ABSTRACT
Turmeric (Curcuma longa Linn), a nature’s precious and most popular Indian spice belonging to the family zingiberaceae is cultivated throughout the Indian subcontinent because of its excellent medicinal properties. The rhizomes of the plant have medicinal values. The active constituents of the turmeric are the flavonoids, curcumin (Diferulomethane) and various volatile oils, which includes zingiberone, tumerone, water and fat soluble extracts of turmeric. The component Curcumin exhibits strong anti-oxidant properties resulting in enhanced cellular resistance to oxidative damage. Extensive research over last fifty years has revealed several important functions of curcumin. Turmeric has been shown with wide spectrum of biological action which includes Anti-mutagenic, Anti-oxidant, Anti-inflammatory, Anti-diabetic, Anti-bacterial, Anti viral, Hepatoprotective, Anti-fungal, Antiprotozoal, Anti-ulcer and Analgesic actions. Curcumin has the ability to inhibit carcinogenesis at three stages, namely tumour promotion, angiogenesis and tumour growth. Curcumin is also used topically to counteract inflammation and irritation associated with inflammatory skin conditions and allergies. This review focuses on the medicinal and pharmacological treatment of diseases with the medicinal values of turmeric.

KEYWORDS: Turmeric, Curcuma longa, Manjal, Hepatoprotective action, Anti-inflammatory action, Anti-diabetic, Anti tumour action.

INTRODUCTION
The Almighty, prior to the creation of mankind had beforehand created the base for all lives the “herb”. This beautiful word ‘The Herb’ has been derived from the Latin word, “herba”
and an old French word “herbe”. These herbs are none but medicinal plants that are used in variety of ways such as food, flavonoid, medicine or perfume and also in certain spiritual activities.

Right from the genesis of mankind plants have always proved to be a life sustainer and had been used for medicinal purposes and life saving purposes. The vitalness of herbs have been vividly depicted even in ancient Siddha, Unani manuscripts and Chinese writings. It is corroborated that for over 4000 years herbs were used as medicine for various healing purposes by Siddha, Indian Vaids, European and Mediterranean cultures.

India has known to be as one of the richest repository of medicinal plants. India’s forests are the greatest resources of a large number of medicinal herbs that are widely used in variety of medicinal fields for the production of medicines and drugs. Of late, WHO (World Health Organization) had reported that all over the globe more than 80 percent of people are totally dependent on natural medicines. The ancient Indian medicine was totally dependent on herbal medicines and true to its reliability the herbal plants exerted their 100% safety. On the whole medicinal plants exhibit a very safe and efficacious treatment with very less or no side effects.

**Turmeric (Curcuma longa)**

Turmeric is a product of Curcuma longa, a rhizomatous herbaceous perennial plant belonging to the ginger family Zingiberaceae, which is native to tropical South Asia. As many as 133 species of Curcuma has been identified worldwide. Almost in all parts of India, where food is greatly respected and rendered importance for its therapeutic properties as for its richness and flavour, every recipe is made successfully completed only with the addition of the fresh roots of this wonderful herb “turmeric”. Right from the head to feet including stomach ailments to cardiovascular problems, this herb individually or grouped together with other herbs has a remedy. This review throws much light on the mysterious healing properties of Turmeric.

**Scientific Classification of Turmeric**

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<td>Kingdom</td>
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<td>Binomial Name</td>
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Geographical Distribution of Turmeric

The native habitat of Turmeric is South and South East Asia. Turmeric is widely distributed in the western coasts of southern parts of India. It is also distributed in Southeast Asia, Malay, China and northern parts of Australia, West Indies and South America. Comparatively India is the largest cultivator of the *C. longa* among all the other countries in the world except for the two countries in Asia i.e., China and Indonesia. From India nearly 50% of the total cultivation is from Andhra Pradesh and Maharastra followed by Tamil Nadu and Kerala.

India produces nearly the world’s entire turmeric crop and consumes 80% of it. With its inherent qualities and high content of the important bioactive compound curcumin, Indian turmeric is considered to be the best in the world. Erode, a city in the South Indian state of Tamil Nadu, is the world’s largest producer of and the most important trading center for turmeric. It is also known as “Yellow City,” “Turmeric City,” or “Textile City.” Sangli, a city of Maharashtra, is second only to Erode in size and importance as a production and trading site for turmeric.

