

Chapter 48

Curcuma longa L: A Promising Drug against Respiratory Disorders

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ABSTRACT

Spices and herbs have used since historic times to improve the flavor of edible food. Apart from this, these are also utilized to prevent and treat chronic health conditions. Turmeric is a well-known culinary spice and also herbal remedy. For many centuries, turmeric (*Curcuma longa* L.) has been utilized to add color and flavor to the food. Along with this, it has been utilized in traditional healing practices to treat skin diseases, digestive disorders, wounds and respiratory problems in India and China. Turmeric has been extensively used traditionally for respiratory and gastrointestinal problems like cough, cold, asthma, throat irritations, flatulence and chronic diarrhea. Because of the existence of various chemical components (such as proteins, starch, vitamins, volatile oils, curcuminoids and curcumin), this plant is considered to have the potential to act like a medicinal plant and having a broad range of pharmacological characteristics. Many phytochemicals are present in turmeric. Curcumin (diferuloylmethane) is the active constituent of turmeric which possesses many therapeutic qualities. While, the defensive actions of this constituent of turmeric were examined in various pulmonary diseases like chronic obstructive pulmonary disorder (COPD), acute respiratory distress syndrome (ARDS), pulmonary fibrosis and asthma in animal studies. The administration of powder of turmeric by oral route notably alleviated cough and asthma. Also, fresh rhizomes appeared to be efficient against dyspnea, whooping cough and other coughs. Over the last 50 years, the safety, efficacy and pharmacokinetics of curcumin have been studied widely in clinical evaluations. Curcumin has less solubility, stability and bioavailability. Researchers are now struggling to solve all these issues by modifying it and also checking it by combinational therapeutics.

KEYWORDS

Inflammation, Turmeric, Curcumin, Treatment, Curcuminoids

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Introduction

Throughout the human history, natural products from plants have been utilized for several reasons. Having co-evolved with animal life, these natural products are acquired from plants which are billions of years old. Higher plants form many of these substances as secondary metabolites for their natural defense against infection and disease. Several of the natural plant products possess biological or pharmacological properties which can be utilized in pharmacological discovery of drug and its design. Plant originated medicines retain a significant part in the health maintenance of different cultures, including modern as well as ancient cultures. Ayurveda which is known as the Indian system of holistic medicine mainly utilizes plant derived formulations or drugs to treat a number of diseases including cancer (Prasad and Aggarwal, 2011). Valuable effects of herbs or spices involve antioxidant, anti-inflammatory, gluco-regulatory, anti-thrombotic and anti-hypertensive actions. Polyphenols are one of the main component of spices and herb. Few of the above mentioned characteristics are associated with polyphenols and they are involved with the attenuation of metabolic syndrome (Panickar, 2013).

Curcuma longa Linn. (*C. longa*), also commonly named as turmeric is a member of the Zingiberaceae family. It has an extensive history of possessing therapeutic qualities against several ailments. In Ayurveda as well as Unani medicine, *Curcuma longa* has been employed for jaundice and obstruction of liver as well as applied for inflammation and ulcers externally. In addition to this, it is used as an antiseptic and for many other problems such as cold, cough, asthma, bronchitis, indigestion, dental issues, blood purification, skin infection, wounds, tumor, and hepatic disorders. *C. longa* possesses curcumin which is its principle constituent. Curcumin is popularly known because of its therapeutic ability

against various diseases (Fuloria et al., 2022). The major route for the administration of *C. longa* is by oral administration. Apart from this, it can be used either through inhalation or topically. It can be applied topically to treat wounds, bruises, boils, blistering, acne, eczema, ulcers, parasitic infection, hemorrhages, skin diseases and insect bite (Labban, 2014). Curcuminoids, borneol, zingiberine, sabinene, phellandrene, cineol, sesquiterpenes as well as essential oils are present. Other than this, turmeric also possesses carbohydrates, proteins, fats, fibres, vitamins and minerals. Turmeric has been extensively used traditionally for respiratory and gastrointestinal problems like cough, cold, asthma, throat irritations, flatulence and chronic diarrhea (Gilani et al., 2005).

