iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** X **Month of publication:** October 2025

DOI: https://doi.org/10.22214/ijraset.2025.74607

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue X Oct 2025- Available at www.ijraset.com

A Review on Phytochemical and Pharmacological Properties of Turmeric the Golden Spice

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Abstract: ***Globally, medicinal plants and their bioactive constituents have found practical applications in treating, managing, and preventing various human and animal diseases in complementary and orthodox medicines. Recently, it has been reported that about 80% of the world's population depends on medicinal plants and their phytoconstituents (bioactive compounds) for their primary health care. Curcuma longa, popularly known as Turmeric, is a rhizomatous herbaceous perennial plant used in folk medicine for the treatment, prevention, and management of various illnesses such as cancer, diabetes, Arthritis, diarrhoea, inflammation, psoriasis, hepatobiliary diseases, gastric and peptic ulcers. In this review, the various pharmacological activities of C. longa might be attributed to the presence of numerous bioactive compounds. However, these varying potentials have not been effectively analysed for optimal application in developing new therapies.***
Keywords: Phytochemicals, turmeric, spices, curcuma, pharmacological activities.

I. INTRODUCTION

Turmeric (Curcuma longa) is a widely used medicinal plant belonging to the family Zingiberaceae and is extensively cultivated throughout India. It is well-known for its broad range of therapeutic applications, which are primarily attributed to its rich content of secondary metabolites. Among these, curcuminoids such as curcumin, demethoxycurcumin, and bisdemethoxycurcumin are considered the major bioactive compounds. Over recent decades, a wide spectrum of pharmacologically significant properties of turmeric and its constituents has been reported, including anti-inflammatory, antioxidant, antimicrobial, and anticancer activities. Numerous studies have investigated the pharmacological mechanisms underlying these effects, revealing that turmeric exhibits exceptionally diverse biological activities. Increasing evidence suggests that the health benefits of turmeric are not due to a single compound, but rather the result of additive or synergistic interactions among its various phytochemicals. Regular dietary intake of such phytochemical-rich substances may contribute to both the prevention and treatment of various diseases. A critical review of available preclinical and clinical data indicates that turmeric is pharmacologically versatile and holds immense potential for development into novel therapeutic agents or standardized Phyto-pharmaceutical products. The aim of this review is to compile and evaluate current scientific findings on turmeric, with a view toward exploring its full therapeutic potential [1].

1) Biological Source: Turmeric obtained from the rhizome of Curcuma longa linn. (curcuma domestic valeton) belonging to the natural Family Zingiberaceae.
2) Geographical source: It is commonly found in Cambodia, China, India, Nepal, Indonesia, Madagascar, Malaysia, Philippines and Vietnam.
3) Indian scenario: It is commonly found in West Bengal, Tamil Nadu, and Maharashtra and also in Madras.

II. TAXONOMY

Family	Zingiberaceae
Scientific Name	Curcuma Longa
Kingdom	Plantae
Subkingdom	Tracheobionts
Order	Zingiberales
Genus	Curcuma
Division	Mangoliophyta
Super Division	Spermatophyta
Species	Longa

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III. DESCRIPTION

Turmeric (Curcuma longa) is a perennial herb and member of the zingiberaceae family and is cultivated extensively in Asia, India, China, and countries with a tropical climate. It grows to a height of 3–5 ft and has large oblong leaves and funnel-shaped yellow or white flowers. The rhizome has a long history of culinary and medicinal use. Descriptions of turmeric use could be found as early as 650 BC in writings by Assyrians who used turmeric as a spice and coloring dye. The Chinese and Ayurvedic (Indian) systems of medicine list turmeric as an ingredient used to treat various illnesses such as rheumatism, body ache, skin diseases, intestinal worms, diarrhea, intermittent fevers, hepatic disorders, biliousness, urinary discharges, dyspepsia, inflammations, constipation, leukoderma, amenorrhea, and colic [2].

