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Pharmacological Activities of Turmeric (*Curcuma longa* Linn): A ReviewVasavda Krup^{1*}, Hedge Prakash L² and Harini A³¹Postgraduate scholar, Department of Dravyaguna, Shri Dharmasthala Manjunatheshwara College of Ayurveda, Karnataka, India²Professor and Head, Department of Dravyaguna, Shri Dharmasthala Manjunatheshwara College of Ayurveda, Karnataka, India³Associate professor, Department of Dravyaguna, Shri Dharmasthala Manjunatheshwara College of Ayurveda and Hospital, Karnataka, BM Road, India**Abstract**

Turmeric (*Curcuma longa* Linn) is extensively used as a spice and grown widely throughout Indian subcontinent. Turmeric plant has been used in traditional medicine as a remedy for various diseases including cough, diabetes and hepatic disorders. For the last few decades, extensive works have been done to establish the pharmacological actions of Turmeric and its extracts. Curcumin is the main chemical compound of Turmeric and proven for its anti-inflammatory, antioxidant, antimutagenic, antidiabetic, antibacterial, hepatoprotective, expectorant and anticancerous pharmacological activities. This review gives update mainly on the pharmacological activities of the Turmeric, its extracts and plausible medicinal applications of Turmeric along with their safety evaluation.

Keywords: Turmeric; Haridra; *Curcuma longa* Linn; Medicinal plant; Dravyaguna

Introduction

Man has been using herbs and plant products for combating diseases since times immemorial. The Indian subcontinent is enriched by a variety of flora- both aromatic and medicinal plants. This extensive flora has been greatly utilised as a source of many drugs in the Indian traditional system of medicine. In India, the earliest mention of the use of medicinal plants is to be found in Rigveda which was written between 4500-1600 BC [1]. Turmeric (Haridra) is one such medicinal plant explained extensively in Indian material medica (Dravyaguna Sastra). It is an auspicious beauty spot, daily applied on the forehead by Hindu females. Application of turmeric a paste to the bride is an essential procedure of Hindu rituals [2]. In Ayurveda, turmeric has been well documented for its therapeutic potentials and described in Dashemani Lekhaniya (emaciating), Kusthagna (Anti-dermatosis), Visaghna (Anti-poisonous) [3].

History of turmeric

Haridra in Sanskrit means 'an efficacious drug for jaundice' [4]. It is known to be one of the oldest spices that have been used in Western and Southern parts of India for thousands of years and is a major part of Ayurvedic medicine [5]. That is why it is also avowed that this spice belongs to India indigenously and also referred to as 'Indian saffron'. Originating in India, Turmeric had reached China by 700 AD, East Africa by 800 AD and West Africa by 1200 AD, and also had begun to become popular all through the world. It is also known that the Arab traders had carried with them turmeric to Europe in the 13th century. Marco Polo, while on his several legendary voyages to India via the Silk Route, was so impressed by turmeric that he had mentioned it as a vegetable that possesses properties of saffron, but actually is not saffron [6].

Turmeric as a folk medicine

Rhizome is used to treat cough and cold in the Basti and Siharthnagart of U.P. The paste of rhizome is applied on the body to treat body pain by tribals of Jhalda, Parulia District. West Bengal. Tribal women of Assam apply paste of fresh rhizome on the skin to protect it from infection and enhance the complexion. Rhizome of this plant along with other ingredients is given to cattle to treat loose stools [7].

***Curcuma longa* Linn. (Haridra) a plant from genus Curcuma**

Among plant known for medicinal value, the plants of genus

Curcuma belonging to family Scitaminae are very important for their therapeutic potentials [8,9]. *Curcuma longa* Linn. (Haridra), *Curcuma aromatica* Salisb. (Vana Haridra), *Curcuma amada* Roxb. (Amaragandhi Haridra), *Curcuma angustifolia* Roxb, *Curcuma caesia* Roxb. (Kali Haridra), *Curcuma zedoaria* Rosc. (Zedoary) are known important species of genus *Curcuma* which grows in different parts of the world. *Curcuma longa* Linn known as 'Haldi' in Hindi is a tall herb cultivated throughout tropical and other regions in India. *Curcuma longa* Linn is used as medicinal plant in day to day practice in Indian homes for various ailments [8,9].

