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Phytochemicaland pharmacological properties of Curcuma longa Linn: A review

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Abstract---Turmeric is the rhizomatous, herbaceous, perineal plant having many traditional and medicinal uses. Traditionally turmeric was used for spices in food and traditional system of medicine as like Ayurvedic system of medicine, Siddha system of medicine, Unani system of medicine, Chinese System of medicine for the purpose of anti-microbial, antiseptic, anti-oxidant and in mild digestive problems.Turmeric consists wide variety of phytochemicals such as Demethoxycurcumin (DMC), Bis-Demethoxycurcumin (BDMC), Zingiberene, cumarin, cumarinol, turmerin, turmerone, turmironol, and other many components. Among them DMC & BDMC are responsible for yellow colour of turmeric. For the medicinal use, extraction is done by steam distillation, soxhlation, ultrasonic assisted extraction, enzymatic extraction, microwave assisted extraction. Thus, extracted components are separated and purified and use according to their pharmacological activities like anti-septic, anti-oxidant, anti-microbial, antifungal, anti-inflammatory, anti-mutagenic and anti-carcinogenic etc.

Keywords---anti-septic, soxhlation, demethoxycurcumin, bisdemethoxycurcumin, perineal, anti-oxidant.

Introduction

Turmeric isan herbaceous tropical perennial plant;it is obtained from the rhizomes of *Curcuma longa Linn* belonging to family Zingibereceae. Traditionally curcuma was used in food as spice, natural colouring agent and as traditional system of medicine [1]. As being used in traditional system of medicine, it become more preferred in treatment of many diseases because of its familiar faith that

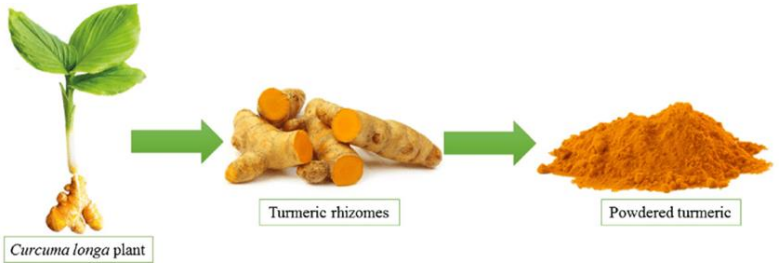
having less adverse effect, easy availability and cheap as compared to synthetic chemicals [2].Plant's height is about 50-80cm, having short stem, elongated leaves, and rhizomes are thick and short. For its cultivation hot and moist having well water supply is necessary. Traditionally use as spices and some religious ceremony. From ancient use to modern times, it is claiming that the *Curcuma longa Linn* is very useful because of its multi-properties, related to its social, cultural, folk and classical art and religious along with medicinal and cosmeceutical uses[5]. Turmeric has a long history of medicinal uses in South Asia specially in India, Nepal, China, Bangladesh. There are 133 species of curcuma have been identified worldwide[7]. Different parts of Turmeric such as, root, bark, leaves, flowers, rhizomes can be used for medicinal and traditional purposes [8].

Taxonomical Classification

Kingdom:	Plantae
Sub-Kingdom:	Tracheobionta
Super division:	Spermatophyta
Division:	Magnoliophyta
Class:	Liliopsida
Sub-Class:	Zingiberidae
Order:	Zingiberales
Family:	*Zingiberaceae*
Genus:	Curcuma
Species:	*Curcuma Longa*

(a) Whole plant of Turmeric. (b)Dried rhizome and powdered form of Turmeric, (c) Curcuma longa Plant, Rhizomes and its Powder.

Phytochemical Study



For the study of Phytochemical properties of Turmeric, Extraction of Turmeric is important. According to the extraction procedure and solvent used in extraction may vary the constituents presents. In this the comparative study was done between *Curcuma angustifolia, Curcuma decipinens, and Curcuma longa Linn* with methanolic extract *by*Gas Chromatography and Mass spectroscopy. The result was found that *Curcuma angustifolia*having34 phytochemicals, *Curcuma decipinens*were found having 63 Phytochemicals and *Curcuma longa Linn*were having 53 Phytochemicals [2]. Was reported by Neeranjana Mehra and Dr. Kumar Jain in study of Comparative Phytochemical screening of *Curcuma angustifolia, Curcuma decipinens, and Curcuma longa Linn*by using GC-MS.The different 46 components of curcuma were identified and separated from the rhizome of Curcuma longa powder by the extraction through Hydro distillation in Clevenger apparatus [3]. S. Balaji et. al., studied 200 chemical constituents and reported their toxicity prediction (such as Human hepatotoxicity, rodent carcinogenicity, and bacterial mutagenicity).

