradar<sup>1</sup>, Sonali G. Telange<sup>1</sup>, Nilesh N. Shinde<sup>2</sup>

<sup>1\*</sup>Department of Pharmacy, Godavari Institute of Pharmacy, Kolpa, Latur-413512, Maharashtra, India. <sup>2</sup>Department of Pharmaceutical Chemistry, Godavari Institute of Pharmacy, Kolpa, Latur-413512, Maharashtra, India.

#### ABSTRACT

*Curcuma longa*, commonly known as turmeric, derived from the rhizome of *Curcuma longa* is a bright yellow spice has been used for centuries in traditional medicine for its medicinal properties, which is native to Southeast Asia. Curcuma long is a member of ginger family (*Zingiberaceae*) and is widely used by traditional healers to treat a wide range of ailments. *Curcuma longa* rhizomes are commonly referred to as Haldi or Turmeric. Rhizomes are underground horizontal stems that produce both shoots and roots. Turmeric contains nutritional as well as therapeutic benefits. Turmeric root powder is used for its flavouring properties as a spice, dietary medicine and variety of critical therapeutic advantages. Many studies have been undertaken morphology, phytochemical profiles of the entire plant and other qualities that have been recorded and documented. This review provides an update on the phytochemistry, pharmacology and therapeutic applications of *Curcuma longa*. A comprehensive literature search was conducted to identify studies on the phytochemical constituents, pharmacological activities and clinical applications of *Curcuma longa*. The review discusses the bioactive compounds present in *Curcuma longa*, including curcuminoids, sesquiterpenes and flavonoids and their potential health benefits. The pharmacological activities of *Curcuma longa*, including anti-inflammatory, antioxidant, antimicrobial and anticancer properties, are also examined. The therapeutic applications of *Curcuma longa* in the prevention and treatment of various diseases, including arthritis, diabetes and cancer, are reviewed. This review highlights the potential of *Curcuma longa* as a therapeutic agent and its significance in modern medicine.

#### **KEYWORDS**

Curcuma longa, Indian saffron curcuminoids, Anticancer, Anti-inflammatory, Antioxidant and Hepatoprotective agent.

Author for Correspondence: Sakhare Kashinath A, Department of Pharmacy, Godavari Institute of Pharmacy, Kolpa, Latur-413512, Maharashtra, India. Email: kashisakhare03@gmail.com

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#### **INTRODUCTION**

Turmeric: A Timeless Healer and Ayurvedic Marvel

Turmeric (*Curcuma longa*), known as *Haridra* in Sanskrit, has been an integral part of Indian medicine and culture for thousands of years. Its name, meaning "efficacious drug for jaundice," July – September 57 highlights its therapeutic significance. Indigenous to India, particularly the Western and Southern regions, it is often called "Indian Saffron" due to its striking yellow hue.

References to turmeric in Ayurvedic texts date back to the *Rigveda* (4500-1600 BCE) and it remains a cornerstone of Ayurveda, Unani and Siddha medicine. With potent anti-inflammatory and antioxidant properties, turmeric has been revered for its healing potential. Historical records trace its journey beyond India-reaching China by 700 AD, East Africa by 800 AD and Europe in the 13th century, likely introduced by Arab traders. Marco Polo, in his travels, noted turmeric's resemblance to saffron, underscoring its value.

Botanically, turmeric belongs to the ginger family (*Zingiberaceae*). The plant grows up to five feet, bearing oblong leaves, funnel-shaped yellow flowers and rhizomes rich in curcuminoids-bioactive compounds responsible for its color and medicinal properties. The primary curcuminoids include curcumin, desmethoxycurcumin and bis-desmethoxycurcumin. Turmeric thrives in tropical climates with temperatures between 20-30°C and annual rainfall of 1500-2500mm, making India the largest global producer.

First isolated in 1815, curcumin's structural composition was determined in 1973. It exhibits solubility in ethanol, alkali, ketone, acetic acid, and chloroform, with a melting point of 176-177°C. Turmeric's versatility extends beyond medicine, serving as a culinary spice, dye, and preservative. Recognized as a safe food additive by the WHO, FDA and European Parliament, its global production exceeds 1.1 million tonnes annually.

Turmeric remains a powerful natural healer, bridging ancient wisdom and modern science, solidifying its place as a botanical marvel in traditional and contemporary medicine

Turmeric has been a cornerstone of traditional medicine for centuries, widely utilized in both Ayurvedic and Chinese systems. In India, it has been primarily used for treating arthritis and muscular disorders, while in China, it has served as a topical analgesic and remedy for ailments such as

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colic, flatulence, ringworm, hepatitis, and chest pain. Its broad therapeutic applications highlight its significance in natural healing practices.