Pharmacological actions

Several medical properties have been attributed to *Curcuma longa* Linn. Rhizome of Haridra is known to possess therapeutic activities and has been used by medical practitioners as an anti-diabetic [8-10], hypolipidemic [8-11], anti-inflammatory [10,11], anti-diarrhoeal [9], hepatoprotective [8,9], anti-asthmatic [10] and anti-cancerous drug. Haridra is widely used in cosmetology [2]. The following section discusses its various therapeutic uses in medicine.

Medicinal uses:

Gastrointestinal disorders: The fresh juice of Haridra is considered to be anthelmintic [12]. The Curcumin acts through nuclear factor (NF)- κ B inhibition and it reduces the production of adhesion molecules and inflammatory cytokines, resulting in the amelioration of gastric injury in NSAIDs-induced gastropathy in rats. It also improves gastric mucosal damage and decreases in leukocyte adhesions, and intercellular adhesion molecule 1 and tumor necrosis factor (TNF)- α production after curcumin administration [13]. *Curcuma longa* extract tablet decreased IBS prevalence and abdominal pain/discomfort score significantly between baseline and after treatment of eight-week. There were significant improvements in the IBS quality of life (QOL)

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scales [14]. In liver injury of Male mice Curcumin prevents APAP-induced hepatitis through the improvement of liver histopathology by decreased oxidative stress, reduced liver inflammation, and restoration of GSH [15].

Respiratory disorders: The fresh juice of rhizome is given in bronchitis. In rhinitis and cough boil Haridra in milk and mixed with jiggery given internally. In catarrhal cough, sore throat, and throat infection the decoction of rhizome is used for gargle and also the piece of rhizome is slightly burnt and given for chewing [11]. The chemical constituents of *Curcuma longa* like Tumerones, curcuminoids, Curcumin and tetrahydrocurcumin has an anti-asthmatic action [16]. In asthma and congestion, fumes of Haridradi dhumvarti (fumes wick) is given [17].

Inflammatory disorders: Curcumin has been shown to inhibit a number of different molecules involved in inflammation including phospholipase, lipooxygenase, COX-2, leukotrienes, thromboxane, prostaglandins, nitric oxide, collagenase, elastase, hyaluronidase, MCP-1, interferon-inducible protein, tumor necrosis factor, and interleukin-12 [18]. Studies has proven bisdemethylcurcumin (BDC) is more potent as an anti-inflammatory agent as indicated by suppression of TNF-induced NF- κ B activation, more potent as an anti-proliferative agent, and more potent in inducing reactive oxygen species (ROS). Hispolon analogues, which lacks one aromatic unit in relation to curcumin, also exhibited enhanced anti-inflammatory and anti-proliferative activities [19]. The beneficial effect of curcumin (anti-inflammatory compound) in sepsis appears to be mediated by the upregulation of PPAR- γ , leading to the suppression of pro inflammatory cytokine, TNF- α expression and release [20].

Diabetes mellitus: Turmeric rhizome powder is very useful with Amla juice and Honey in Madhumeha (diabetes mellitus) [21]. The ingestion of 6 g *Curcuma longa* increased postprandial serum insulin levels, but did not seem to affect plasma glucose levels or GI, in healthy subjects. The results indicate that *Curcuma longa* may have an effect on insulin secretion [22]. The active principles in the rhizome of Turmeric plant viz; curcuminoids lower lipid peroxidation by maintaining the activities of antioxidant enzymes like superoxidedismutase, catalase and glutathione peroxidase at higher levels. Antioxidant properties of curcuma longa is due to curcumin and its three derivatives (demethoxy curcumin, bisdemethoxy curcumin and diacetyl curcumin) [23]. A scientific and systemic exploration reveals the antidiabetic, hypolipidemic and hepatoprotective effects of *Curcuma longa* freeze dried rhizome powder dissolved in milk which could be used as an effective and safe antidiabetic dietary supplement of high potential [24]. *Curcuma longa* is known to contain curcuminoids, glycosides, terpenoids, and flavonoids. Maximal inhibition of the enzyme Human Pancreatic Amylase (HPA) was obtained with *Curcuma longa* isopropanol extract and acetone extract. This inhibitory action on HPA causes reduction in starch hydrolysis leading to lowered glucose levels [25].

