IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Curcuma Longa (Turmeric): Ethnomedicinal Uses, Chemistry, Morphology And Pharmacological Activities —A Review

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Abstract:

Curcuma longa L. is a member of the ginger family (Zingiberaceae) and is widely used by traditional healers to treat a wide range of ailments. Because of its high curcumin content, Indian turmeric is especially popular in compared to other countries. Curcuma longa rhizomes are commonly referred to as Haldi or Turmeric. Rhizomes are underground horizontal stems that produce both shoots and roots. Turmeric includes curcuminoids, which are fat-soluble polyphenolic pigments. The most important of these is curcumin (deferulolyl methane), which is responsible for the yellow colour of Indian curries; others are demethoxy curcumin and bisdemethoxy curcumin. Turmeric, commonly known as 'Indian saffron,' is a natural antibacterial agent. Turmeric contains nutritional as well as therapeutic benefits. Turmeric contains phytochemicals, making it a therapeutic plant Nonnutritive plant compounds (phytochemical components) can prevent illness. Turmeric root powder is used for its flavouring properties as a spice, dietary medicine, and for a variety of critical therapeutic advantages. Many studies have been undertaken on morphology, phytochemical profiles of the entire plant, and other qualities that have been recorded and documented. This paper seeks to describe turmeric's uses, botanical description, taxonomical categorization, phytochemical constituents, and pharmacological activities, as well as current research developments.

Keywords: ***Curcuma longa, Taxonomical Classification, Curcumin, Turmeric, Phytochemistry, Pharmacological activities, Ethnomedicinal properties***

INTRODUCTION-

For thousands of years, natural products have been employed in traditional medicine, and they have showed promise as a source of components for the development of novel pharmaceuticals. [Newman 2003] Turmeric is a Zingiberaceae (ginger) family herbaceous evergreen plant [B.T. Tung, D.T. Nham 2010] It is widely grown in Asia, primarily in India and China. Turmeric, which is said to have originated in India, has been used for at least 2500 years. The turmeric plant grows throughout the tropics and subtropics of the world. The plant's origin is unknown, however it is assumed to have originated in south-east Asia, most likely in India. The plant is grown in every corner of India. [Kapoor 2000].

Turmeric powder is often used in curries and mustards as a colouring and flavouring agent. Turmeric has traditionally been used to preserve mouth hygiene in India. [TP Chaturvedi 2009] For millennia, it has been used for medical purposes in nations such as India and China to cure jaundice and other liver disorders. [Mukerjee A, Vishwanatha2009] [Perko T, Ravber2015]

The majority of the World's supply is produced in India [Leung and Foster, 1996], although turmeric is also grown in southern China, Taiwan, Japan, Burma, and Indonesia, as well as throughout the African continent. Turmeric use has expanded in Brazil, owing mostly to its colourant properties and ability to enrich meals. [Neghetini et al., 2006].

The commercially accessible substance (turmeric powder) in Europe comes primarily from India and, to a lesser extent, from other south eastern Asian countries. It is especially prevalent in southern Asia, particularly India. Turmeric is a sterile plant that does not bear seeds. The shrub can reach a height of 3-5 feet and produces dull yellow blooms. [Murugananthi et al., 2008]

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Since the birth of civilization, medicinal plants have been a reliable source for the development of new pharmaceuticals as well as the treatment of ailments. An exhaustive review of the literature found that Curcuma turmeric is widely recognised as a universal panacea in herbal therapy, with a broad range of pharmacological acidities. [Nasri et al., 2014].

A number of pharmacological properties, including anticancer activity, of turmeric compounds have been described. [Nair, K.P.P2013] [Basnet, P.; Skalko-Basnet2012]. The majority of them demonstrated the pharmacological actions of curcumin, the main active component present in turmeric rhizome, and turmeric oil was also mentioned. [Atsumi, T.; Tonosaki2007] [Yue, G.G.; Chan2020]

It contains antioxidant effects and is beneficial in illnesses such as inflammation, ulcers, and cancer. The presence of numerous metabolites, such as curcuminoid, oil content, flavonoids, phenolics, some essential amino acids, protein, and a high alkaloid content, suggests a link between its medicinal properties. [Sarangthem and Haokip, 2010].