#### PLANT PROFILE

**Common Names:** Curcuma, Turmeric, Indian Saffron, Yellow Ginger **Linguistic Variations** 

Hindi: Haldi (हल्दी)

Sanskrit: Haridra (हरिद्रा)

**Tamil and Malayalam:** Manjal (மஞ்சள் / മഞ്ചര്)

Telugu: Pasupu (పసుపు)

Kannada: Arishina ( හර්ඵි ත්)

# **Biological Source**

Derived from the rhizomes of *Curcuma longa* (Zingiberaceae), turmeric is a tropical plant thriving in warm, humid climates with well-drained soil (pH 6.0-7.0).

#### **Geographical Distribution**

**Native Regions:** India (Tamil Nadu, Kerala, Karnataka, Maharashtra) and Southeast Asia (Indonesia, Malaysia, Thailand, the Philippines).

#### **Cultivated Regions**

Widely grown in China, Japan, Sri Lanka, Africa (South Africa, Nigeria, Ethiopia), Central and South America (Costa Rica, Brazil, Peru) and the Caribbean (Jamaica, the Dominican Republic).

Turmeric's extensive global cultivation underscores its medicinal, culinary, and economic importance

#### **Major Producing Countries**

India – Leading producer, contributing over 70% of global supply.

China – Second-largest producer.

Indonesia – Ranks third in production.

Bangladesh – A significant contributor.

Other key producers include Sri Lanka, Thailand, and the Philippines.

### **Taxonomical Classification**

Scientific Name: Curcuma longa L. (1753)

Family: Zingiberaceae

Genus: Curcuma

Species: Curcuma longa L.

Plant Type: Perennial herbaceous plant Kingdom: Plantae Clade: Angiosperms, Monocots Order: Zingiberales Class and Subclass: Liliopsida, Zingiberidae **Organoleptic Properties** Color: Golden yellow to orange yellow Odor: Aromatic Taste: Bitter Shape and Size: Cylindrical; length - 71.3mm, breadth - 25.2mm, thickness - 24.1mm Turmeric's widespread cultivation and unique properties reinforce its medicinal, culinary, and economic significance worldwide.

# **MORPHOLOGY OF THE PLANT-**

#### **Roots**

Turmeric's rhizomes and bulbs serve as essential components in both medicine and food. Root initials emerge from the diffuse meristem, a specialized cell zone that generates the root meristem. The root apex comprises three sets of initials-for the root cap, Pleroma, and a shared dermatogen-Pleroma zone. These roots develop rhizomes, which further produce stems and roots for new growth. Once harvested, turmeric roots are sun-dried and ground into a fine powder. A mixture of turmeric powder, honey, and bitter gourd leaf juice is traditionally used to support measles recovery.

#### Flowers

Turmeric (Curcuma longa) produces spike-like inflorescences, reaching 10-15cm in length. The funnel-shaped flowers, about 2-3cm long, are pale yellow to yellowish-white and are subtended by lanceolate greenish-yellow bracts. The calyx is tubular with three teeth, while the corolla has three lobes. The androecium comprises six stamens in two whorls, and the gynoecium consists of three fused carpels forming a single ovary. Turmeric blooms in summer, with a flowering period lasting several weeks.

#### Curcuma Longa Leaves

Turmeric (Curcuma longa) leaves are large, green and glossy with a smooth, slightly waxy texture.

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They are oblong-lanceolate or elliptic-lanceolate, measuring 30-40cm in length and 8-10cm in width. The leaf margin is entire, with an acute apex and a narrow, tapering base. The petiole is relatively long (10-15cm) and the surface is either globous or sparsely hairy. The venation is parallel, with several prominent veins running parallel to each other.

#### **Nodes and Internodes**

Turmeric nodes are greenish-yellow, swollen and joint-like, measuring 1-2cm in diameter, marking leaf attachment points. The internodes are cylindrical, slightly tapering and 5-10cm long, covered with scale-like structures and sometimes trichomes, especially when young.

# **Aerial Shoot and Shoot Apex**

The aerial shoot develops from overlapping leaf sheaths, forming a pseudo stem that reaches 60-100cm in height. The leaves, arranged alternately, have tubular sheaths wrapping around the pseudo stem. The shoot apex is dome-shaped, about 1-2mm in diameter, with papillae, trichomes and a thin waxy cuticle. It exhibits a tunica-corpus structure with an apical meristem and leaf primordia.