Cardiovascular disorders: The antioxidants in turmeric also prevent damage to cholesterol, thereby helping to protect against atherosclerosis. In fact, the ability of the antioxidants in turmeric to decrease free radicals is similar to that in vitamins C and E. Since the antioxidant activities of turmeric are not degraded by heat (unlike most vitamins), even using the spice in cooking provides benefits. Animal studies show that curcumin lowers cholesterol and triglycerides, another fat that circulates in the blood stream and is a risk factor for cardiovascular disease [26]. In a recent study of atherosclerosis, mice were fed a standard American diet, rich in refined carbohydrates and

saturated fat, but low in fiber. Some of the mice, however, received this diet plus turmeric mixed in with their food. After four months on these diets, the mice that consumed the turmeric with their food had 20 percent less blockage of the arteries than the mice fed the diet without the turmeric [26]. In another study, rabbits were fed turmeric plus a diet designed to cause atherosclerosis. Several risk factors for the disease were improved, including a decrease in cholesterol, triglycerides, and free-radical damage [27].

Hepatoprotective: The powder of the rhizome mixed with amla juice is used in jaundice [11]. Corriyium (Anjana) with Haridra, Red ochre (Gairika), and Amalaki (*Embllica officinalis*) cures jaundice [28]. Curcumin, the most common antioxidant constituent of *Curcuma longa* rhizome extract, was reported to enhance apoptosis of damaged hepatocytes which might be the protective mechanism whereby curcumin down-regulated inflammatory effects and fibrogenesis of the liver. The ethanolic extract of *Curcuma Longa* rhizomes showed a significant hepatoprotective effect when orally administered in doses of 250 mg/kg and 500 mg/kg, and the protective effect was dose-dependent. The main constituents of *Curcuma longa* rhizome ethanolic extract are the flavonoid curcumin and various volatile oils, including tumerone, atlantone, and zingiberene. The hepatoprotective effects of turmeric and curcumin might be due to direct antioxidant and free radical scavenging mechanisms, as well as the ability to indirectly augment glutathione levels, thereby aiding in hepatic detoxification. The volatile oils and curcumin of *Curcuma longa* exhibit potent anti-inflammatory effects [29].

Neuroprotective activity: Curcuma oil significantly reduces the ill effect of ischemia by attenuating nitrosative and oxidative stress. Ischemia induces collapse of mitochondrial membrane potential, cytochrome c release, altering the Bax: Bcl-2 ratio and subsequently caspases activation led to induction of apoptosis in sequential fashion was reverse significantly by Curcuma oil. So there is an evidence for the high efficacy of Curcuma oil as a neuroprotective, with an excellent therapeutic window for the prevention of ischemic brain injury [30].

Alzheimer's disease: Curcumin when fed to aged mice with advanced plaque deposits similar to those of Alzheimer's disease, curcumin reduced the amount of plaque deposition. It reduced oxidative damage and reversed the amyloid pathology in an Alzheimer's disease transgenic mouse. Alzheimer's disease symptoms characterized by inflammation and oxidation were also eased by curcumin's powerful antioxidant and anti-inflammatory properties [31].

Chemoprotective activity: Curcumin activate the DDR (DNA damage response), providing an opportunity and rationale for the clinical application of these nutraceuticals in the chemoprevention of prostate cancer [32]. Chemoprotective effects in esophageal epithelial cells exposed to bile acids; Curcumin reverses bile acid suppression of gene expression of SOD-1 and also able to inhibit bile acid induction of COX-2 gene expression [33]. Curcumin has demonstrated these chemopreventive properties in cell cultures, animal models and human investigations [34].