1) Plant Type: Turmeric is a perennial, herbaceous, and rhizomatous plant.
2) Growth Habit: Individual plants can grow to about 1 meter (3 feet) in height, with long, oblong leaves.
3) Rhizome: The plant is harvested for its tuberous, segmented rhizomes, which have a rough, yellowish-brown skin with a dull orange interior.
4) Color: The primary active compound, curcumin, is a polyphenol responsible for the bright yellow color of the spice.

IV. HABITAT AND CULTIVATION

Before turmeric can be used, the turmeric rhizomes must be processed. Rhizomes are boiled or steamed to remove the raw odor, gelatinize the starch, and produce a more uniformly colored product. In the traditional Indian process, rhizomes were placed in pans or earthenware filled with water and then covered with leaves and a layer of cow dung. The ammonia in the cow dung reacted with the turmeric to give the final product.

For hygienic reasons, this method has been discouraged. In present-day processing, rhizomes are placed in shallow pans in large iron vats containing 0.05–0.1% alkaline water (e.g., solution of sodium bicarbonate). The rhizomes are then boiled for between 40–45 minutes (in India) or 6 hours (in Hazare, Pakistan), depending on the variety. The rhizomes are removed from the water and dried in the sun immediately to prevent overcooking. The final moisture content should be between 8% and 10% (wet basis). When finger tapping of the rhizome produces a metallic sound, it is sufficiently dry. The dried rhizomes are polished to remove the rough surface. Sometimes, lead chromate is used to produce a better finish, but for obvious reasons this practice should be actively discouraged. The powder maintains its coloring properties indefinitely, although the flavor may diminish over time. Protecting the turmeric powder from sunlight retards the rate of deterioration.[3]

Origin: Turmeric is native to the Indian subcontinent and Southeast Asia.

Climate: It thrives in tropical climates with temperatures between 20 and 30°C (68–86°F) and high annual rainfall.

Distribution: Wild turmeric is found throughout India and other parts of South Asia. It is also cultivated in China, Indonesia, Malaysia, Thailand, Cambodia, and Vietnam.

Growth Cycle: The perennial foliage dies back in late autumn, and the rhizomes remain dormant until the next growing season, typically during the summer monsoon.

V. CHEMICAL CONSTITUENTS

The main constituent groups are poly phenolic curcuminoids which include: curcumin (diferuloylmethane), demethoxy curcumin, bisdemethoxycurcumin, and cyclo curcumin. Curcumin (3-4%) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%). The yellow-pigmented curcuminoids represent 2% -5% of the root, typically composed of 85% as curcumin, 10% as demthoxy curcumin and 5% as disdemethoxy curcumin. Curcumin is the wellstudied constituent. Turmeric also contains: sesquiterpene, (6S)-2-methyl-6-(4- hydroxyphenyl-3-methyl)-2-hepten-4-one (turmerone, atlantone, zingiberone, turmeronol, germacrone, and bisabolene), carbohydrates, protein, resins, and caffeic acid [4]. The main chemical components are phenolic compounds and terpenoids have been identified, including di-aryl heptanoids (curcuminoids), diarylpentanoids, monoterpenes, sesquiterpenes, diterpenes, triterpenoids, alkaloids, and sterols. Curcumin (60%), desmethoxycurcumin, monodemethoxycurcumin, bisdemethoxycurcumin, dihydrocurcumin and cyclocurcumin. The essential oil (5.8%) obtained by steam distillation of rhizomes has aphelladrene (1%), sabinene (0.6%), Cineol (1%), borneol (0.5%), Zingiberene (25%) and sesquiterpines (53%). Curcumin(diferuloylmethane) (3-4%) is responsible for yellow color and comprises of curcumin I (94%), curcumin II (6%) and curcumin III (0.3%). Demethoxy and bis-demethoxy derivatives of curcumin have also been isolated [5, 6].