The predominant habitat for medicinal herb “Turmeric” (*Curcuma longa*) are the forest regions, in clearings, or on riverbanks and it is also imbibed with a natural feature that is to adapt itself to withstand even during unfavourable drought conditions. It loses its leafy parts and has the adaptability to survive in the dry season as underground rhizomes. Some *Curcuma* species also produce tuberous roots, which act as an additional store of food and water.

Thus the fruits of turmeric ripen underneath the ground. The leafy shoots may grow high in the air from three to five metres height. The flowers are brightly coloured and the slender flower tubes are compacted with nectar. The butterflies aids in the pollination process of this plant. The life span of the flowers are too short, may be lasting only a few hours.

The turmeric plant needs temperatures between 20°C and 30°C and a considerable amount of annual rainfall to thrive. Individual plants grow to a height of 1 m, and have long, oblong leaves. Plants are gathered annually for their rhizomes, and are reseeded from some of those rhizomes in the following season. The rhizome, from which the turmeric is derived, is tuberous, with a rough and segmented skin. The rhizomes mature beneath the foliage in the ground. They are yellowish brown with a dull orange interior. The main rhizome is pointed or
tapered at the distal end and measures 2.5–7.0 cm (1–3 inches) in length and 2.5 cm (1 inch) in diameter, with smaller tubers branching off. When the turmeric rhizome is dried, it can be ground to a yellow powder with a bitter, slightly acrid, yet sweet, taste.

**Medicinal value**

Turmeric (*Curcuma longa*) has been used in traditional medicine as a household remedy for various diseases, including biliary disorders, anorexia, cough, diabetic wounds, hepatic disorders, rheumatism and sinusitis. For the last few decades, endeavoured labour has been exercised to make a deep impact about the manifold biological activities and pharmacological effects of turmeric and its extracts in the society. It is found that a wide spectrum of biological present is available in Curcumin (diferuloylmethane), the main yellow bioactive component of turmeric. The pharmacological properties such as antivenom, antiulcer anticarcinogenic, antimitagenic, anticoagulant, hypotensive and hypocholesteremic activities, antifertility, antidiabetic, antibacterial, antifungal, antiprotozoal, antiviral, anti inflammatory, antioxidant, antifibrotic are observed. Turmeric aggravates the anticancer effect by mediating through apoptosis induction.\(^1\) Its antiinflammatory, anticancer and antioxidant roles may be clinically exploited to control rheumatism, carcinogenesis and oxidative stress-related pathogenesis. Clinically, curcumin has already been used to reduce post-operative inflammation.

Safety evaluation studies indicate that both turmeric and curcumin are well tolerated at a very high dose without any toxic effects. Thus, both turmeric and curcumin have the potential for the development of modern medicine for the treatment of various diseases.\(^2\)

**Anti inflammatory property of Turmeric**

Tumor promotion being intertwined to proinflammatory states is a well known and vividly understood fact.\(^3\),\(^4\) Consequently, phytochemicals like curcumin that exert a strong anti inflammatory effect are anticipated to have some degree of chemopreventive activity. Preclinical cancer research using curcumin has shown it inhibits carcinogenesis in a number of cancer types, including colorectal, pancreatic, gastric, prostate, hepatic, breast and oral cancers and leukemia and at various stages of carcinogenesis.\(^5\) The anticarcinogenic potential of curcumin are triggered by the few factors: (1) inhibition of NF-κB and COX-2 (increased levels of COX-2 are associated with many cancer types)\(^6\),\(^7\) (2) inhibition of arachidonic acid metabolism via lipoxygenase and scavenging of free radicals generated in this pathway; (3) decreased expression of inflammatory cytokines IL- 1b, IL-6 and TNF-a,
resulting in growth inhibition of cancer cell lines.\[8\] and (4) down-regulation of enzymes, such as protein kinase C, that mediate inflammation and tumor-cell proliferation.\[9\]