Among 200 chemical constituents, 64 compound were reported as hepatotoxic, 136 were predicted as mutagenic, 153 compound were predicted as carcinogenic and 184 compound were predicted as toxigenic. Out of 200 constituents 16 compound were found and predicted as non-carcinogenic, non-hepatotoxic, non-mutagenic and having very less side effects. Firstly 200 chemical constituents were identified according to their classifications as like, Bisabolane type (ST) sesquiterpenoid, Cadalene type ST, Cadinane & Furanocadinone type ST, Carabrane type ST, Curcumane type ST, Dimeric Phenylpropane derivation, Diphenyl Heptanoid, Diphenyl pentanoid, Elemane type ST, Eudesmane and furanoeudesmane type ST, Germacrane type ST, Guaione type ST, Monomeric phenylpropane derivative, Monoterpenoids, Sesquiterpenoid dimer, sesquiterpenoid and Miscellaneous.The non-carcinogenic, non-mutagenic, non-hepatotoxic properties showing chemical constituents are as follows: -

Bisabolane type ST

-1,3,5,11-bisobolatetraene, 3-Hydroxyl-1, 10-bisabolidiene-9-one, ar-turmerone, Biscurone, bisacurone epoxide, (A, B & C), Turmeronol B.

Carabrane type ST: - 4S-Dihydrocurcuminone.

Diphenyl Heptanoids

(E) 1,7 diphnyl-1-hepten-5-one, (E) 1,7-diphnyl-1-hydroxy-1-hepten-5-one.

Guanine type ST

-Zedoaronediol, Isozedoarondiol, Zedoarondiol.
Rest of the chemical constituents except these 16 compounds, all have activity either carcinogenic, hepatotoxic, and mutagenic properties.

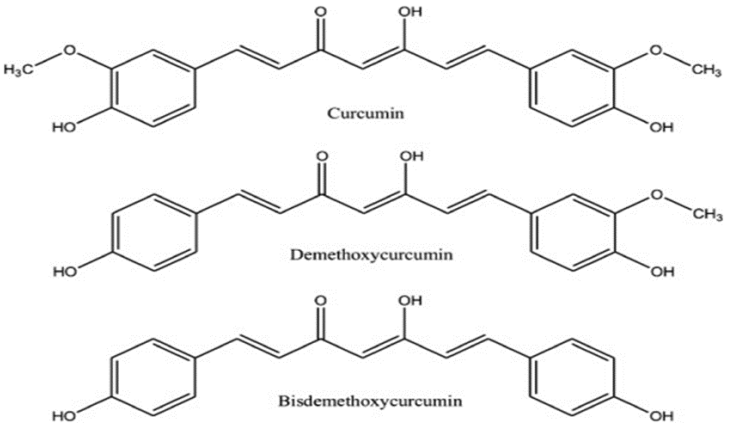


Fig: - Chemical Structure of Curcumin (I-III)

Pharmacological Activity
Antifungal Activity

Dermatophytosis (Dermatomycosis, Ring worm), is most common type of fungal infection occurs in human. Disease caused by Keratinophilic Fungi is called Dermatophytes.It causes fungal disease of skin, nail and hairs. Dermatophytes are of three types on the basis of ecology.

- Geophilic- Transmitted from Soil to Human
- Zoophilic- Transmitted from Animal to Human
- Anthrophilic- Transmitted from Human to Human

For the study of anti-fungal study in-vitro test was done and observe that have minimal inhibitory concentration. From this study it is concluded that the crude curcumin has very less anti-fungal activity and it's extracted oil can inhibit fungal infection. The essential oil extracted from the root of curcuma longa is then observed for anti-fungal property and was identified that the essential oil of curcumin can be used as fungicidal in food for the inhibition of fungal contamination. It acts by disrupting plasma membrane and mitochondrial disfunction[3]. [thiswas reported by Amphawan Apisariyakul et al. study Antifungal activity of turmeric oil extracted from *Curcuma longa*]. Raw powder of Turmeric has polyphenolic compound (Curcumin) which works as anti-fungal activity against *Aspergillus* sps. &*Fusarium*sps. [Table 1 and 2]. Curcuma show inhibitory effects against themwith methanolic extract [4].