Anti cancer activity: Curcumin has been found to possess anti-cancer activities via its effect on a variety of biological pathways involved in mutagenesis, oncogene expression, cell cycle regulation, apoptosis, tumorigenesis and metastasis. Curcumin has shown anti-proliferative effect in multiple cancers, and is an inhibitor of the transcription factor NF-B and downstream gene products (including c-myc, Bcl-2, COX-2, NOS, Cyclin D1, TNF-a, interleukins and MMP-9). In addition, curcumin affects a variety of growth factor receptors and cell adhesion

molecules involved in tumor growth, angiogenesis and metastasis [35]. Curcumin asserts its anti-tumor activity in cancer cells by altering the deregulated cell cycle *via* (a) cyclin-dependent (b) p53-dependent and (c) p53-independent pathways. Such influences of curcumin upon key signal transduction pathways of cell cycle and effectiveness in animal model systems have qualified it as a multiple edged sword in combating the deadly disease-cancer [36]. Curcumin as a natural phytochemicals could communicate with these novel targets and show synergism to chemotherapy. Additionally, curcumin is well tolerated in humans. Therefore, EGFR- miRNA- autophagy and cancer stem cell-based therapy in the presence of curcumin might be promising mechanisms and targets in the therapeutic strategy of lung cancer [37].

Anti allergic activity: Curcumin suppressed compound 48/80-induced rat peritoneal mast cell (RPMC) degranulation and histamine release from RPMCs. Curcumin inhibited compound 48/80-induced systemic anaphylaxis *in vitro* and anti-DNP immunoglobulin E (IgE) mediated passive cutaneous anaphylactoid response *in vivo*. Curcumin has an ability to inhibit nonspecific and specific mast cell-dependent allergic reactions [38].

Antidermatophytic activity: Fresh juice of rhizome of Haridra is used as antiparasitic in many skin affections [12]. Its rhizome powder mixed with cow's urine is taken internally in itching and dermatitis [2]. *Curcuma longa* L. leaves have good promise as an antifungal agent that could be used as a therapeutic remedy against human pathogenic fungi on account of its various *in vitro* and *in vivo* antifungal properties, *viz.*, strong fungicidal action, long shelf-life, its tolerability of heavy inoculum density, thermo stability, broad range of antidermatophytic activity and absence of any adverse effects. Curcumin obtained from the turmeric rhizome (*Curcuma longa*) have shown to possess the ability to protect the skin from harmful UV-induced effects by displaying anti-mutagen, antioxidant, free radical scavenging, anti-inflammatory and anti-carcinogenic properties [39].

Curcumin prevents drug resistance: The Curcumin is a potent drug resistance preventer. It exhibits novel ability to prevent the up-regulation of P-glycoprotein and its mRNA induced by adriamycin (ADM). The prevention capacity is also functionally associated with the elevated intracellular drug accumulation and parallel enhanced ADM cytotoxicity [40].

Synergistic effect of Curcumin: Curcumin is known for its Synergistic effect as well. Curcumin (CCM) and Docosahexaenoic acid (DHA) are dietary compounds known to antagonize breast cancer cell proliferation. This study reveals that these compounds in combination exert a variable antiproliferative effect across multiple breast cell lines, which is synergistic in SK-BR-3 (Human Breast Cancer Cell Line) cells. DHA enhanced cellular uptake of CCM in SK-BR-3 cells without significantly enhancing CCM uptake in other cell lines. The combination of DHA and CCM is potentially a dietary supplemental treatment for some breast cancers, likely dependent upon molecular phenotype. DHA enhancement of cellular curcumin uptake is one potential mechanism for observed synergy in SK-BR-3 cells; hence, an event unique to the combined presence of the two compounds [41]. Human pancreatic carcinoma cell lines BxPC-3 and Panc-1 were obtained from American Type Culture Collection (Manassas, VA, USA). Authors observes that both curcumin and garcinol significantly ($P < 0.05$) reduced cell viability in both cell lines in a dose-dependent manner. Garcinol-(upper panel) or curcumin-(lower panel) treated cytosolic extracts were used to evaluate induction of apoptosis in PaCa cells. BxPC-3 and Panc-1 using ELISA-Histone DNA Enrichment Assay. Results demonstrate a significant dose-dependent increase in