Composition

The known significant species of genus *Curcuma* are *Curcuma zedoaria* Rosc. (Zedoary), *Curcuma angustifolia* Roxb, *Curcuma aromatica* Salisb. (Vana Haridra), *Curcuma caesia* Roxb. (Kali Haridra), *Curcuma amada* Roxb. (Amaragandhi Haridra) and *Curcuma longa* Linn. (Haridra). These grow in various parts of the world. In Hindi, *Curcuma longa* Linn. is known by the name of 'Haldi'. It is a tall herb and cultivated across the tropical and other regions in India. In Indian homes, *Curcuma longa* Linn. is used as therapeutic plant in day to day practice for different illnesses (Krup et al., 2013). *Curcuma longa* contains curcumin (diferuloylmethane) which is the potent principal curcuminoid. The other two curcuminoids include bisdesmethoxycurcumin and desmethoxycurcumin and several volatile oils including zingiberone, atlantone and tumerone. Further components are proteins, sugars and resins. The curcuminoids are the polyphenols. These are also accountable for the yellow color of turmeric (Ansari et al., 2020).

History

Turmeric has been described as an important plant in old scriptures. It has been used for over 4000 years and is described as 'Indian saffron'. It is also predominant in prehistoric Indian medicine, Ayurveda. Without any doubt, the utilization of turmeric as a medicine, paint and condiment has extended to a lot of countries. Turmeric has digestive characteristics and also used for flavoring. It is distinctly regarded by the Hindus and offered in many temples as "Prasad". Different uses of turmeric have been mentioned by great earlier Indian doctors. Dioscorides, who was a Roman Army Greek scientist also talked about turmeric. Europeans discovering the Asian continent took turmeric to the West in the 14th century. The powdered and crushed turmeric rhizome was routinely used in Asian cooking, fabric dyeing, cosmetics and medicine for 4000 years. Approximately 40 species of *Curcuma* are native to India indicating their origination from India. Though, in tropical Asia nearly 70 to 110 species have been recorded and the most diverse are found in Thailand, India and Myanmar. Some species are scattered in Australia, China and the South Pacific. While others are raised in all tropical regions (Abd El-Hack et al., 2021).

Pharmacokinetics

In animals, the pharmacokinetics evaluations indicated that when curcumin is administered orally, 40 to 85 percent of it passes unchanged through the gastrointestinal tract. Much of the absorbed flavonoid is being metabolized in the mucosa of intestine as well as in liver. As it has less absorption rate, so to increase the absorption and anti-inflammatory activity, curcumin is many times formulated with bromelain. Curcumin has an approximate bioavailability of 65% after oral administration. It is metabolized by means of glucuronidation. It inhibits cytochrome P-450 isoenzyme 1A1 (Kumar and Sakhya, 2013).

Therapeutic Properties of *Curcuma longa*

Curcumin has captured significant scientific attention during the recent years as a result of its broad range of valuable pharmacological characteristics. These include antioxidant, anti-inflammatory, anticancer, anti-mutagenic, anti-infective, anti-angiogenic and anti-diabetic properties. A number of publications are present in the literature which describe the useful role of curcumin to prevent and treat chronic conditions such as atherosclerosis, Alzheimer's disease, different type of cancers, diabetes type-2 and multiple sclerosis (Karlovicz-Bodalska et al., 2017).

In Ayurvedic medicine, *Curcuma longa* L. has been used for a long time to treat inflammatory diseases (Boskabady et al., 2020). Turmeric has demonstrated variety of biological activities including anti-inflammatory, anti-viral, anti-bacterial, anti-protozoal, anti-fungal, antioxidant, anti-diabetic, anti-mutagenic, anti-ulcer, hepato-protective as well as analgesic effects. Inflammation and irritation associated with allergies and inflammatory skin conditions can be prevented when curcumin is used topically. The anticancer, anti-inflammatory and antioxidant effects of curcumin might be employed clinically for the control of carcinogenesis, rheumatism and oxidative-stress associated pathogenesis. Curcumin has been used clinically to overcome post-operative inflammation. Studies on the safety evaluations show that curcumin and turmeric both are well tolerable at an elevated dose without imposing toxic actions. So, both curcumin and turmeric have the ability for the manufacturing of modern medicine to treat several diseases (Nisha and Anbu, 2017).