Turmeric possess a huge variety of molecular targets that renders it great potential as a therapeutic agent for a variety of inflammatory conditions and cancer types. Consequently, there is extensive interest in its therapeutic potential. In the recent past extensive research works are done regarding the anti-inflammatory property of turmeric in which several ongoing phases II and III clinical trials stands as evidences. Due to the limited systemic bioavailability of curcumin which acts a small hurdle in using curcumin longa for its anti-inflammatory property researchers have fixed their minds in investigating a number of different curcumin compounds and analogs that may be more effective and better absorbed. Successful and promising results from the so far accomplished clinical trials are revitalizing and forthwith trials being conducted for both inflammatory conditions and cancer vividly renders curcumin’s value as a therapeutic agent and confirms some of the mechanisms responsible for its efficacy.\[10\]

**Composition of Turmeric**

Nearly, 100 components have been isolated from turmeric till date. The prime component of the root is a volatile oil, containing turmerone, and there are other coloring agents called curcuminoids in turmeric. Curcumin was first isolated in 1815 and its chemical structure was determined by.\[11\] It has a melting point at 176–177°C; forms a reddish-brown salt with alkali and is soluble in ethanol, alkali, ketone, acetic acid and chloroform. Curcuminoids consist of natural antioxidants curcumin demethoxycurcumin, 5′-methoxycurcumin and dihydrocurcumin.\[12\]|\[13\] Curcuminoids belong to the group of diarylheptanoids (or diphenylheptanoids) having an aryl-C7-aryl skeleton.\[14\] Turmeric contains protein (6.3%), fat (5.1%), minerals (3.5%), carbohydrates (69.4%) and moisture (13.1%). The essential oil (5.8%) obtained by steam distillation of rhizomes has a-phellandrene (1%), sabinene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpenes (53%).\[15\] Curcumin (diferuloylmethane) (3–4%) is responsible for the yellow colour, and comprises curcumin I (94%), curcumin II (6%) and curcumin III (0.3%).\[16\] Demethoxy and bisdemethoxy derivatives of curcumin have also been isolated.\[17\]

In a standard form, turmeric contains moisture (>8%), curcumin (5–6.9%), extraneous matter (<0.5% by weight), mould (<3.5%) and volatile oils (<3.8%). Volatile oils include d-\(\alpha\)-phellandrene, d-sabinene, cinol, borneol, zingiberene and sesquiterpenes (Ohshiro,
There are a variety of sesquiterpenes, like germacrene; termerone; ar-(+)-, α- and β-termerones; β-bisabolene; α-curcumene; zingiberene; β-sesquiphellandrene; bisacurone; curcumene; dehydrocurdione; procumadiol; bis-acumol; curcumene; isoprocurcumeneol; epiprocurcumeneol; procumeneol; zedoaronediol; and curlone, many of which are specific for a species. The components responsible for the aroma of turmeric are turmerone, arturmerone and zingiberene. The rhizomes are also reported to contain four new polysaccharides-ukonans along with stigmasterol, β-sitosterol, cholesterol and 2-hydroxymethyl anthraquinone. Nutritional analysis showed that 100 g of turmeric contains 390 kcal, 10 g total fat, 3 g saturated fat, 0 mg cholesterol, 0.2 g calcium, 0.26 g phosphorous, 10 mg sodium, 2500 mg potassium, 47.5 mg iron, 0.9 mg thiamine, 0.19 mg riboflavin, 4.8 mg niacin, 50 mg ascorbic acid, 69.9 g total carbohydrates, 21 g dietary fiber, 3 g sugars and 8 g protein.

**Antimicrobial properties of Turmeric**

Right from the time of old many medicinal plants have stood as a proof of an excellent source of antimicrobial agents. In the countryside regions many plant components are used as a traditional medicine which are readily available and relatively cheaper than modern medicine. Plants generally produce many Secondary metabolites (compound related to groups like phenol, alkaloid, terpenoids, glycosides, etc.) are the usual compounds produced by the plants which constitute an important source of microbicides, pesticides, fungicides and many pharmaceutical drugs. Plant products still remain the principle source of pharmaceutical agents used in traditional medicine. Member of Zingiberaceae family are found to be a rich source of substances of phytochemical interest. They are rich in curcuminoids, and recognized for their broad spectrum of biological activities, curcuminoids vary in chemical structures, physico-chemical characteristics as well as the functional properties. Numbers of plants from this family are used in traditional system of medicine because of its wide spectrum of pharmacological activities. Many species of Curcuma longa are traditionally used for their medicinal properties. In many literatures antifungal, antibacterial and anti inflammatory activity has been reported for species such as *Curcuma longa*, *Curcuma zedoaria*, *Curcuma aromatica* and *Curcuma amada*. From ancient time most people use the rhizome of these plants use as a traditional medicine due to their medicinal effect. Fungi and bacteria are significant destroyers of food stuffs and produced various types of diseases in human. The Gram-positive bacteria such as Staphylococcus aureus and Bacillus subtilis are mainly responsible for post-operative wound infection, toxic
shock syndrome and food poisoning. The Gram-negative bacterium such as Pseudomonas aeruginosa is present in human lung, urinary track and kidney; causes lower urinary tract infection, inflammation and sepsis.\[31\]