apoptotic cells in individual treatment with either agent for 48 hours. Enrichment factor was measured using subtraction of background signal. $*P < 0.05$ relative to control. This study shows the synergistic effect between curcumin and garcinol in pancreatic cancer cells [42]. This *in vitro* study is carried out on human multiple myeloma cell line U266 by Ghoneum and Gollapudi [43] to investigate the synergistic apoptotic potential of arabinoxylan rice bran (MGN-3/Biobran) and curcumin (turmeric) in USA. This synergy was characterized by an 87% decrease in cell number and a 2.6 fold increase in the percentage of apoptotic U266 cells. Cell cycle analysis has showed a 53% decrease in the percentage of cells in the G0-G1 phase treated with MGN-3 and curcumin (from 36% to 17%). Analysis of the expression of the pro and antiapoptotic molecules Bax and Bcl-2 revealed synergistic effects of these agents, as the expression of Bcl-2 was decreased and Bax was increased. This resulted in a cellular microenvironment favourable for apoptosis. Authors concluded that MGN-3 and curcumin synergize in the induction of U266 cell apoptosis.

Discussion

Turmeric (Haridra) is explained extensively and well documented for its therapeutic efficacy in Indian material medica. The genus of this plant is *Curcuma*. Haridra is belonging to Scitaminae family. Haridra is widely used in cosmetology as well. In GIT disorders, it is consider to be best antihelmintic and useful in IBS. In Respiratory disorders like bronchitis, rhinitis, sore throat and cough Haridra is said to be the best herb. Acharya Charaka has explained Haridradi dhumvarti (fumes wick) in the condition like asthma and congestion. Curcumin is observed as a best anti-inflammatory agent in many of the research works. Acharya Charaka has mentioned Haridra with amla juice and honey in all types of prameha. Haridra has already been proven clinically for its anti-diabetic activity. Haridra is observed to decrease several risk factors like cholesterol, triglycerides, and free-radical damage. Dr. Gyanendra Pandey in Dravyaguna Vijnana Part1 has explained that the powder of the rhizome mixed with amla juice is useful in jaundice. Corriilyum (Anjana) with Haridra, Red ochre (Gairika), and Amalaki (*Embllica officinalis*) cures jaundice. The ethanolic extract of *Curcuma Longa* rhizomes has significant hepatoprotective effect when orally administrated. It is ought to be one of the best anti-oxidant. Curcuma oil believed to reduce the ill effect of ischemia by attenuating nitrosative and oxidative stress. Induction of apoptosis in sequential fashion was reverse significantly by Curcuma oil. So there is an evidence for the high efficacy of Curcuma oil as a neuroprotective. Curcumin has demonstrated the chemopreventive properties in cell cultures, animal models and human investigations. Curcumin is considered to possess anti-cancer activities via its effect on a variety of biological pathways involved in mutagenesis, oncogene expression, cell cycle regulation, apoptosis, tumorigenesis and metastasis. It has also shown anti-proliferative effect in multiple cancers. Curcumin is used to inhibit systemic anaphylaxis *in vitro* and anti-DNP immunoglobulin E (IgE)-mediated passive cutaneous anaphylactoid response *in vivo*. Curcumin is a potent drug resistance preventer. It exhibits novel ability to prevent the up-regulation of P-glycoprotein and its mRNA. Curcumin is known for its synergic effect as anti-cancer agent. Curcuma longa rhizome is used as a Folk medicine in U.P., Bihar and West Bengal for cough, cold, and loose stools. The efficacy of Haridra is well known worldwide as a curative as well as preventive measure.

Conclusion

In the light of above facts, it can be concluded that the Turmeric (Haridra) has a lot of potentials when it comes to its medicinal usage

Turmeric has a broad spectrum actions with certain effects and is beneficial for long term and daily usage. Turmeric is an auspicious beauty agent, daily applied on the forehead by Hindu females. Turmeric is the household spice for diverse cuisines in all parts of India since many centuries. Generally the rhizome powder of Turmeric is used as a spice all over India but only a few people are aware of its therapeutic properties. Turmeric is regarded as one of the best drug in many diseases like Diabetes, Skin diseases etc, which is in use since ages owing to its multiple pharmacological activities. Turmeric is enriched with many useful phytoconstituents which are responsible for its efficacy. Curcumin is one such phytoconstituent, a nutraceutical substance with numerous pharmacological activities proven experimentally and clinically. It has been established beneficial in treating Anti-inflammatory, Anti-allergic, Anti-oxidant, Anti-hyperglycaemic and Anti-cancer properties. Till date many researches have been carried out on the medicinal effects of Turmeric, this review will give a new impetus to utilise turmeric in various disorders.

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