Health Benefits

C. longa is employed to alleviate dental issues along with digestion problems including pain or discomfort in the upper abdomen and acidity, gas, ulcers, as well as indigestion. Furthermore, it reduces the hallucinogenic effects of

hashish and other psychoactive drugs (Fuloria et al., 2022). *Curcuma longa* as a medicinal herb has a background to be used in medicine in view of the fact that it has anti-inflammatory, anticancer antimicrobial, antioxidant together with analgesic characteristics. Turmeric possesses two classes of secondary metabolites i.e. curcuminoids (curcumin, demethoxycurcumin, and bisdemethoxycurcumin) and the other is turmeric essential oils (TEO). Turmeric's active constituent, curcumin is highly pleiotropic molecule. Curcumin acts as antimicrobial agent against various strains of viruses, bacteria and fungus and works by targeting their membrane efficiency. On the other hand, it works against different types of cancers by targeting molecular markers. Moreover, this constituent also demonstrates effective results against a number of diseases such as neurodegenerative diseases and rheumatoid arthritis. It can also restrain cataractogenesis induced by selenium and ionizing radiations. Curcumin may target different signaling pathways. It assists to cure different types of cancers such as pancreatic, gastric, prostate, endometrial, lungs, ovarian, leukemia, ovarian and oral cancer. Treatment like chemotherapy and radiotherapy are considered effective for cancer. But medicinal herbs have the ability to treat threatening diseases. Medicinal effects have also been demonstrated in diseases like neurodegenerative diseases, cataract and musculoskeletal pain. Curcumin has less solubility, stability and bioavailability. Researchers are now struggling to solve all these issues by modifying it and also checking it by combinational therapeutics. When curcumin is incorporated with piperine, ascorbic acid it provides more effective results. Numerous formulations are developed with the assistance of nanotechnology to reduce its size and to combine with nanoparticles to make it more efficient and useful (Gul and Basheer, 2016).

In Ayurvedic medicine, turmeric is a widely known remedy for a number of respiratory problems (for example, allergy, asthma and bronchial hyperactivity), liver disorders, diabetic wounds, cough, sinusitis and runny nose (Prasad and Aggarwal, 2011). Turmeric appears to have hepato-protective effect just like silymarin. The hepato-protective action of turmeric is fundamentally an outcome of its antioxidant characteristics along with its potential to reduce the production of pro-inflammatory cytokines (Kumar and Sakhya, 2013). Oil of turmeric as well as ether and chloroform extracts incorporate antifungal activity. Crude ethanol extract also has antifungal effect. Oil of turmeric appears to be effective against *Fusarium moniliforme*, *Penicillium digitatum*, *Aspergillus flavus* and *A. parasiticus*. Healthy level of cholesterol is beneficial for the prevention of cardiovascular problems and other major health issues. High level of cholesterol can be harmful for health, therefore people are always exploring ways to reduce the level. Investigations have demonstrated that simply adding turmeric to season your food can markedly lower cholesterol levels in blood. Previous studies proposed that turmeric may aid in the prevention of atherosclerosis (building up of plaque which can block arteries and contribute to heart attack or stroke) (Verma et al., 2018).

Throughout the world, curcumin is well-known and utilized for numerous possible health benefits. Turmeric which has curcumin has been used in curries, presented as tea in Japan, used in China, used in cosmetics in Thailand, served in drinks in Korea, used as anti-inflammatory in Pakistan and India, and used as an antiseptic in Malaysia. In the USA, it is also used in chips, cheese, mustard sauces, and butter. Some different types of products at hand include curcumin capsules, ointments, tablets, soaps, power drinks, and cosmetics. The United States Food and Drug Administration classified the curcuminoids as "generally recognized as safe" products. Moreover, clinical evaluations have described great tolerability as well as safety profiles at doses varying from 4000-8000 mg (Abd El-Hack et al., 2021).

Curcuma longa for the Treatment of Respiratory Disorders

Turmeric is one of the most powerful natural healers. It is used for the removal of mucus from throat. In China, India and other Southeast Asian countries, turmeric is a traditional remedy for the treatment of colds, asthma, and is applied as an ointment, paste, or poultice for scabies, insect bites, bruises, boils, and other skin lesions. Orally, turmeric is administered for other conditions, such as pain, bleeding, jaundice, diarrhea, rheumatic disorders, epilepsy, menstrual problems, and respiratory tract infections. A pinch of turmeric mixed with organic ghee is applied to the mucus lining of nose to stop the sniffles. It also ceases bleeding from nose, aids to clear the sinuses, re-establishes a more acute sense of smell, and assists to purify the brain and mind (Bhowmik et al., 2009).