Also the toxic effects produced by Aspergillus includes carcinogenicity, genotoxicity, terratogenicity, nephrotoxicity, hepatotoxicity, reproductive disorders and immune suppression\[32\] Candida albicans is a diploid fungus that grows both as yeast and filamentous cells and a causal agent of opportunistic oral and genital infections in human.\[33\],[34\]

**Other Medicinal properties of Turmeric**

Curcumin has exhibited a powerful scavenger of oxygen free radicals. Its antioxidant activity is comparable to vitamins C and E.\[35\] 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, bisdemethoxycurcumin and demethoxycurcumin also have antioxidant activities.\[4\]

Curcumin pre-treatment has been shown to decrease ischemia-induced oxidative stress and changes in the heart.\[36\] An in vitro study measuring the effect of curcumin on an inducible stress protein, resulted in enhanced cellular resistance to oxidative damage.\[37\]

**Cardioprotective effects**

Turmeric exerts cardio-protective effects mainly by antioxidant activity, lowering lipid peroxidation, antidiabetic activity and inhibiting platelet aggregation. A study of 18 atherosclerotic rabbits given 1.6-3.2 mg/kg/day of turmeric extract demonstrated decreased susceptibility of LDL to lipid peroxidation, in addition to lower plasma cholesterol and triglyceride levels. Turmeric effect on cholesterol levels may be due to decreased cholesterol uptake in the intestines and increased conversion of cholesterol to bile acids in the liver. Inhibition of platelet aggregation by turmeric constituents is thought to be via potentiation of prostacyclins synthesis and inhibition of thromboxane synthesis.\[38\]

**Gastrointestinal effects**

Turmeric exerts several protective effects on the gastrointestinal tract. Turmeric also inhibits ulcer formation caused by stress, alcohol, Indomethacin, reserpine, pyloric ligation, increasing gastric wall mucus in rats subjected to these gastrointestinal insults. It also inhibits intestinal spasm and increases bicarbonate, gastrin, secretin and pancreatic enzyme secretion.
An open, phase II trial performed on 25 patients with endoscopically-diagnosed gastric ulcer, given 600 mg powdered turmeric five times daily, showed complete recovery in 48 percent of patients. No adverse reactions or blood abnormalities were recorded. Curcumin reduced mucosal injury in mice with experimentally induced colitis. Ten days prior to induction of colitis, with 1, 4, 6-trinitrobenzene sulphonyl acid, administration of 50 mg/kg curcumin resulted in a significant reduction of diarrhea, neutrophil infiltration and lipid peroxidation in colonic tissue. Also all indicators inflammation were reduced and the symptoms improved. In rat models of experimentally-induced pancreatitis, curcumin was able to decrease inflammation. In cerulean or ethanol induced pancreatitis, curcumin was also able to inhibit the inflammatory mediators, resulted in amelioration in disease severity as measured by histology, pancreatic trypsin, serum amylase, and neutrophil infiltration.

**Anti-cancer effect**

Numerous animal studies have explored turmeric influence on the carcinogenesis. Several studies have demonstrated that curcumin is able to inhibit carcinogenesis at three stages: angiogenesis, tumor promotion, and tumor growth. In two studies of colon and prostate cancer, curcumin was shown to inhibit cell proliferation and tumor growth. Turmeric and curcumin are also able to suppress the activity of several common mutagens and carcinogens. The anticarcinogenic effects of turmeric and curcumin have been related to direct antioxidant and free-radical scavenging effects, as well as their ability to indirectly increase glutathione levels, thereby aiding in hepatic detoxification of mutagens and carcinogens and inhibiting nitrosamine formation. Curcumin has also been shown to inhibit the mutagenic induction effect of UV rays.