Botanical description-

Curcuma longa belongs to the Zingiberaceae family. It is a perennial herbaceous plant with tall leafy branches bearing up to twelve (12) leaves that can grow up to two metres in height. The leaves are oblong or lanceolate, up to 1 m long, and dark green from above and pale green from below. The sheath and petiole are about the same length as the blade. Curcuma longa has a sterile, pale yellow and reddish bloom, with a green and purplish flowering bract. [S. Fuloria, J. Mehta2022] [B. Jyotirmayee, G. Mahalik2022]. Curcuma longa has a rhizome that grows underground. The plant is mostly grown for its rhizome, which has tough segmented skins. [S. Prasad, B.B. Aggarwal 2011]. The rhizome can grow to be 2.5-7.0 cm long and 2.5 cm in diameter. The rhizome has a pleasant aroma and a bitter taste. Curcuma longa plants are grown in the tropics and subtropics at temperatures between 20 and 30 degrees Celsius, with adequate rainfall. [K. Karłowicz-Bodalska2017].

Geographical Distribution-

Curcuma longa (Turmeric) is native to India and is widely available in the following countries: Andaman Islands, Assam, Borneo, Bangladesh, Belize, China South-Central, China Southeast, Cambodia, Caroline Islands, Cook Islands, Costa Rica, Cuba, Comoros, Congo, Nigeria, Dominican Republic, East Himalaya, Easter Islands, Fiji, Gilbert Islands, Guinea Bissau, Gulf of Guinea Islands, Haiti, Hawaii, Ivory Coast, Jawa, Leeward Islands, Lesser Sunda Islands, Malaya, Marquesas, Mauritius, Myanmar, New Caled. [Eigner D, Scholz D]

Scientific classification-

- Kingdom - Plantae
- Sub-kingdom - Tracheobionta
- Super division - Spermatophyta
- Division - Magnoliophyta
- Sub-class - Zingiberidae
- Order - Zingiberales
- Family - **Zingiberaceae**
- Genus - Curcuma

- Species - Longa
- Scientific name - **Curcuma longa**

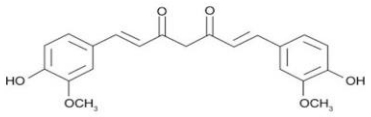
Chemistry-

Turmeric's chemical composition Turmeric's chemical composition is diverse. Turmeric's qualitative and quantitative components vary greatly depending on variety, region, source, and cultivation conditions. [Heath DD, Khwaja F2004] This spice has yielded approximately 235 chemicals, the majority of which are phenolic compounds and terpenoids. There are 22 diarylheptanoids and diarylpentanoids among these chemicals, as well as phenylpropene and other phenolic compounds, sesquiterpenes, diterpenes, triterpenoids, sterols, monoterpenes, alkaloids, and other compounds. Turmeric's main bioactive components are curcuminoids, which belong to the diarylheptanoids group. Curcumin, the most common curcuminoid found in turmeric, has been used medicinally for thousands of years. Curcumin (71.5%), demethoxycurcumin (19.4%), and bisdemethoxycurcumin (9.1%) are the three curcuminoids often found in commercial curcumin. [Pfeiffer, E., Hhle, S., Solyom2003].