Aside from this, the defensive actions of curcumin were examined in numerous pulmonary diseases like chronic obstructive pulmonary disease (COPD), acute respiratory distress syndrome (ARDS), asthma as well as pulmonary fibrosis in animal studies. Curcumin decreased the production of interleukin-1 β (IL-1 β), interleukin-8 (IL-8), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF- α), matrix metalloproteinases-2 (MMP-2) and matrix metalloproteinases-9 (MMP-9) in mice and in A549 cells infected with influenza A virus. These cytokines aggravate acute lung injury (ALI). Curcumin @ 20 mg/kg orally markedly stops ovalbumin (OVA)-induced airway constriction and airway hyper-reactivity to histamine in sensitized guinea pigs. In the mouse model of asthma, curcumin @ 2.5 mg/kg and 5 mg/kg by intranasal route remarkably decreased bronchoconstriction. In addition to this, in rats, the extract of *Curcuma longa* (1.5 and 3 mg/ml) decreased tracheal contractile response to OVA and maximum response to methacholine. Along with this, it also reduced interstitial fibrosis. Standard therapy with curcumin capsule (500 mg BD daily for 30 days) in patients with bronchial asthma notably improved forced expiratory volume one second (FEV1) in contrast to the standard treatment. For bronchial asthma, curcumin is suggested to be used as an add-on treatment (Babaei et al., 2020).

Curcumin can reduce or prevent the inflammation of respiratory tract induced by bacterial or viral infections and also decrease the extent of inflammation of animal skin in preclinical studies. Chronic obstructive pulmonary disease (COPD) is a progressive airflow limitation disease associated with consistent inflammation of respiratory system, particularly in the

airways and lungs. It can be a result of long-term exposure with gases and toxic particles like smoke or air pollutants. In animal model, the preclinical investigations showed that the anti-inflammatory activity of curcumin can decrease and relieve respiratory inflammation and oxidative stress occurred as result of exposure to soot or other pollutants of air. Over and above that, curcumin is helpful to reduce allergic asthma by suppressing the PPAR γ /NF- κ B signaling pathway in respiratory mucosa to hinder chronic obstructive pulmonary disease (COPD). Acute lung injury can result from the clinical application of radiotherapy or chemotherapeutic drugs and contribute to pulmonary fibrosis. Treatment with curcumin can lower the extremity of pulmonary fibrosis (Fu et al., 2021).

Former studies indicated the bronchodilatory as well as preventive effects of this plant and its components on respiratory diseases (Boskabady et al., 2020). The effectiveness of volatile oil of turmeric as an oral drug in the treatment of bronchial asthma was reported in a clinical trial. The administration of powder of turmeric by oral route notably alleviated cough and asthma. Also, fresh rhizomes appeared to be efficient against dyspnea, whooping cough and other coughs. In coryza and catarrh, the act of inhaling burning turmeric fumes results in abundant discharge of mucous and allows immediate relief. In bronchitis, the parched and powdered root is given. Acute lung injury (ALI) is a pulmonary disorder caused by bacteria, sepsis, or intestinal ischemia. Acute lung injury (ALI) is marked by an inflammatory response resulting in alveolar damage, edema, accumulation of neutrophil, including hemorrhage. The most severe form of it is acute respiratory distress syndrome. Curcumin manifests anti-inflammatory activity by the regulation of inflammatory cytokines (Satpathy and Parida, 2023). The antioxidant and anti-allergic activities of curcumin together with related compounds (such as glycosides, reductants and bis-demethoxy analogs) have recently been examined. Their outcomes recommend that the curcumin's hydroxy groups have an important function in exhibiting both the anti-allergic and antioxidant effects (Kurup and Barrios, 2008).