Antifungal activities and its efficacy of Turmeric essential oil against fungus *aspergillus flavus* in-vivo (by fungus grown on maize) and invitro (aflatoxin production) study was done. In in-vivo, maizes were placed with 10µL ofspore suspension containing 10^6 spores/ml of *Aspergillus flavus*and 4µL/ml concentration of Turmeric essential oil was administered and observed at 5 days [Table 3]. In case of invitro study, aflatoxin (mixes of four types of aflatoxin such as AFG_2, AFG_1, AFB_2, and AFB_1) were produced in YES medium, after incubation period of 5 days, inhibition rate of Turmeric essential oil was calculated (table). From this study it was reported that Turmeric essential oil have good inhibitory

activity specially against AFB_1 production. Inhibitory activity was directly proportional to dose of Turmeric essential oil [Table 4] [6].

Table 1
Zone of inhibition against *aspergillus* species

S. N	Concentration of extract (Inmg)	Zone of inhibition(in mm)
1.	5 mg	2.0mm
2.	10mg	2.5mm
3.	15mg	7.5 mm
4.	20mg	8.0 mm

Table 2
Zone of Inhibition against *Fusarium* Species

S. N	Concentration of extract (in mg)	Zone of inhibition (in mm)
1.	5mg	2.0 mm
2.	10mg	2.5 mm
3.	15mg	3.0 mm
4	20mg	3.5mm

Table 3
Amount of *Aspergillus Flavus* Decreased

	Before Turmeric E.O administered.		After Turmeric E.O administered	
	Percentage of Contamination	Amount of AFB_1	Percentage of Contamination	Amount of AFB_1
	74.30%	116.30 µg/Kg	7.48%	7.76 µg/Kg

Table 4
Inhibition rate of Turmeric Essential Oil

S. N	Concentration of Turmeric E. O	Percentages of Inhibition
1	2 µL/ml	34.6%
2	4 µL/ml	58.5%
3	8 µL/ml	78.4%

Wound healing properties

Adiliana* et. al reportedthe wound healing properties of curcuma longa, the turmeric gel was extracted and the in-vivo preclinical experiment was done over group of 12 female rabbit.The rabbit was injured at peritoneal area with different length of wound. The turmeric extract gel was made up of different concentration as like 5%, 10% and 15% and the gel bases was used as blank. Turmeric gel extract was applying twice a day as morning and evening. The experiment was observed for 21 days and length of wound was used to measure and observed on 3rd, 7th, 14th and 21th days. In this experiment, 5% turmeric gel extraction was found to be of good efficacy. 5% turmeric gel extract was healed the wound <14 days and was found as of good efficacy than 10% and 15% concentration [6].

Anti-inflammatory activities

The molecules and enzymes involved in process of inflammations such as phospholipase, lipoxygenase, cyclooxygenase, cyclooxygenase-2, leukotrienes, collagenases, prostaglandins, nitric oxide. The turmeric has many components having medicinal properties as like as cumarin, curcumin, demethoxycurcumin, bis-demethoxycurcumin which were concluded that they have activity of inhibition of components involved in inflammationthat is why authors had concluded that Turmeric has anti-inflammatory activities and is safe in human [16]. Curcuma containing curcumin inhibit 5-lipoxygense activity in Rat long with that it inhibits 12-lipoxygenase & cyclooxygenase in platelet in human. Curcumin inhibits prostaglandin and gluco-corticosteroids synthesis (which re responsible for inflammation cause) by interfering cyclooxygenase. [15]. [Reported byH.P.T. Ammon et.al., in study Mechanism of anti-inflammatory actions of curcumine and boswellic acids].