#### Rhizome

The turmeric rhizome, an underground stem, is yellowish-brown, cylindrical, or oval, 2-3cm in diameter and 5-10cm long with a rough surface. It comprises an epidermis, a thick parenchymatous cortex, and a central stele with vascular tissues. Rich in starch grains, Fibers, and oil cells, the rhizome serves as the plant's primary storage organ.

#### PHYTOCHEMISTRY

(Curcuma longa), Turmeric a rhizomatous herbaceous perennial, has been valued for centuries as both a spice and a medicinal plant. Beyond its role as a food colorant, it exhibits significant biological properties, including anticancer. antioxidant and anti-inflammatory effects. Its rich phytochemistry varies based on variety, region, and cultivation conditions. The primary bioactive compounds, curcuminoids, are yellow-orange volatile oils, with curcumin being the most studied. Curcumin, also known as Natural Yellow, exists in keto and enol forms, is lipophilic, water-insoluble,

and remains stable in the acidic environment of the stomach.

Turmeric is comprised of a group of three curcuminoids (2-5%)

Curcumin-I (Curcumin1-2%) C21H20O6: A polyphenol with anti-inflammatory, antioxidant, and anticancer properties.

Curcumin-II (Desmethoxycurcumin 0.5-1%) C20H18O5: A polyphenol with anti-inflammatory and antioxidant properties.

Curcumin-III (Bisdemethoxycurcumin 0.5-1%) C19H16O4: A polyphenol with anti-inflammatory and antioxidant properties.

Turmeric contains up to 5-10% Volatile Oil including

Turmeron (2-4%) -A sesquiterpene with antiinflammatory and antioxidant properties.

Atlantone (1-2%): A sesquiterpene with antiinflammatory and antioxidant properties.

Zingiberene (1-2%): A sesquiterpene with antiinflammatory and antioxidant properties.

### **Other Constituents**

Starch (40-50%): A complex carbohydrate that provides energy.

Fiber (10-20%): A complex carbohydrate that provides dietary fibre.

Proteins (5-10%): Amino acids that provide building blocks for growth and repair.

Minerals (5-10%): Essential minerals like potassium, sodium, and iron.

Vitamins (1-5%): Essential vitamins like vitamin C, vitamin E and vitamin K.

These compounds further contribute to the overall therapeutic potential of turmeric.

The combination of various phytochemicals in turmeric contributes to its multifaceted health benefits.

# PHARMACOKINETIC

Curcumin, the primary bioactive compound in *Curcuma longa*, has low oral bioavailability (1-5%) due to poor absorption and rapid metabolism. Around 40-85% of an oral dose remains unchanged in the gastrointestinal tract, with most of the absorbed portion metabolized in the liver and

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intestinal mucosa. To enhance absorption and antiinflammatory effects, curcumin is often combined with bromelain. Peak plasma levels are reached within 2-4 hours post-ingestion, with an estimated bioavailability of 65%.

Curcumin has a large volume of distribution (10-20L/kg), indicating widespread tissue penetration, including the liver, kidneys, lungs, and brain. Highly bound to plasma proteins (90–95%), it undergoes metabolism through:

**Glucuronidation** – forming curcumin glucuronide (major metabolite).

**Sulfation** – converting to curcumin sulphate.

**Reduction** – forming tetrahydro curcumin.

With an elimination half-life of 6-8 hours, curcumin is primarily excreted through faeces (60-70%) and urine (10-20%).

#### **Factors Affecting Pharmacokinetics**

**Food:** Food can enhance the bioavailability of curcumin, particularly fatty foods.

**Piperine:** Piperine, a constituent of black pepper, can increase the bioavailability of curcumin by inhibiting glucuronidation.

**Dose:** The pharmacokinetics of curcumin can vary depending on the dose, with higher doses resulting in nonlinear increases in plasma concentrations.

# USES OF CURCUMA LONGA

A flowering plant *Curcuma longa* (Turmeric) in the ginger family has been used for centuries in traditional medicine, cooking and other applications. It is commonly used as a food colouring and is one of the basic ingredients in curry powder and to heal many health disorders.

Food Use

Cosmetic Use

Medicinal Use

# Food use

In rural and tribal communities, dried turmeric rhizomes are added to boiling curries for flavor and consumed along with meals. Turmeric powder is widely used as a natural colorant in food, imparting its characteristic yellow hue. Recent studies highlight the potential of *Curcuma longa* aqueous extracts as bio-preservatives, effectively inhibiting

foodborne pathogens like Penicillium panemun, citrinum, Penicillium and Cladosporium oxysporum, thereby extending food shelf life.

#### **Food Additive Uses**

Essential ingredient in curry powders and spice blends.