Among various mechanisms, induction of apoptosis plays an important role in its anticarcinogenic effect. It induces apoptosis and inhibits cell-cycle progression, both of which are instrumental in preventing cancerous cell growth in rat aortic smooth muscle cells. The antiproliferative effect is mediated partly through inhibition of protein tyrosine kinase and c-myc mRNA expression and the apoptotic effect may partly be mediated through inhibition of protein tyrosine kinase, protein kinase C, c-myc mRNA expression and bcl-2 mRNA expression. Curcumin induces apoptotic cell death by DNA-damage in human cancer cell lines, TK-10, MCF-7 and UACC-62 by acting as topoisomerase II poison. In an animal study, rheumatoid arthritis induced by streptococcal cell wall, intraperitoneal injection of turmeric extract containing 4 mg total curcuminoids/kg/day for four days prior to...
induction of arthritis, inhibited joint inflammation in both acute (75%) and chronic (68%) phases. To test the efficacy of an oral preparation, a 30-fold higher dose of the curcuminoid preparation, given to rats four days prior to arthritis induction, reduced joint inflammation by 48%.\[49\]

Curcumin suppresses human breast carcinoma through multiple pathways. Its antiproliferative effect is estrogendependent in ER (estrogen receptor)-positive MCF-7 cells and estrogen-independent in ER-negative MDA-MB-231 cells.\[50\] Curcumin also downregulates matrix metalloproteinase (MMP)-2 and upregulates tissue inhibitor of metalloproteinase (TIMP)-1, two common effector molecules involved in cell invasion. It also induces apoptosis through P53-dependent Bax induction in human breast cancer cells.\[52\] However, curcumin affects different cell lines differently. Whereas leukaemia, breast, colon, hepatocellular and ovarian carcinoma cells undergo apoptosis in the presence of curcumin.\[51\]

Curcumin also suppresses tumour growth through various pathways. Nitric oxide (NO) and its derivatives play a major role in tumour promotion. Curcumin inhibits iNOS and COX-2 production\[53\] by suppression of NFkB activation\[54\] Curcumin also increases NO production in NK cells after prolonged treatment, culminating in a stronger tumouricidal effect\[55\] Curcumin also induces apoptosis in AK-5 tumour cells through upregulation of caspase-3. Reports also exist indicating that curcumin blocks dexamethasone induced apoptosis of rat thymocytes\[56\] [57\] Recently, in Jurkat cells, curcumin has been shown to prevent glutathione depletion, thus protecting cells from caspase-3 activation and oligonucleosomal DNA fragmentation.\[58\]

**Anti-diabetic potential**

In a research study conducted by Lekshmi et al, the turmeric extracts were screened for their inhibitory activity against α-glucosidase and α-amylase enzymes and the Turmeric rhizome extracts showed high potential to inhibit glucosidase activities and glycation reactions. Ethyl acetate, methanol and water extracts of Turmeric inhibited α-glucosidase activity in dose dependent manner with IC50 values 0.4, 3.1 and 12.6 μg/mL. IC50 values obtained for α-amylase inhibitory potential of ethyl acetate, methanol and water extracts were respectively 71.6, 90.3 and 498.3 μg/mL. Under the experimental conditions, the standard glucosidase inhibiting drug acarbose inhibited α-glucosidase and α-amylase enzymes with IC50 values 17.1 and 290.6 μg/mL respectively. Ethyl acetate extract of turmeric had the highest α-glucosidase and α-amylase inhibitory potential among the extracts. Glucose inhibitory
potential of both ethyl acetate and methanol extracts was significantly (p < 0.05) higher than those of acarbose. The extracts were also effective in scavenging free radicals and inhibiting LDL and cellular oxidations and ACE activity. The high antidiabetic, Antioxidant and antihypertensive capacities of turmeric rhizome revealed in this research highlighted its potential to serve as a source for preventive and therapeutic agents for the management of diabetes and related disorders.\[^{59}\]

**CONCLUSION**

Through this review the pharmacological properties of the single herb Turmeric (Curcuma longa) has been scientifically analyzed and it has proved it to be a golden spice with multimodal action that can be therapeutically used for various ailments. Thus the scientific analysis also confirms the traditional claims of the medicinal value of Turmeric.

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