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VI. TRADITIONAL USES

It is an essential substance to purify the gum resin of Commiphoramukul (Guggul) before it is made use of in ayurvedic formulations. In veterinary medicine, turmeric is used to heal wounds or ulcers of animals. Turmeric powder is used as an insect and ant repellant and sprinkled around the vessels to be protected. Turmeric and its constituents play an important role in our life. Turmeric has been found to have a hepatoprotective characteristic similar to that of silymarin. The volatile oils and curcumin and turmeric exhibit potent antiinflammatory effects. Constituents of turmeric exert several protective effects on the gastrointestinal tract. Constituents of turmeric affect Alzheimer's disease. Extract of turmeric suppresses symptoms associated with arthritis. Turmeric and its extract inhibit angiogenesis. Turmeric constituents can induce radioprotection. Turmeric constituents inhibit proliferation of vascular smooth muscle cell. Turmeric lower serum cholesterol levels. · Constituents of turmeric block the replication of HIV [7].

VII. PHARMACOLOGICAL PROPERTIES

1) Alzheimer's disease: The ability of curcumin to scavenge free radicals has shown that it is able to outperform vitamin E (α-tocopherol) and tetrahydro curcumin. The studies proved that the connection between curcumin and AD is the blood-brain-barrier (BBB), Curcumin was shown to be able to cross the BBB and prevent disruption and degradation of the BBB by preventing damage from ONOO. These studies suggest that curcumin may be able to serve as an indicator of Alzheimer's disease by identifying A β plaques. Curcumin may inhibit A β plaque formation indirectly as well through macrophages [8].
2) Analgesic activity: The powdered rhizome is effective in the treatment of sprain and inflammation. Turmeric paste mixed with a little lime and salt peter and applied hot is a popular application to sprains [9].
3) Anti-bacterial activity: Antibacterial activity of all leaf and rhizome extracts was tested. Promising use of turmeric rhizome essential oil as a novel natural effective antibacterial agent for the prevention and treatment of boils infections instead of the chemical drugs. Future clinical trials on the infected animals and humans (in vivo) are required to support the obtained outcomes [10]
4) Anti-cancerous activity: It is now proved that the antioxidants present in turmeric neutralize carcinogenic free radicals. It is evaluated and proved the anticancer activity of turmeric. The antioxidant and antitumor promoting effects of curcumin were shown to be due to the induction of apoptosis in human leukaemia cells, and this aspect was studied and positively proved. Supporting investigation on the specific inhibitory effect of cyclooxygenase (cox) - 2 by dietary curcumin in human colon cancer cells. Curcumin has showed a suppressive effect on human breast carcinoma cells [11].
5) Anti-coagulant property: The anticoagulation activity of curcumin has shown that curcumin extends the blood clotting times as proved by prothrombin time, thrombin time and activated partial thromboplastin time analysis in comparison with the control bloodsample. Curcumin and its derivative (bisdemethoxycurcumin) has prolonged activated partial thromboplastin time and prothrombin time significantly and inhibited thrombin and activated factor X activities [12].
6) Anti-diabetic activity: Oral administration of the aqueous rhizome extract of Curcuma longa to the diabetic rats significantly reduced the level of TG, TC, and LDL and significantly increases the level of HDL. The results suggest that aqueous extract of Curcuma longa rhizome possesses potential therapeutic value in combating atherosclerosis, which is one of the major complications of diabetes by lowering serum lipids particularly total cholesterol, triglyceride and low density lipoprotein level [13].
7) Anti-fertility activity: Turmeric is reported to possess anti-fertility activity, as observed in experimental animals. Petroleum ether and aqueous extracts produced 100% anti-implantation effects in rats at a dose of 200 mg/kg body weight fed orally on the first to seventh day of pregnancy. Studies showed the effect of curcumin as a potential vaginal contraceptive and found that it inhibited human sperm motility and had the potential for the development of novel intra vaginal contraceptive. The test results indicated that curcumin had a selective sperm-immobilizing effect in addition to a previously studied antihuman immunodeficiency virus (HIV) property. Investigation showed the contraceptive effect of turmeric in male albino rats and observed a reduction in sperm motility and density in treated group. Turmeric is supposed to have affected the androgen synthesis, either by inhibiting the Leydig cell function or hypothalamus pituitary axis, thereby inhibiting the spermatogenesis [14].
8) Anti-Hyper lipidemic: Turmeric, as well as curcumin, is reported to reduce the uptake of cholesterol from the gut and increase the high-density lipids (HDL) cholesterol and decrease low-density lipids (LDL) type. It can also inhibit the peroxidation of serum LDL, which can lead to atherosclerotic lesions. It is reported that the levels of serum cholesterol and liver cholesterol decreased to one-half, while cholesterol-fed rats were treated with curcumin [15].