Protects packaged food from sunlight-induced degradation.

Used in oil-based and water-containing products as a natural colorant.

Enhances the color stability of pickles, mustard, and processed foods.

Widely used in dairy products, beverages. confectionery, baked goods, and sauces.

Serves as a mustard substitute in cattle feed.

Curcumin, the active compound in turmeric, is an approved food additive by the WHO, European Parliament, and FDA. It is commonly used in dairy, flavored drinks, and processed foods, contributing to both flavor and preservation.

#### **Cosmetic uses**

Turmeric is globally utilized for medicinal, cosmetic, dyeing, and coloring purposes. It serves as a natural colorant in pharmaceuticals, mustard, and cosmetics, while Curcuma longa rhizome and leaf oils are widely used in skincare formulations. In Asia, turmeric water is traditionally applied for a radiant complexion and it remains a key ingredient in herbal skincare products.

#### **Cosmetic Uses**

Raw turmeric paste enhances skin glow.

Integral to Indian pre-wedding skincare rituals.

Believed to slow body hair growth with regular use. Helps achieve soft, smooth and even-toned skin.

Used in treating pigmentation, blotches, and

eczema.

Turmeric's natural properties make it a vital ingredient in various creams, lotions, and beauty treatments.

#### **Medicinal Uses and Pharmacological Effects**

Curcuma longa L. (Turmeric) belongs to one of the oldest cultivated spice crops, is indigenous to the Indian sub-continent and is one of the most powerful herbal medicinal plants. The rhizome of

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the plant is the threshold as the powder of rhizome has extensive medicinal values.

#### Hepatoprotective activity

Turmeric plays a significant role in liver protection by preventing the accumulation of collagen and other macromolecules that contribute to cirrhosis. Studies confirm its effectiveness against hepatotoxic agents like carbon tetrachloride, galactosamine and acetaminophen. It is traditionally recommended for jaundice and hepatitis due to its antioxidant and anti-inflammatory properties.

Curcumin, the key bioactive compound, reduces liver damage, inhibits proinflammatory cytokines and protects against lipid peroxidation. Other active compounds, such as turmerone, atlantone, and zingiberene, help counter liver toxicity. Additionally, sodium curcuminate enhances bile secretion, potentially aiding in gallstone prevention. Anticarcinogenic

Turmeric exhibits potent anticancer properties by neutralizing carcinogenic free radicals. Studies on animal models and human cell lines have demonstrated curcumin's ability to inhibit tumor promotion, angiogenesis, and tumor growth. It suppresses breast carcinoma cells and mitigates the activity of mutagens and carcinogens. Its anticarcinogenic effects stem from its antioxidant activity, free-radical scavenging, and ability to enhance glutathione levels for detoxification. Curcumin also induces apoptosis in cancerous cells, reinforcing its role as an anti-tumoral agent.

supports cardiovascular health Turmeric by lowering cholesterol and triglyceride levels, reducing LDL oxidation, and inhibiting platelet aggregation. Its components enhance prostacyclin synthesis while inhibiting thromboxane synthesis, thereby preventing clot formation. Curcumin improves cardiac glutathione levels, preserving membrane integrity and reducing cardiac tissue damage. Additionally, it mobilizes  $\alpha$ -tocopherol from adipose tissue, protecting against oxidative damage linked to atherosclerosis.

#### **Gastrointestinal Effect**

Turmeric extract offers significant gastrointestinal protection due to its anti-inflammatory and

mucosal-protective properties. Curcumin has been effective against various digestive disorders, including dyspepsia, Helicobacter pylori infection, peptic ulcers, irritable bowel syndrome, Crohn's disease and ulcerative colitis. It enhances mucin secretion, increases digestive enzyme activity and protects the gastric mucosa similarly to ranitidine. Studies have shown that turmeric inhibits ulcer formation caused by stress, alcohol and certain medications while reducing stomach acidity and ulcer severity.

Additionally, turmeric possesses anticoagulant properties by inhibiting platelet aggregation and interfering with thrombin and factor Xa activity. Curcumin extends blood clotting times and disrupts the arachidonic acid pathway, reducing fibrin formation and slowing clot development. Its derivatives, including bisdemethoxycurcumin, further enhance anticoagulant effects, making turmeric a potential natural blood thinner.

### Antidepressant

Turmeric exhibits antidepressant effects primarily through neurotransmitter modulation, antiinflammatory activity, and neurogenesis. Curcumin, its active compound, enhances serotonin, dopamine, and norepinephrine levels, playing a vital role in mood regulation. Its ability to inhibit monoamine oxidase increases neurotransmitter availability, contributing to its antidepressant action.