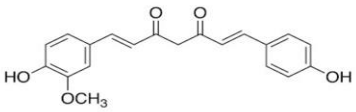
Turmeric has also yielded three diarylpentanoids having a five-carbon chain between two phenyl groups. Other phenylpropene and phenolic substances discovered from turmeric include calebin-A, vanillic acid, and vanillin. Monoterpenes are commonly found in essential oils extracted from plants and flowers. [Li, S. Y., Yuan, W 2011] Turmeric contains the following monoterpenes: p-cymene, -phellandrene, terpinolene (terpenoline), p-cymen-8-ol, cineole, and myrcene. Dried turmeric rhizomes typically yield 1.5-5% essential oils, the majority of which are sesquiterpenes, which are responsible for the fragrant flavour and smell. Turmeric's most frequent sesquiterpenes are -turmerone, -turmerone, turmeronol A, and turmeronol B. [Golding BT, Pombo-Villar E]

Structure of Chemical Constituents-

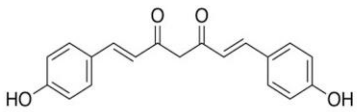
A. Diarylheptanoids



1.Curcumin

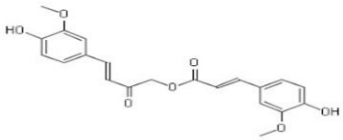


2.Demethoxycurcumin

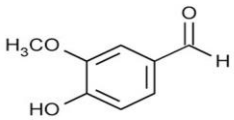


3.Disdemethoxycurcumin

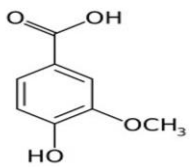
B. Phenolic compound



1.calebin-A

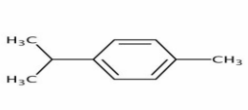


2.vanillin

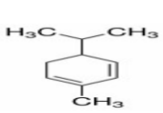


3.Vanillic acid

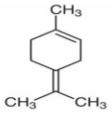
C. Monoterpenes



1.P-cymene

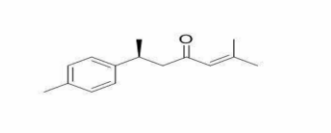


2.Phellandrene

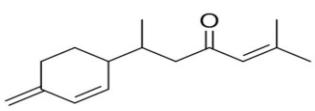


3.Terpinolene

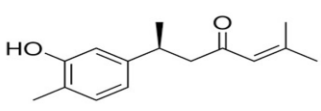
D. Sesquiterpene



1.a-Turmerone



2. β-Turmerone



3.Turmeronol A

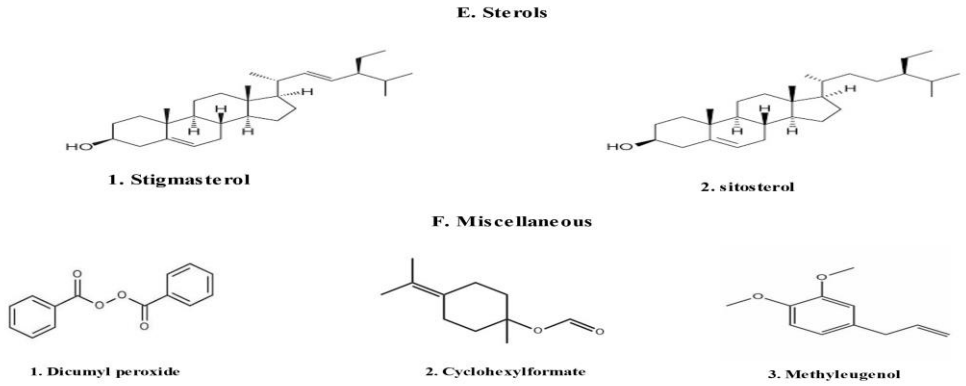


Fig: structure of chemical constituent of turmeric [Golding, B., Pombo]

MORPHOLOGY OF THE PLANT-

Fig.1 Turmeric plant

Fig.1 Turmeric flower

Fig.3 Turmeric powder

Fig.3 Turmeric Rhizome

A. Roots:

Root initials emerge from the diffuse meristem, a narrow cell zone dividing the inner and outer ground tissues that is an outgrowth of the primary elongating meristem and seen below the second or third node. The diffuse meristem gives rise to the root meristem. Turmeric's root apex has three sets of initials growing from the diffuse meristem, one for the root cap, one for the plerome, and a shared zone of dermatogens and plerome. [Raju and Shah 1975].