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9) Anti-inflammatory activity: Inflammatory changes of joints are often associated with rheumatic complaints. Turmeric is attributed with hot potency and antiinflammatory action. It cures the etiological factors and pathological changes of inflammation. It was further reported that oral doses of curcumin possess significant antiinflammatory action in both acute and chronic animal models [16].

10) Antioxidant activity: Curcumin has been shown be a powerful scavenger of oxygen free radicals. Its antioxidant activity is comparable to vitamins C and E. It can protect lipids or hemoglobin from oxidation. It can significantly inhibit the generation of reactive oxygen species (ROS) such as H2O2, superoxide anions and nitrite radical generation by activated macrophages. Its derivatives, bis-demethoxycurcumin and demethoxycurcumin also have antioxidant activities. Curcumin pre-treatment has been shown to decrease ischemia-induced oxidative stress and changes in the heart. An in vitro study measuring the effect of curcumin on an inducible stress protein, resulted in enhanced cellular resistance to oxidative damage [17].

11) Cardio protective activity: Curcumin, the main bioactive compound in these plant extracts increases the cardiac glutathione content, suggesting that it may augment the action of these naturally occurring sulfhydryl groups to maintain membrane integrity with concomitant decrease of enzymes leakage from the cardiocytes, protection of cardiac tissue from damage [18].

12) GIT protective activity: Turmeric is a traditionally used spice. In the digestive system, turmeric acts as a carminative and protective against intestinal gas formation. Turmeric acts as anti-flatulent, digestive, and stimulant due to its hot potency (as per ayurveda). It is reported to have anti-spasmodic activity, inhibiting excessive peristaltic movements of the intestine [19].

13) Healing property: Skin care Oil of turmeric have proved to be antifungal, anti-protozoan, antiviral, and antibacterial. In a screening for antibiotic property, turmeric showed broad-spectrum antibacterial activity. Polyphenols, terpenoids present in curcumin fights against free radicals and its high antioxidant content is responsible for healiing property and protects skin [20].

14) Hepatoprotective activity: Turmeric is considered good for afflictions of the liver. Turmeric is effective in treatingjaundice and is recommended in the diet of patients suffering from jaundice or even infective hepatitis [21].

15) Respiratory diseases: Turmeric is well accepted as a Kaphahara drug (phlegmatic conditions are termed as “Kapha” and that which cures it is Kaphahara). Turmeric is anti-inflammatory and anti-purulent in nature. It is reported that volatile oil of turmeric as oral drug in a clinical trial was found very effective in the treatment [22].

16) Rheumatoid Arthritis: In a preliminary double-blind, Randomized Controlled Trial (RCT), curcumin was compared to phenyl butazone in patients with rheumatoid arthritis. Curcumin given at 1200 mg daily was effective in improving joint swelling, morning stiffness, and walking time [23].

VIII. CONCLUSION

Curcuma longa (turmeric) offers significant therapeutic potential due to its diverse pharmacological properties, including anti-inflammatory, antioxidant, antimicrobial, and anticancer effects, largely attributed to its active component, curcumin. In this review, Studies demonstrate its promise effect for managing conditions like Alzheimer’s disease, analgesic, antibacterial, respiratory disease, rheumatoid arthritis, though further review for turmeric is needed to optimize for its uses and pharmacological potential.