Since previous times, turmeric is extensively utilized in respiratory disorders. It is anti-purulent and anti-inflammatory in nature. It is very beneficial for the treatment of bronchial asthma. A fume of Haridradi dhumvarti (fumes wick) is provided in congestion and asthma. Majorly, the chemical components of turmeric (such as tumerones, curcuminoids, tetrahydrocurcumin, and curcumin) have an anti-asthmatic action. At times, it has been observed that boiled Haridra in milk (mixed with jiggery) is offered internally in cough and rhinitis. In cough and cold, a piece of lightly burnt rhizome is given for chewing. In sore throat, throat infection and catarrhal cough, decoction of rhizome is also used for gargle (Bhattacharjee et al., 2017).

Curcumin may have a role to play in the treatment of COVID-19 according to scientific research. The scientific evidence indicates that curcumin (the chief curcuminoid ingredient present in turmeric) may decrease inflammation and also provide protection against oxidative stress. It also possesses antifungal, antibacterial, wound-healing as well as hypoglycemic qualities. As part of a new method of drug development to enhance the bioavailability of curcumin, important technologies like nanoparticles, liposomes, adjuvants, along with phospholipid complexes are being investigated. It has been frequently utilized for sore throats, coughs as well as for respiratory disorders as a home remedy. It could be an outstanding immune-booster against SARS-CoV-2 therapy. The critical proteins of SARS-CoV-2 can be inhibited by turmeric spice. Therefore, it could be utilized as a medicinal drug against SARS-CoV-2 by the inhibition of important SARS-CoV-2 virus proteins (Jyotirmayee and Mahalik, 2022).

Asthma and allergy both are pro-inflammatory diseases, stemming from inflammatory cytokines. The rhizomes of turmeric have been used for a long time to treat asthma and allergy in Asia, particularly in India. In Thailand, it has been also utilized for the treatment of skin diseases in addition to itching. Curcumin's hydroxyl groups have shown to reduce the allergic reactions. Moreover, it possesses beneficial activity against asthma by extending the narrowed air pathway and enhancing the antioxidant capability (Kocaadam and Şanlıer, 2017).

Toxicology of Curcumin

Curcumin has been stated as a "generally recognized as safe" compound by Food and Drug Administration (FDA). According to Joint FAO/WHO Expert Committee on Food Additives (JECFA) and European Food Safety Authority (EFSA) reports, 0-3 mg/kg is the adequate daily intake (ADI) value of curcumin. There are few worries about the relationship between inhibition of some enzyme working in metabolism of drug, potential impairment of DNA, chelation of iron and intake of curcumin. Anyhow, further research is required to be performed to investigate these relationships (Kocaadam and Şanlıer, 2017).

Future Prospects of *Curcuma longa* L.

Turmeric possesses antioxidant, ant-inflammatory, anti-mutagenic, neuro-protective, anti-fibrotic and antibacterial properties. As a pharmacological agent, the prime drawback of *Curcuma longa* L. is its mediocre bioavailability when orally administered because of less intestinal absorption and fast hepatic metabolism through glucuronidation and instant excretion through bile and feces. In several animal models, the studies demonstrated that inhalation and intra-peritoneal injection have greater bioavailability and efficiency as compared to oral administration. Future studies directed toward understanding the action of turmeric on the visual circuit pathway of pulmonary disorders and the protective role of *Curcuma longa* L. might address the probable mode of action of herbal intervention against pulmonary disorders (Satpathy and Parida, 2023).

Conclusion

In Ayurvedic medicine, turmeric has been used since long time with many biological applications. In Ayurvedic medicine, turmeric is widely known therapy for a number of respiratory problems (for example, allergy, asthma and bronchial hyperactivity), liver disorders, diabetic wounds, cough, sinusitis and runny nose. Curcumin can be recognized as a potent curative agent for a number of health problems like inflammatory conditions and many types of cancer. As a result, its therapeutic potential is a matter of great interest. Over the last 50 years, the safety, efficacy and pharmacokinetics of curcumin have been studied widely in clinical evaluations. The results from many clinical studies indicated that curcumin may be effective for the prevention and treatment of a number of diseases. Curcumin is less costly than drugs and considered a safe natural product. Curcumin has been shown in preclinical investigations to lower the extent of inflammation in animal skin as well as prevent or minimize respiratory tract inflammation induced by bacterial or viral infection. The main obstruction in using curcumin as a therapeutic agent is its limited systemic bioavailability, but researchers are trying to discover the most effective method of application.

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