B. Flowers:

With a pale yellow and reddish border, the flower is smaller than the bracts. Calyx: 10-15 mm length, obtuse, with three teeth Long tubular corolla with pale yellow lip - 3 lobed semi-elliptic. The flowers are around 5 cm long, thin-textured, and fugacious. The calyx is small, tubular, and toothed, with a break almost midway down one side. The corolla is tubular at the base and cup-shaped in the upper part, with three unequal lobes inserted on the cup lip. It is pale, slender, and translucent, with a hooded dorsal lobe. [Nazeer et al. 1993; Purseglove et al. 1981]

C. Fruit and seed:

The ripe fruit, which is white in coloration, resembles a little garlic bulb. Immature seeds range in colour from white to light brown, while mature seeds are brownish black. Different seeds originating from the same fruit occasionally revealed embryos at various stages of development. The embryos were obviously monocotyledonary, like cardamom embryos in structure. The nucellus was still present in the mature seed. [Nair et al. 2004].

D. Leaves:

The leaves are borne in tufts and are alternating, obliquely erect, or subsessile, with long leaf stalks or sheaths forming a pseudo stem or aerial shoot. The leafy shoots are erect and rarely reach 1 m in height. A leafy sprout will typically have 6-10 leaves. The slender petiole broadens abruptly to the sheath. The ligule lobes are tiny, and the sheaths surrounding the ligules have ciliate margins. The lamina is lanceolate, acuminate, and thin, dark green above and pale green beneath, with pellucid spots; it can grow to be up to 30 cm long and 7-8 cm wide, and seldom grows to be more than 50 cm long. [Purseglove et al. 1981].

E. Nodes and Internodes:

Mature mother rhizomes can have 7 to 12 nodes and an intermodal length of 0.3 to 0.6 cm. The first few internodes at the proximal end, however, are extended, allowing the mother rhizome to reach ground level. When compared to mother rhizomes, primary and secondary fingers have internodes that are around 2 cm 2.6 Morphology of Turmeric 17 longer. Except for the first or two, all nodes in the mother rhizome and fingers bear axillary buds. Only scale leaves are present on the secondary and tertiary branches. Negative geotropic growth branches have pointy scale leaves or sheath leaves. (Shah and Raju 1975)

F. Aerial Shoot:

The foliage leaves develop from the buds on the axils of the underground bulb's nodes, as well as from the major finger. The foliage leaf's petiole is lengthy and has a thick leaf sheath. The aerial shoot is formed when the lengthy leaf sheaths overlap. [Ravindran et al. 2007]

G. Shoot Apex:

The shoot's apical meristem features a tunica-corpus structure. The tunica is two-layered, with cells dividing anticlinally, whereas cells divide in all directions in the corpus, which is the region proximal to the tunica. The rib meristem is the centre region beneath the corpus layer that gives rise to a file of cells that later becomes the ground meristem. The flank meristem, which produces the procambium, cortical area, and leaf primordium, surrounds the central region. [Ravindran et al. 2007].

H. Rhizome:

The underground stem of turmeric is known as the rhizome. Most of the time, there is only one major axis. A whole finger or a mother rhizome is used as planting material. It is often referred to as the "seed rhizome." The rhizome seed only generates one main axis, which develops into the aerial leafy shoot. The base of the main axis extends and creates the initial rhizome unit, which eventually grows into the mother rhizome. [Ahmed SR, Siddiq2009]

Pharmacological Properties of Turmeric-

A. Antidiabetic Effect-

A hexane extract (containing ar-turmerone), an ethanolic extract (containing ar-turmerone, curcumin, demethoxycurcumin, and bisdemethoxycurcumin), and an ethanolic extract from the hexane extraction residue (containing curcumin, demethoxycurcumin, and bisdemethoxycurcumin) were found to stimulate adipocyte differentiation dose-dependently. According to the findings, turmeric ethanolic extract containing both curcuminoids and sesquiterpenoids is more hypoglycemic than either curcuminoids or sesquiterpenoids alone. [Nishiyama T, Mae T 2005] [R. Essa, A.M. El Sadek, M.E. Baset]