Chronic inflammation is linked to depression, and curcumin's anti-inflammatory properties help reduce pro-inflammatory cytokines such as IL-6 and TNF. Additionally, curcumin promotes neurogenesis, particularly in the hippocampus, an area crucial for memory and mood regulation. Studies on chronic moderate stress (CMS) models demonstrate that curcumin normalizes stressinduced changes in serotonin turnover, cortisol and corticotrophin-releasing factor levels, restoring mood balance and reducing depressive symptoms.

# Antioxidant activity

Curcumin, the active compound in turmeric, plays a crucial role in protecting against oxidative stress, particularly in ischemic conditions. It enhances cellular resistance to oxidative damage by

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increasing stress protein expression, making it a promising candidate for ischemic injury treatment. Curcumin exhibits strong antioxidant activity, comparable to vitamins C and E, and is eight times more potent than vitamin E in preventing lipid peroxidation.

# Antioxidant Mechanisms

# **Free Radical Scavenging**

Neutralizes reactive oxygen and nitrogen species, reducing cellular damage.

# **Enzyme Modulation**

Enhances antioxidant enzymes like superoxide dismutase, catalase and glutathione peroxidase.

**Lipid Peroxidation Inhibition:** Prevents oxidative damage to cell membranes, reducing inflammation.

#### Anti-inflammatory Effects

Curcumin inhibits key inflammatory mediators, cyclooxygenase (COX-2) including and lipoxygenase (LOX), reducing leukotrienes and prostaglandins. It also suppresses inflammatory cytokines like TNF and IL-12, modulates immune cell behavior and decreases nitric oxide production, mitigating thereby chronic inflammation. curcumin's topical Additionally, application provides relief for inflammatory skin conditions such as eczema and psoriasis, highlighting its broad therapeutic potential.

#### Antifungal

Curcumin exhibits strong antifungal properties by inhibiting fungal growth, disrupting fungal cell and potentially down-regulating membranes. aflatoxin gene expression. The rise in antifungal resistance necessitates alternative treatments, especially for immunocompromised individuals. Ethanolic extracts of turmeric, rich in phenolics, display terpenes and alkaloids. enhanced antimicrobial potential. Curcumin and turmeric oil are particularly effective against Fusarium solani and Helminthophobia oryzae, highlighting their broad-spectrum antifungal capabilities.

#### Antidiabetic Potential

Turmeric has been a key component in traditional medicine for managing diabetes. Curcumin regulates blood glucose levels by improving insulin signalling and enhancing insulin sensitivity through

increased Fibroblast Growth Factor (FGF) expression. It also reduces oxidative stress and lipid peroxidation while promoting antioxidant activity. Bioactive turmeric compounds, including arturmerone and desmethoxycurcumin, contribute to metabolic regulation and adipocyte differentiation, making curcumin a promising natural remedy for diabetes management.



Figure No.1: Plants of Curcuma Longa



Figure No.2: Roots of Curcuma Longa



 Figure No.3: Flowers of Curcuma Longa

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Figure No.4: Leaves of Curcuma Longa



Figure No.5: Rhizome of Curcuma Longa



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Figure No.8: Schematic diagram showing various pharmacological activities of Curcuma Longa L



Figure No.9: Mechanism of action of Curcuma Longa

#### CONCLUSION

*Curcuma longa*, widely known as turmeric, has been a cornerstone of traditional medicine for centuries due to its diverse pharmacological properties. A member of the Zingiberaceae family, turmeric owes its therapeutic potential to its active compound, curcumin, which exhibits antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, anticancer, antidiabetic, and cardioprotective effects.

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The bioactive components of turmeric, including curcuminoids, flavonoids, and sesquiterpenes, contribute to its medicinal efficacy. However, one of the major limitations of curcumin is its low bioavailability. To overcome this challenge, researchers have explored various strategies such as combining it with piperine and utilizing lipid-based delivery systems to enhance absorption.

Beyond its medicinal applications, turmeric is widely used as a natural food additive, cosmetic ingredient and dye, showcasing its versatility.

Ongoing scientific studies continue to validate its traditional uses, reinforcing its potential as a natural therapeutic agent. Future research should focus on optimizing its bioavailability and conducting clinical trials to establish standardized dosages for different health conditions.

Turmeric remains a promising natural compound with immense potential in modern medicine. Continued research and innovation in its formulation could pave the way for new therapeutic applications, solidifying its role in holistic health and disease management.

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#### **CONFLICT OF INTEREST**

I declare that I have no conflict of interest.

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