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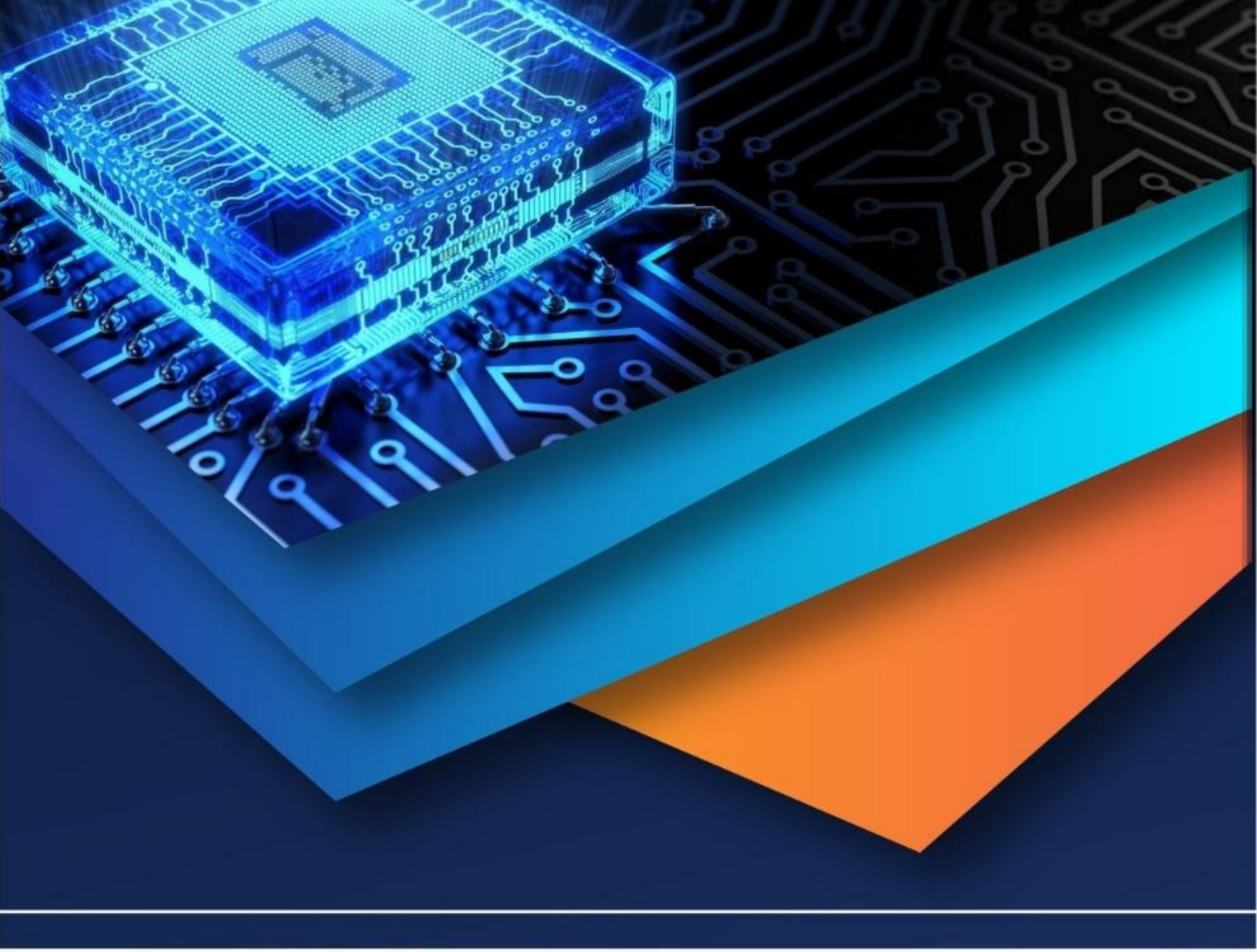

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