The insulin change was substantially higher 30 and 60 minutes following the OGTT with C. longa. The insulin AUCs were likewise considerably greater after C. longa ingestion following the OGTT. [Wickenberg J, Ingemansson SL 2010]

B. Hepatoprotective properties –

Turmeric has been shown in studies to protect the liver from a range of hepatotoxic insults, including carbon tetrachloride (CCl4), galactosamine, and acetaminophen (paracetamol). [Rao CV, Desai D,]. Turmeric's hepatoprotective qualities are mostly due to its antioxidant characteristics as well as its ability to inhibit the generation of proinflammatory cytokines. Curcumin supplementation dramatically reduced liver damage. [Ruby J, Kuttan G,] [H.Y. Lee, S. W. Kim, G.-. H. Lee]

Turmeric lowered Aspergillus parasiticus infection and suppressed fungal aflatoxin formation by 90%. Aflatoxin-induced biliary hyperplasia, lipid alterations, and necrosis were likewise reversed by turmeric and curcumin. Sodium curcuminate, a curcumin salt, also has choleretic characteristics since it increases biliary excretion of bile salts, cholesterol, and bilirubin, as well as bile solubility, potentially preventing and treating cholelithiasis. Curcumin also protects cells from paracetamol-induced lipid peroxidation. This could be due to the antioxidative characteristics of curcumin's phenolic groups. [Park EJ, Jeon CH,2000].

C. Anti-cancer property-

Anti-cancer properties Animal studies show that inhibition occurs at all three stages of carcinogenesis: initiation, promotion, and progression. Curcumin regulates transcription factors that control phase I and II carcinogen detoxification during initiation and promotion.; [Garg R, Gupta S 2008] downregulates proinflammatory cytokines, free radical-activated transcription factors, and the

vicyclo oxygenase and lipoxygenase pathways involved in arachidonic acid metabolism; and scavenges free radicals [Hong J, Bose M, Ju J2004]. Curcumin has been shown in animal experiments and in vitro research using human cell lines to suppress carcinogenesis at three stages: tumour promotion, angiogenesis, and tumour growth. [Shao ZM, Shen ZZ,2002] [T. Jia, L. Zhang, Y. Duan2014]

Turmeric and curcumin have been shown in both in vitro and in vivo studies to reduce the effect of several prevalent mutagens and carcinogens in a variety of cell types. Turmeric and curcumin are anticarcinogenic due to their direct antioxidant and free-radical scavenging properties, as well as their potential to indirectly boost glutathione levels, assisting in hepatic detoxification of mutagens and carcinogens, and blocking nitrosamine production. Curcumin also kills cancer cells and inhibits angiogenesis. [Thaloor D, Singh AK 2001].

The effectiveness of turmeric extract in decreasing chemically-induced tumours was investigated. When compared to controls, the use of curcumin and turmeric extract during carcinogenesis and promotion resulted in fewer papilloma creation. This suggests that the greatest characteristics of curcumin and turmeric extract are produced during tumour promotion. [Khar A, Ali AM, Pardhasaradhi BV 2001]

D. Anti-microbial properties

Turmeric extract and essential oil of Curcuma longa suppress the growth of a variety of bacteria, parasites, and harmful fungi. Turmeric-enriched meals were observed to reduce small intestine lesion scores while enhancing weight gain in chicks infected with the caecal parasite Eimera maxima. [HB Rasmussen, SB Christensen] Another study discovered that applying turmeric oil topically to guinea pigs infected with dermatophytes, pathogenic moulds, or yeast suppressed dermatophyte and pathogenic fungus growth. Seven days after turmeric treatment, lesions in guinea pigs infected with dermatophytes and fungus improved and eliminated. Curcumin also exhibits anti-Plasmodium falciparum and anti-Leishmania major organism action. [et. L Allen PC Danforth 2001]

Antifungal, antibacterial, phytotoxic, cytotoxic, and insecticidal properties of an ethanolic extract of turmeric were investigated. Trichophyton longifusus and Microsporum canis were resistant to the extract's antifungal and antibacterial properties, but not Staphylococcus aureus. Lemna minor was discovered to be poisonous. [Rasmussen HB2000]

E. Anti-depressant properties-

Curcuma longa extract restored the decrease in serotonin, and dopamine concentrations while increasing serotonin turnover, cortisol levels, and serum corticotrophin-releasing factor. [Xia X, Cheng G, 2002].