For some abnormal condition of health such as atherosclerosis, high cholesterol, TG, age, genes etc are responsible, to prevent this risk by reducing inflammation authors had studied the anti-inflammatory activity of *Curcuma longa* on Vascular Smooth Muscle Cell (VSMC) and on Proliferation of mononuclear blood cells. This study showed that curcumin has an anti-proliferative effect on vascular SMC and mononuclear blood cells [13]. Curcumin has COX-I, COX-II enzyme inhibitory activity. in case of COX-I,at 125µg/ml of Curcumin-I, Curcumin-II, and Curcumin-III having 32%, 38.5% and 39.2% inhibition of enzyme respectively and in case of COX-II, at 125µg/ml of Curcumin-I, Curcumin-II, and Curcumin-III enzyme inhibition was found to be 89.7%, 82.5% and 58.9% respectively [17].

Anti-cancer activity

Turmeric extracts are cytotoxic to normal human lymphocytes, leukemic cells. The turmeric extract with benzene as solvent was found to be most toxic and extraction with water as solvent has minimal activity. But the extract of turmeric was found to be potential anti-cancer agent. The curcumin was major component which was able to inhibit the formation of tumour in tested animal. An essential volatile oil extracted from turmeric was less effective than curcumin for bactericidal activities. Exact mechanism of action of curcumin against cancer is unknown and is under study yet but is doubtfully believed that it interferes with the nucleic acid formation, spindle fibre formation after administration. Curcumin extracted (benzene extraction were most cytotoxic) from turmeric rhizomes was evaluated using invitro by tissue culture and in-vivo in mice using Dalton's lymphoma cells. Curcumin was reported as having inhibitory activities against cancer cell in Chinese hamster (a types of Chinese mouse) ovary at concentration of 0.4µg/ml (of curcumin) and was seen inhibitory against Dalton's lymphoma cell.

At the same concentration (0.4µg/ml), 1 million Dalton's lymphoma cells were given through intraperitoneal for 10 days. After 30 and 60 days of administered Dalton's lymphoma cell, the number of survived animals were reported, then studied that the turmeric extract was found to be cytotoxic[18]. Another study reported that the Curcumin-I, curcumin-ii,curcumin-iii (curcumin,

demethoxycurcumin and bisdemethoxycurcumin) extracted from turmeric were reported as cytotoxicity. The study of curcumin against cytotoxic cell were studied and evaluated by NCI (national cancer institute) using different cancerous cell line, 60 cell line consisting cell panel. The turmeric chemical constituents were examined for cytotoxicity. NCI evaluated curcuma i-iii (curcumin, demethoxycurcumin and bisdemethoxycurcumin) invitro using various cancerous cell line for cytotoxic activity.

The efficacy of test compound and percentage growth was measured using NCI's protocol. Curcumin-iii was reported as having good cytotoxicity activity against MOLT-4 and SR cell line. Curcumin-I was reported as having excellent activity against leukaemia cell line[19]. In another study, the effect of *Curcuma longa* Linn on topical cancer treatment was studied with direct ethanolic extract and ointment of *Curcuma longa* and its chemical constituents were tested in cancer therapy as topically applying agent. In case of external or topical cancerous lesion, in this study reduction in itching and skin allergy was found to be good in almost cases observed effective in 70% of cases and in case of reduction in size and pain of skin lesion with approximately 0.5% concentration of curcumin were used and effectiveness wasfound to be quite effective as 10%[20].

Anti-bacterial activity

According to the study of turmeric it was found that it has many pharmacological activities. In this study the antibacterial activities of Homemade Turmeric and some Open market reputed branded Turmeric powder were compared and was concluded that the homemade Turmeric was rich in phytoconstituents (such as Flavonoids, Terpenoids, Glycosides etc). Homemade powder had the largest quantity of curcumin as compare to other marketed product of turmeric. Ethanolic extract of Turmeric (Curcumin) was used against bacteria like *Escherichia Coli* and *Staphylococcus aureus*. The zone of inhibition of homemade turmeric against *Escherichia Coli* and *Staphylococcus aureus*was found to be 17.07 ± 0.27 and 17.03 ± 0.30 respectively. In this Antibiotic Erythromycin (15µg/disc) was used as standard whose zone of inhibition was ranging from 15.50±0.25 to 23.58 ±0.538[9].Another study was done for the synergistic effect of turmeric with Chitosan against multidrug resistant (MDR) activity of bacteria. The turmeric extract with chitosan was found to have synergistic properties to MDR bacteria [10]. [It was reported by R. Ghotaslou et. al., in study Synergistic effect of Turmeric aqueous extract & Chitosan against Multidrug Resistant Bacteria]