The effect of curcumin was investigated in a chronic moderate stress (CMS) paradigm. CMS-treated rats consume much less sucrose and have greater levels of IL-6, TNF, CRF, and cortisol than control rats. Treatment with ethanolic extract restored sucrose intake to normal control levels, reduced the CMS-induced increase in blood IL-6 and TNF- levels, and restored CRF levels to normal levels in serum and the medulla oblongata. It also returned blood cortisol levels to normal. Turmeric has antidepressant properties that are mediated through the inhibition of monoamine oxidation.

F. Cardiovascular diseases -

Turmeric has been shown to reduce cholesterol and triglyceride levels, reduce LDL susceptibility to lipid peroxidation, and prevent platelet aggregation. Turmeric extract lowered LDL lipid peroxidation susceptibility while also reducing plasma cholesterol and triglyceride levels. [Wing RR, Lang W2011]

Turmeric extract has been shown to reduce cholesterol levels via lowering cholesterol uptake in the intestines and increasing cholesterol conversion to bile acids in the liver. It is hypothesised that C. longa components reduce platelet aggregation by enhancing prostacyclin synthesis and lowering thromboxane synthesis. [Srivastava R]

Traditional/Ethnomedicinal uses-

Curcuma species are used to treat pneumonia, bronchial problems, leucorrhoea, diarrhoea, dysentery, infectious wounds or abscesses, and insect bites in Asian nations such as Bangladesh, Malaysia, India, Nepal, and Thailand. [J. jabaco2016] Turmeric is used in both traditional and modern Indian medicine to cure jaundice, rheumatism, cough, and a variety of other ailments. [H.P. Ammon, M.A. Wahl 1991]. Vaughn reported curcumin's use in treating obesity and inflammation, emphasising its maximum ethnomedicinal efficacy in India. Powdered C. longa extract is used to treat acne and wounds in Pakistan. [Z. Ayati, M. Ramezani2019].

Singh et al. [G. Singh, I. Kapoor2010] reported in an ethnomedicinal survey in Nepal that paste made from the rhizome of C. longa might be used to treat wounds and injuries. The juice extracted from its leaves is antihelmintic and acts as a blood purifier. [G. Singh, I. Kapoor, P. Singh2010]. In the Philippines, the juice extracted from powdered C. longa is also used to cure arthritis. [R. Abe, K. Ohtani2013] Curcuma longa leaves are utilised in facial massages and the treatment of arthritis in Iraq's Kurdish minority. Simultaneously, the anticancer activity of the rhizome decoction has been reported. [H.M. Ahmed2016].

Curcumin, derived from the rhizomes of Curcuma longa, has been recognised as a traditional cure for a wide range of ailments and is also used by a variety of societies, most notably the Asian population, with applications extending back over 2500 years. [S.C. Gupta, S. Patchva2013]

Credit author statement

Swapneel Suryawanshi- Investigation, writing the initial draft, reviewing & editing the manuscript, visualization with the figures.
Pravin Badhe: Guidance, rechecking the data and literature manuscript.

Declaration of Competing Interest

The authors state that they have no relevant financial relationships with any companies or organisations and have no conflicts of interest.

Acknowledgment

This work was supported by the Sinhgad College of Pharmacy, Pune & Principal Dr. R.B. Patil, I would like to give heartfelt thanks to Dr. Pravin Badhe & Divya Thite for providing Help required to carry out my work

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