Curcuma for treatment of Arthritis & Osteoarthritis

Osteoarthritis is the condition in which the destruction and breakdown of joint cartilage, ligament, joint lining and underlying bone. It is commonly occurring in older people in all types of joint but specially seems symptoms in knees joint, toes joint, hands and spinal joints. Arthritis is characterized by the accumulation of the uric acid in the joint and synovial cavity of joint by disturbing synovial fluid and disrupting joint and the movements of joint occurs. Usually, the medication used for the treatment of knee treatment are NSAIDS, which act by Inhibition of Prostaglandin synthesis via COX-I & COX-II enzyme. Regular use of NSAIDS have side effect on Kidney, Liver, & GI. Whereas the authors [Pinsornak P*, Niempoogs

MD*, The efficacy of *Curcuma longa* Linn extract as an adjuvant therapy in primary Knee Osteoarthritis: A Randomized Control Trial] found and reported that the adjuvant treatment of Osteoarthritis with NSAIDs (Diclofenac) and curcumin has potential beneficial effect as compare to monotherapy of NSAIDs [7]. [Reported by Pinsornak P*, Niempoogs MD*]. in another study, the amount of curcuminoid were studied in crude curcumin extract. Essential oil depleted and purified turmeric fraction

Anti-Oxidant Activity

Turmeric anti-oxidant protein (TAP) was isolated from aqueous extract of *Curcuma longa Linn,* TAP is heat stable protein (e.g., Trypsin), which shows anti-oxidant activity. The turmeric anti-oxidant protein found in Turmeric is made up of concentration 50µg/ml showed 50% inhibitory activity. Ca^{2+} ATPase in Brain of Rat was protected by about 50% of initial activity [10]. [It was reported by R. Selvam et. al., in study the anti-oxidant activity of turmeric (*Curcuma longa*)]. The liposome peroxidation was inhibited by Curcumin-I (Demethoxycurcumin), Curcumin-II (Monodemethoxycurcumin), And Curcumin-III (Bisdemethoxycurcumin) at 100µg/ml were 58%, 40% and 20% respectively. This assay is done using liposome oxidation assay using fluorescence spectroscopy [13]. [it was reported by R. S. Rarnsewak et. al., in study Cytotoxicity, antioxidant and anti-inflammatory activities of Curcumins I-III from Curcuma longa]. The ethanolic extract of Turmeric, Cinnamomum, and Ginger was studied for antioxidant activity. The anti-oxidant activity was evaluated by measuring ferric measuring anti- oxidant Power (FRAP), The ethanolic extract of *Curcuma longa* was found as anti-oxidant with FRAP value 0.38mM/100gm [14]. *Curcuma longa*consist curcuminoids (Curcumin,desmethoxycurcumin, Bismethoxycurcumin) which are rich in antioxidants [15].

Turmeric extract for flavour masking

Turmeric extracts are used in food industry for flavour and taste masking in food industry. Microencapsulation and physiochemical properties of turmeric extracts are prepared by a binary blending of materials, i.e.,Brown rice flour (BRF) and beta-cyclodextrin. The constituents found in turmeric are having pungent aroma and yellow colour, because of these the masking of taste and flavour is occurs on which the application is done. For the taste masking, microencapsulation is done with the purpose of preventing evaporation and degradation of active compound which are enclosed inside. Encapsulation prevent of unpleasant odour or taste and provide good bioavailability of the medicament. For example, brown rice contains more dietary fibres, anti-obesity and anti-diabetic than white rice. For reduction of unpleasant odour, beta-cyclodextrin are beneficial. Flavour masking help to protect evaporation of active ingredients, prevent from reaction and migration, provide barrier between two reactive bioactive chemical compounds, and external environment. Flavour masking stabilises food and increase bioavailability of active compounds[23].

Conclusion

According to the data obtained in this study of curcuma longa, it can be express that the intake of turmeric in normal quantity in daily basis is beneficial to our health. Because the turmeric extracts have various types of chemical constituents having different pharmacological properties along with other health benefits. It has been seen that turmeric extract have pharmacological activities as like antimicrobial, anti-bacterial. Anti-fungal, anti-cancer, anti-inflammatory. From this study, it is concluded that the turmeric is medicinally Important plant and also can be defined as novel medicinal plant in future.

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